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LICO 500

USER MANUAL

March 2007 Edition 1

sd/sk

Table of contents

Table of Contents

Section 1 Specifications

Specifications are subject to change without notice.

Performance specifications	
Operating mode	Color measurement, color difference measurement, Absorbance and Concentration
Colorimetric evaluation	All color values calculated for standard illuminant C of ASTM E 308 and a 2°standard observer.
Source lamp	Gas-filled Tungsten (visible)
Wavelength range	320–1100 nm
Wavelength accuracy	± 1.5 nm (wavelength range 340–900 nm)
Wavelength reproducibility	≤ 0.1 nm
Wavelength resolution	1 nm
Wavelength calibration	Automatic
Wavelength range for color measurement	380 to 720 nm step 10 nm
Scanning speed	≥ 12 nm/s (in steps of 1nm)
Spectral bandwidth	5 nm
Photometric measuring range	± 3.5 Abs (wavelength range 340–900 nm)
Photometric accuracy	5 m Abs at 0.0 to 0.5 Abs 1% at 0.50 to 2.0 Abs
Photometric linearity	< 0.5% to 2 Abs < = 1% at > 2 Abs with neutral glass at 546 nm
Stray light	< 0.1% T at 340 nm with $NaNO_2$
Data log	500 color measurements, 50 color reference values, 500 photometric measurements, 20 wavelength scans, 20 time scans
Physical and environmental specifications	
Width	368 mm (14.5 in.)
Height	144 mm (5.7 in.)
Depth	359 mm (14.1 in.)
Weight	6.4 kg (14.11 lb)
Operating requirements	10–40 °C (50–104 °F), max. 80% relative humidity (non-condensing)
Storage requirements	–40–60 °C (-40–140 °F) max. 80% relative humidity (non-condensing)
Additional technical data	
Mains connection	External power supply: 100-240V/50-60Hz (Input); 15V/30VA (output)
Interfaces	Use only screened cables with maximum length of 3 meters. 1 x USB type A 1 x USB type B
Enclosure rating	IP3X
Protection Class	Class II

Section 2 General Information

2.1 Safety information

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger, warning and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To make sure that the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that specified in this manual.

2.1.1 Use of hazard information

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

Important Note: *Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.*

Note: *Information that supplements points in the main text.*

2.1.2 Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol, if noted on the instrument, will be included with a danger or caution statement in the manual.

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of life equipment to the Producer for disposal at no charge to the user. ***Note:*** *For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories and all auxiliary items for proper disposal.*

2.1.3 Chemical and Biological Safety

DANGER
Potential Chemical/ Biological Exposure Hazards. Handling chemical samples, standards and reagents can be dangerous. Users of this product are advised to familiarize themselves with safety procedures and the correct use of chemicals, and to carefully read all relevant Material Safety Data Sheets.

Normal operation of this instrument may involve the use of hazardous chemicals or biologically harmful samples.

• The user must observe all cautionary information printed on the original solution containers and safety data sheet prior to their use.

• All waste solutions must be disposed in accordance with local and national law.

• The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

2.2 Overview of product

The LICO 500 is a VIS spectrophotometer with a wavelength range of 320 to 1100 nm. The instrument comes with a complete set of application programs and multi-language support.

The LICO 500 contains the following application modes: Color scales (pre installed), Single Wavelength Mode, Multi-Wavelength Mode, Wavelength Scan and Time Course Mode.

The LICO 500 provides digital readouts in direct concentration units, absorbance or percent transmittance.

The LICO 500 can carry out an exact colorimetric evaluation in conformity with ISO/ASTM standards with just a single measurement and display the result in terms of traditional color systems such as Iodine, Hazen or Gardner color numbers.

Besides the 20 color indexes, transmittance and absorbance can be measured at individual wavelengths, so that the LICO 500 can also be universally used for analytical purposes in the laboratory.

Section 3 Installation

WARNING
Electrical and Fire Hazards. Use only the provided power supply. Only qualified personnel should conduct the tasks described in this section of the manual.

3.1 Unpack the instrument

The LICO 500 comes packaged with the following items:

- LICO 500
- Dust cover
- External power supply, including 4 adapter for EU, UK, USA and AUS/China
- LICO 500 user manual
- Quick start guide LICO 500

Note: *If any of these items are missing or damaged, contact the manufacturer or a sales representative immediatly.*

3.2 Environment considerations

The following conditions are necessary to make sure correct instrument operation and accurate results:

- Place the instrument firmly on an even surface. Do not push any objects under the instrument.
- Maintain an ambient temperature of 10 to 40 ºC (50 to 104 ºF) for proper instrument operation.
- The relative humidity should be less than 80%; moisture should not condense on the instrument.
- Leave at least a 15 cm (6 in.) clearance at the top and on all sides for air circulation to avoid overheating of electrical parts.
- Do not operate or store the instrument in extremely dusty, damp or wet locations.
- Keep the surface of the instrument, the cell compartment and all accessories clean and dry at all times. Splashes or spills on and in the instrument should be cleaned up immediately (see section 7.1 on page 85).
- After a continuous operating time of more than 24 hour without switching off the instrument we recommend to perform a new calibration with a distilled water cuvette/sample cell.
- After a continuous operating time of more than 7 days without switching off the instrument we recommend to switch off and on the instrument to perform a new system check with filter adjustment and lambda-calibration

Important Note: *Protect the instrument from temperature extremes, including heaters, direct sunlight and other heat sources.*

3.3 Power connections

Install the correct adapter plug on the supplied external power supply (Figure 1). Slide the adapter on until it "clicks" into position. Plug the external power supply cord into the connector on the back panel of the instrument, then plug the supply into a power outlet (100–240 V~ / 50–60 Hz). Press the power switch on the back of the instrument to initialize power (Figure 2 on page 11).

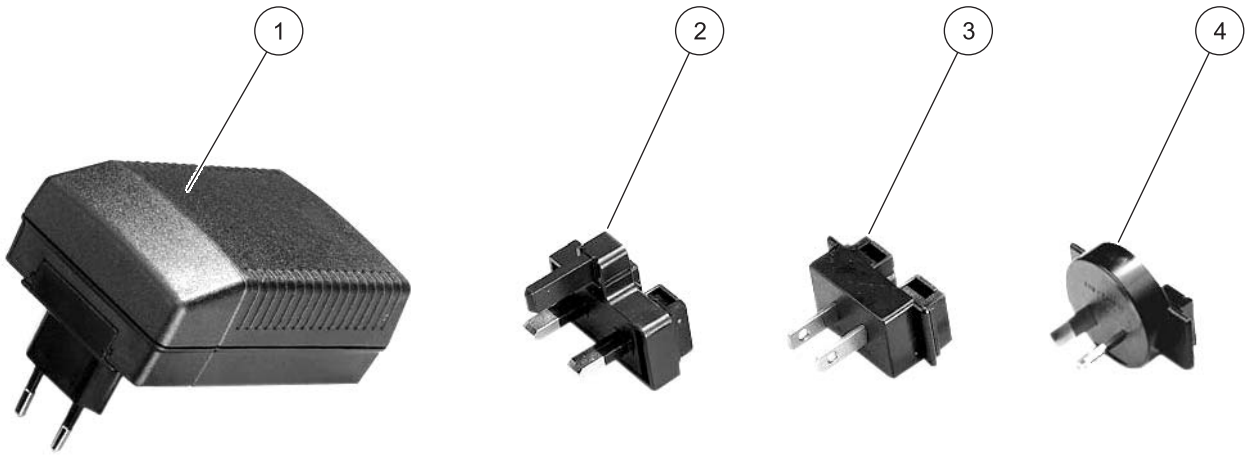


Figure 1 Power adapter

1	Power supply with EU adapter plug installed	**3**	USA adapter plug
2	UK adapter plug	**4**	AUS/China adapter plug

3.4 Interfaces

The LICO 500 has two USB interfaces as a standard feature, located on the back of the instrument (Figure 2). The USB Type A interface is used for communications with a printer, USB memory stick or keyboard. A USB memory stick is used to update instrument software.

The USB Type B interface is used for communications with a PC. The optional Hach Data Trans software (see Section 9 on page 93) must be installed on the PC for this use.

A USB hub may be used to connect several accessories at a time.

Note: USB cables** must not be longer than **3 meters (10 feet).

These USB interfaces enable data and graphics to be output to a Printer and a PC and upgrade instrument software (see section 6.1.2 on page 76).

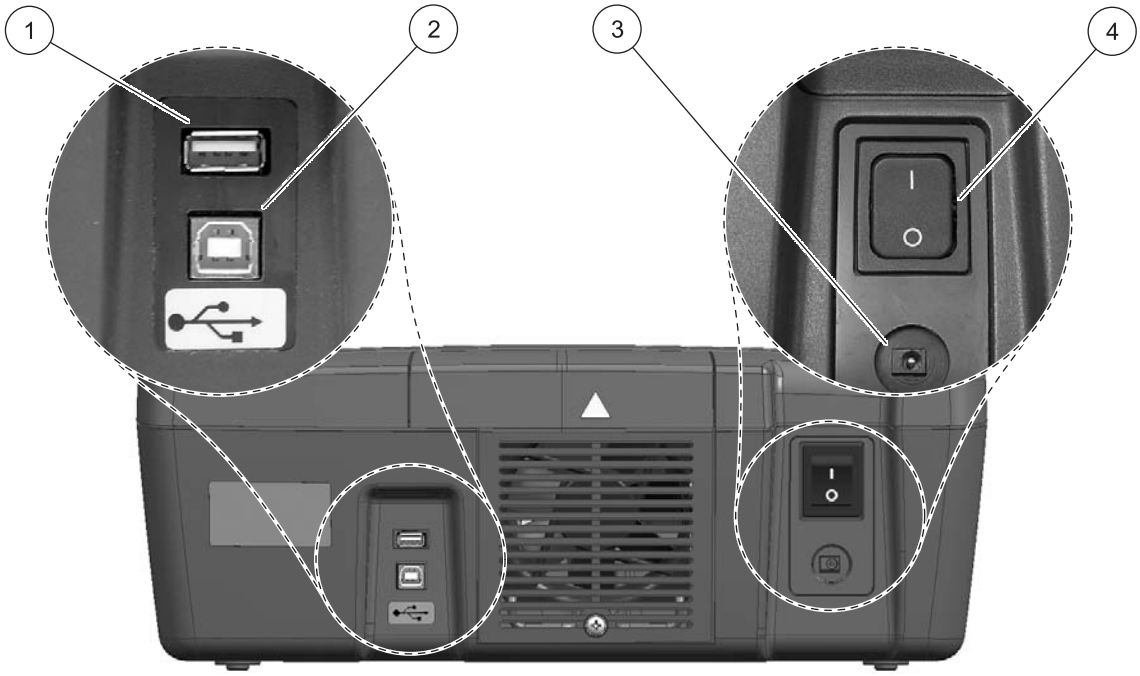


Figure 2 Interfaces

1	USB type A	**3**	Plug in power supply
2	USB type B	**4**	On/Off switch

3.5 Cell compartments and cell adapter

3.5.1 Cell compartments and adapter

The LICO 500 has two cell compartments (Figure 3). Only one cuvette/sample cell type at a time can be used for a measurement.

Cell compartment #1

- 11-mm round cuvettes/sample cells
  For measurements with 11mm round cuvettes/sample cells in cell compartment #1 insert the adapter Z into cell compartment #2.

Cell compartment #2

Cell compartment #2 uses adapters to accommodate different cuvette/sample cell types.

- 50-mm rectangular cuvettes/sample cells (can be inserted directly into the cell compartment without using an adapter).
- Adapter Z: 10-mm square cuvettes/sample cells

Important Note: *Be sure that the adapter Z is inserted proper into the cell compartment. Press the adapter down until it snap into the compartment.*

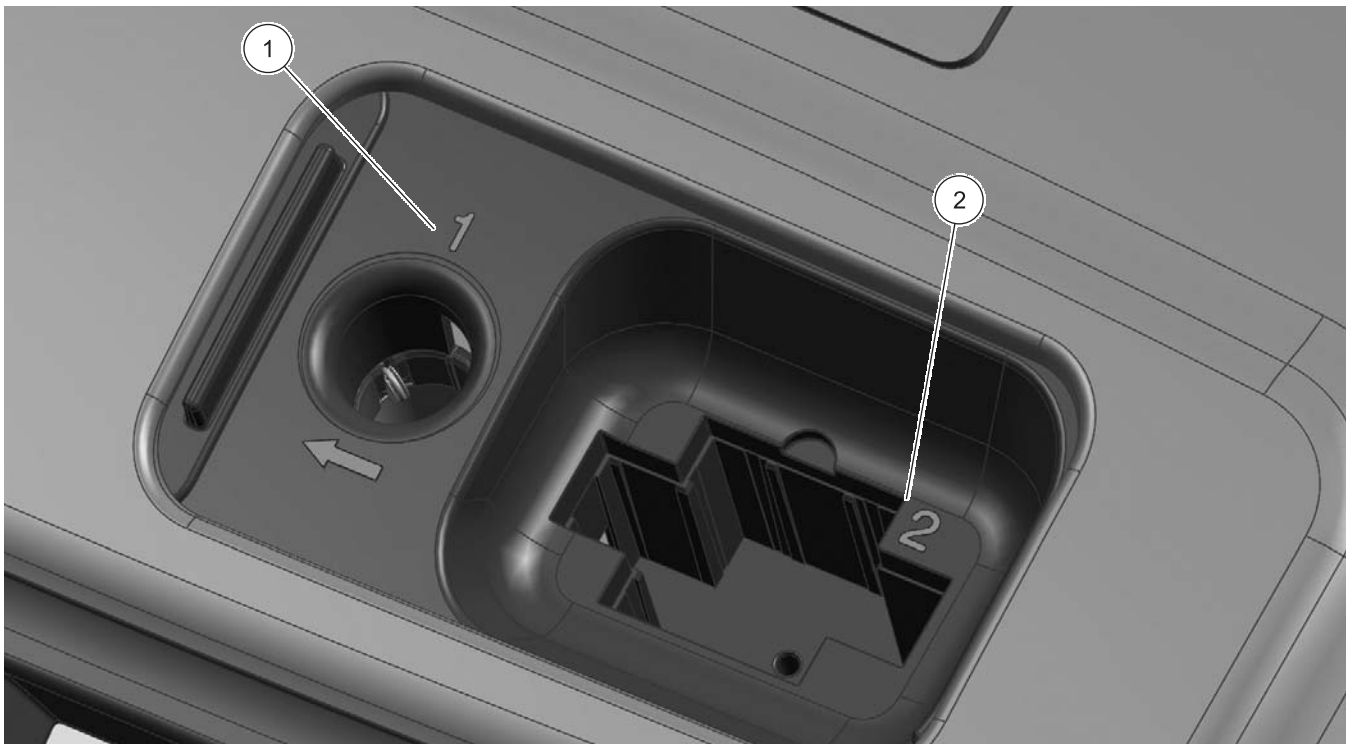


Figure 3 Cell compartments

1	Cell compartment #1	**2**	Cell compartment #2

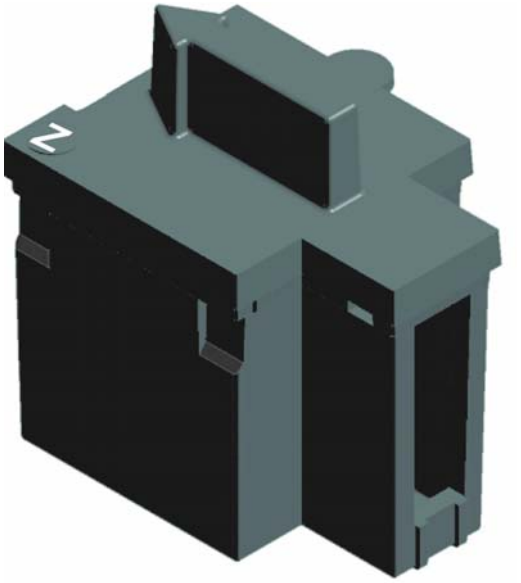


Figure 4 Cell adapter Z

1	Adapter Z: 10 mm square cell adapter

3.5.2 Installation of the cell adapter

1. Open the cell compartment.
2. Insert the adapter for measurements with the round cuvette/sample cell (11 mm) and/or 10 mm square cuvette/sample cell so the arrow on top of the adapter points to the left (Figure 4) and the orientation tab fits the groove in the compartment opening.

Note: *The arrow on top of the adapter indicates the direction of the light beam path.*

3.6 Beam path

Figure 5 shows the beam path of the LICO 500.

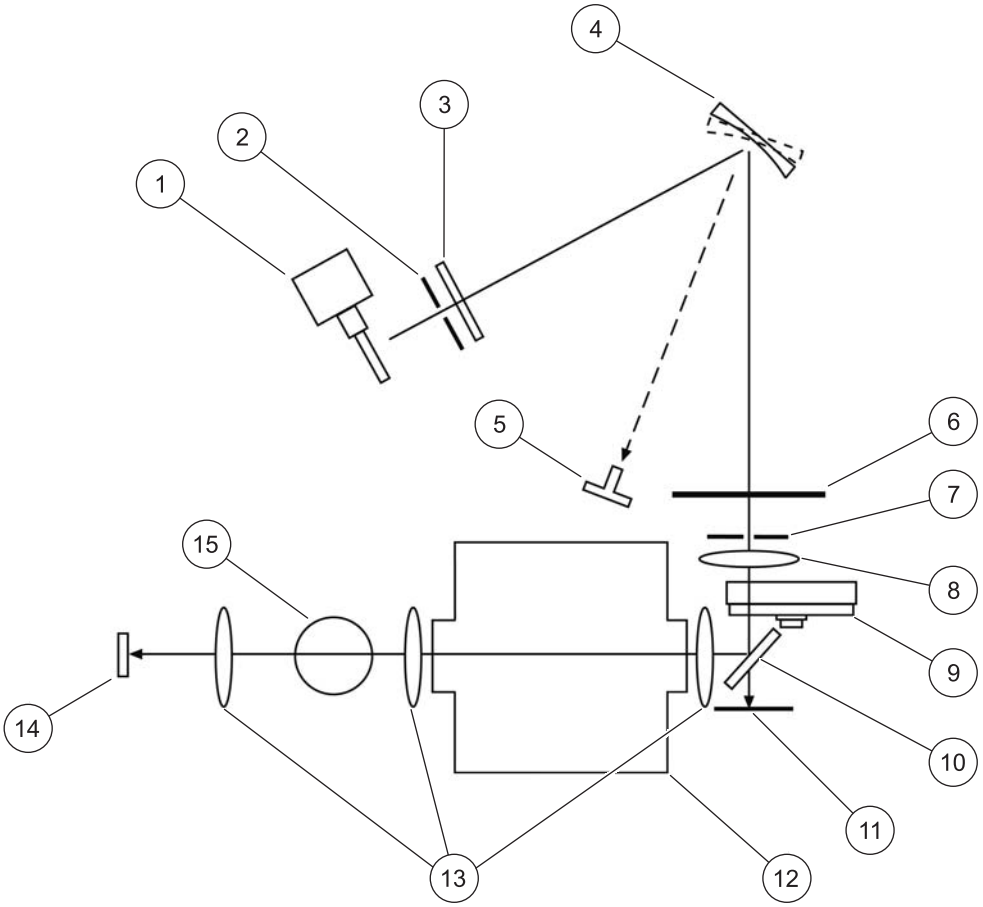


Figure 5 Beam path

1	Tungsten lamp	**9**	Filter wheel
2	Entrance slit	**10**	Splitter mirror
3	Heat-protection glass	**11**	Reference-element
4	Grating	**12**	Cell compartment #2
5	LED	**13**	Lens
6	Chopper	**14**	Measurement element
7	Exit slit	**15**	Cell compartment #1
8	Lens		

4.1 Power the instrument on and off

1. Plug external power supply into an electrical outlet.
2. Press the power switch on the back of the instrument to initialize power.

Note: *Do not turn the instrument off and on in rapid succession. Always wait about* ***20 seconds*** *before turning the instrument on again, otherwise the electronic and mechanical systems will be damaged.*

4.2 Language selection

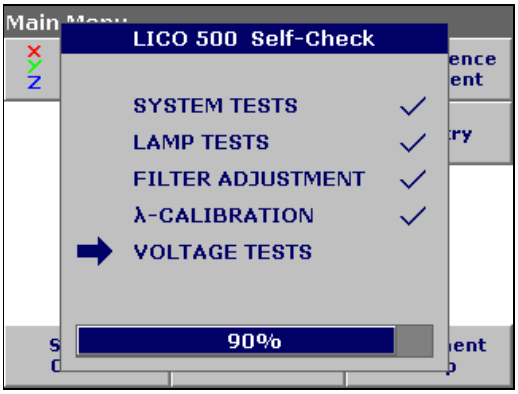
The LICO 500 software includes several language options. The first time the instrument is turned on, the language selection screen will appear.

1. Select the desired language.
2. Press **OK** to confirm. The self-check will start automatically.

Changing the language setting
The instrument functions in the selected language until the option is changed.

1. While turning the instrument on, touch the screen at any point until the list for selecting a language appears (about 30 seconds).
2. Select the required language.
3. Press **OK** to confirm. The self-check will start automatically.

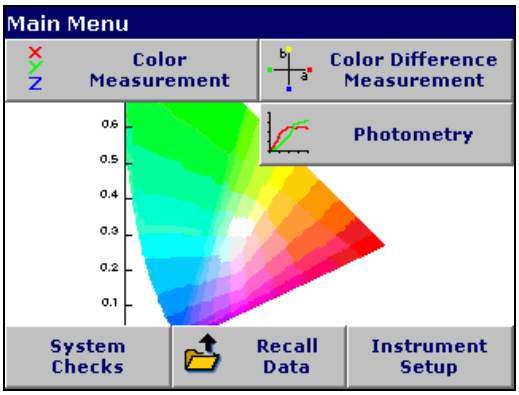
4.3 Self-Check



Each time the instrument is powered, a series of diagnostic tests are performed automatically to make sure operation of major system components.

This procedure, which takes approximately two minutes, checks the system, lamp, filter adjustment, wavelength calibration and voltage. Each test which functions correctly is confirmed with a check mark.

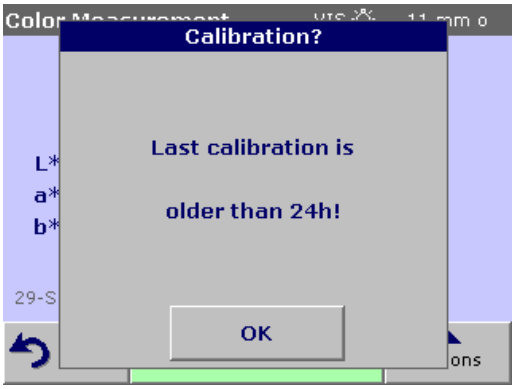
Note: *For further error messages during self-check, see* *Section 8 on page 91**.*



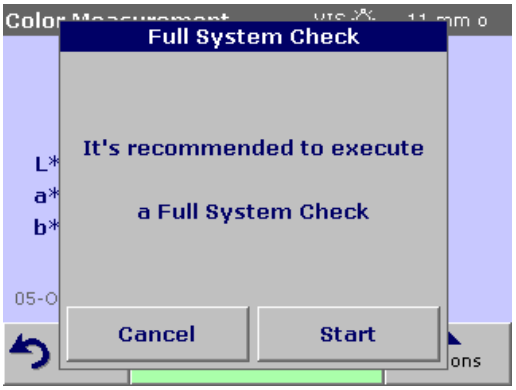
The Main Menu is displayed when diagnostics are completed.

See section 5.1.3 Main Menu on page 18 for a detailed description.

4.4 Characteristics in continuous operation



After a continuous operating time of more than 24 hour without switching off the instrument we recommend to perform a new calibration with a distilled water cuvette/sample cell.



After a continuous operating time of more than 7 days without switching off the instrument we recommend to switch off and on the instrument to perform a new system check with filter adjustment and lambda-calibration.

Section 5 Standard Operations

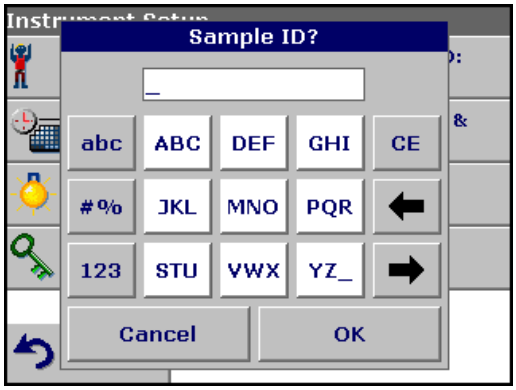
5.1 Overview

5.1.1 Tips for the use of the touch screen

The entire screen is touch-activated. To make a selection, press the screen with a fingernail, fingertip, pencil eraser or a stylus. Do not press the screen with a sharp object, such as the tip of a ball point pen.

- Do not place anything on top of the screen, to prevent damage or scratching on the screen.
- Press keys, words or icons to select them.
- Use scroll bars to move up and down long lists very quickly. Press and hold the scroll bar, then move up or down to move through the list.
- Highlight an item from a list by pressing it once. When the item has been successfully selected, it will be displayed as reversed text (light text on a dark background).

5.1.2 Use of the alphanumeric keypad



This display is used to enter letters, numbers and symbols as needed when programming the instrument. Unavailable options are disabled (grayed out). The icons on the right and left of the screen are described in Table 1.

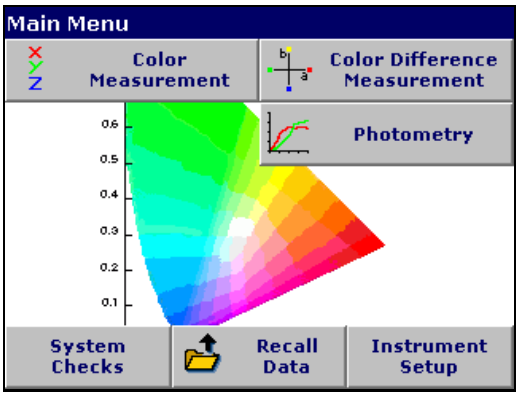
The central keypad changes to reflect the selected entry mode. Press a key repeatedly until the desired character appears on the screen. A space can be entered by using the underscore on the **YZ_** key.

Note: *A USB keyboard (with US keyboard layout) or a USB Barcode handset scanner can be used for input (see Section 9 on page 93).*

Table 1 Alphanumeric keypad

Icon / key	Description	Function
ABC/abc	Alphabetic	When entering alphabetic characters (ex. user-entered units), this key allows to toggle between upper and lower case letters.
# %	Symbols	Punctuation, symbols and numerical sub- and superscripts may be entered.
123	Numeric	For entering regular numbers.
CE	Clear Entry	Clear the entry.
Left Arrow	Backspace	Moves back one position. This deletes the character previously entered in the new position.
Right Arrow	Advance	Moves to the next space in an entry when two adjacent characters occur on the same key.

5.1.3 Main Menu

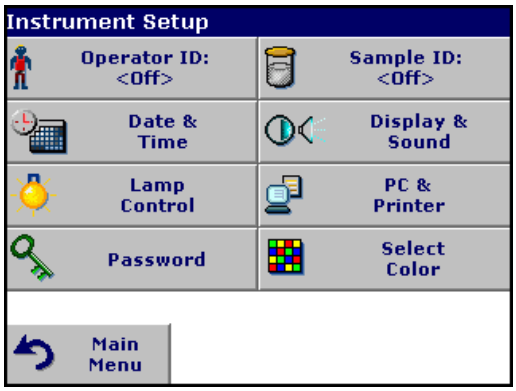


A variety of modes may be selected from the **Main Menu**. Table 2 briefly describes each menu option.

Table 2 Main Menu options

Option	Function
Color Measurement	The **COLOR MEASUREMENT** mode is used to determine visual color values like Hazen, Gardner, Saybolt as well as three-dimentional absolute colorimetric values like CIE Lab, Hunter Lab or European Pharmacopoeia skale.
Color Difference Measurement	The **COLOR DIFFERENCE MEASUREMENT** mode is used to determine a quantitative color difference between a reference (R) and a sample (S) in the three-dimensional color space (CIE L*a*b* or Hunter Lab). In this mode, an additional reference memory for up to 50 references is available.
Photometry	**SINGLE WAVELENGTH** Single wavelength measurements are: **Absorbance measurements:** The light absorbed by the sample is measured in absorbance units. **Transmittance measurements (%)**: The percentage of the light that passes through the sample and reaches the detector is measured. **Concentration measurements:** A concentration factor can be entered to enable the measured absorbance values to be converted into concentration values. **MULTI WAVELENGTH** In the multi-wavelength mode, absorbance (Abs) or percentage transmittance (%T) is measured at up to four wavelengths and absorbance differences and absorbance relationships are calculated. Simple conversions into concentrations can also be carried out. **TIME COURSE** The time scan records the absorbance or % transmittance at a wavelength over a defined time. **WAVELENGTH SCAN** A wavelength scan shows how the light from a sample is absorbed over a defined wavelength spectrum.This function can be used to determine the wavelength at which the maximum absorbance value can be measured.The absorbance behavior is displayed graphically during the scan.
System Checks	The system checks menu offers a number of options, including optical checks, output checks, lamp history, instrument update, service time and instrument backup.
Recall Data	Stored data can be recalled, filtered, sent to Printer, Memory stick or PC and deleted.
Instrument Setup	In this mode, user-specific or method-specific settings can be entered: Operator-ID, Sample-ID, Date & Time, Display & Sound, Lamp Control, PC & Printer, Password and Select Color.

5.2 Instrument Setup mode

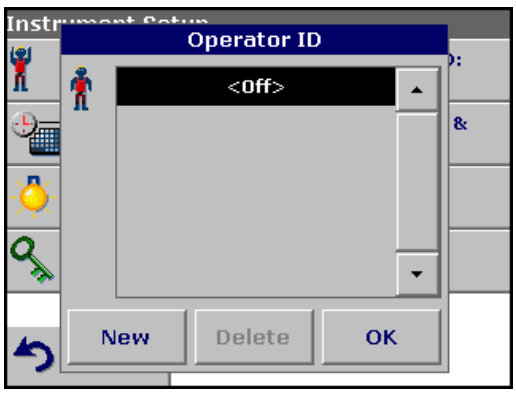


1. Select **Instrument Setup** in the Main Menu.

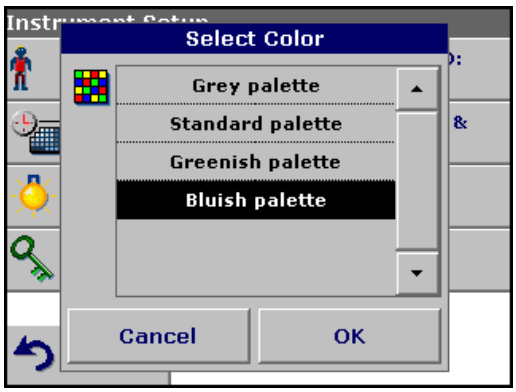
A selection of configuration options appear.

5.2.1 Operator ID

Use this option to enter up to 30 sets of operator initials (up to five characters each). Also the color can assigned for each Operator ID. This feature helps record which operator measured each sample.



1. Press **Operator ID** in the Instrument Setup.
2. Press **New** to enter a new Operator ID.
3. Use the alphanumeric keypad to enter a new Operator ID.
4. Press **OK** to confirm.

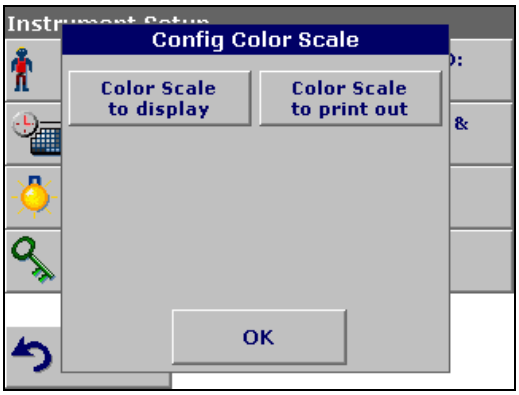


Select one of the four preset color palette in the Select Color menu to assign to the Operator ID.

5. Select a color category to highlight the color for the display background.

   Note: *Press* ***Cancel*** *to select the default setting.*

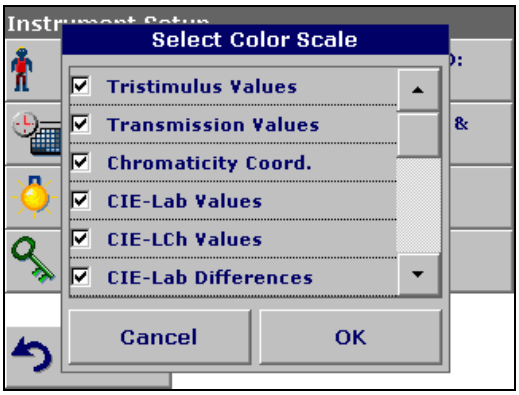
6. Press **OK** to confirm.



Each operator is able to configure his own set of color scales for display and printout independent of the settings or configuration of other operators.

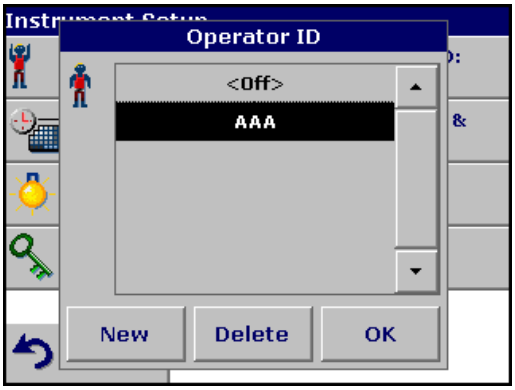
When the operator ID is changed from A to B the color scales for the display and printout also change.

7. Press **Color Scale to display**.



8. Select the color scales for the display. Scoll up or down for more available colors.

9. Press **OK** to confirm.



10. The display shows the selected Operator ID.

11. Press **OK** to return to Instrument Setup.

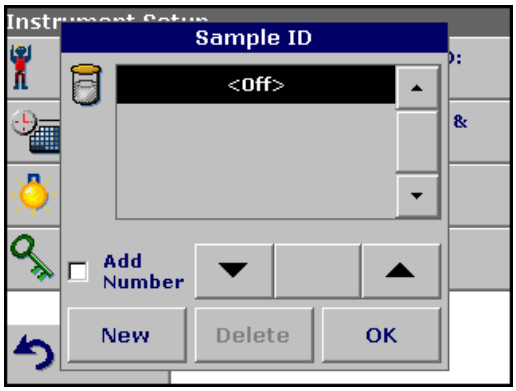
12. The selected Operator ID is activated.

Note: *Press* ***Delete*** *to remove an Operator ID from the list.*

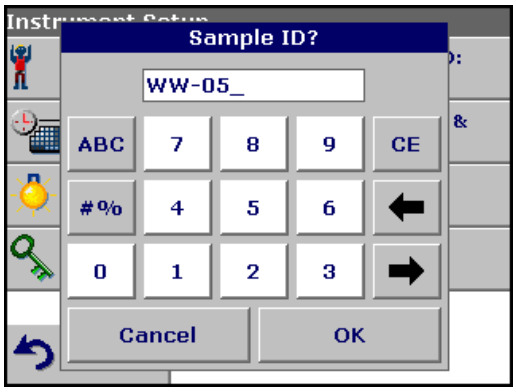
Note: *Alternatively, enter or change an Operator ID in measurement mode. In the results screen, press* ***Options*****>*****More*****>*****Instrument Setup*** *or if an Operator ID is already assigned, select the Operator ID symbol immediately in the results screen.*

5.2.2 Sample ID

Use this option to enter up to 100 Sample Identification tags (up to 13 characters each) into the instrument. Sample IDs can be used to specify the sample location or other sample specific information.



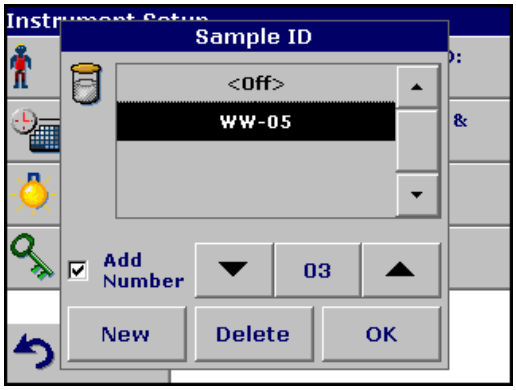
1. Press **Sample ID** in the Instrument Setup.
2. Press **New** to enter a new Sample ID.



3. Use the alphanumeric keypad to enter a new Sample ID.

   Note: *If a USB Barcode handset scanner (see Section 9 on page 93) is connected, Sample IDs can also be scanned.*

4. Press **OK** to confirm.

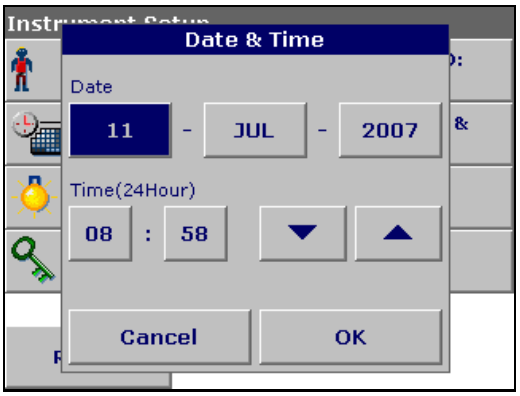


5. To number the Sample IDs sequentially (e.g. Inflow (01 etc.)), select **Add Number**.
   - Use the arrow keys to specify the first number of the sequence.
   - Use the key between the arrow keys to enter the first number of the sequence using the alphanumeric keypad.
6. Press **OK** to return to Instrument Setup.
7. The Sample ID is activated. Each Sample ID is automatically numbered in ascending order after a measurement. The number is shown in parentheses behind the Sample ID.

Note: *To remove a Sample ID, highlight the ID and press* ***Delete****.*

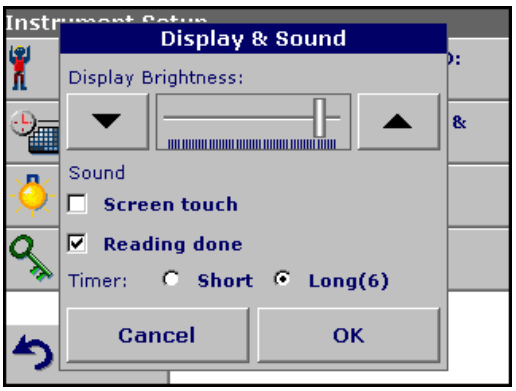
Note: *A Sample ID can be entered or changed in measurement mode. In the results screen, press* ***Options****>****More****>****Instrument Setup****. If a Sample ID is already assigned, select the Sample ID symbol in the results screen.*

5.2.3 Date and time



1. Press **Date & Time** in the Instrument Setup.
2. The date and time are subdivided over a number of fields. Press the appropriate field and use the arrow keys to change the value.
3. Press **OK** to return to Instrument Setup.

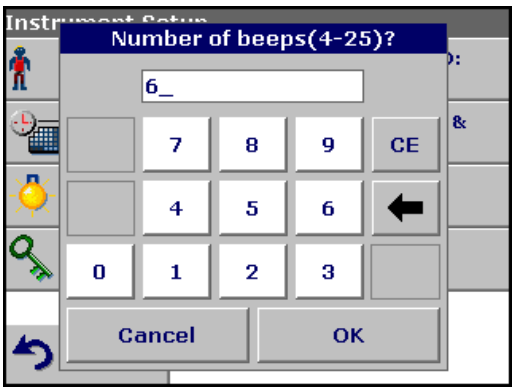
5.2.4 Display and sound preferences



1. Press **Display & Sound** in the Instrument Setup.

The following options will be displayed:

- **Display Brightness—**Adjusts the display brightness to suit lighting conditions.
- **Screen touch—**Activates//Deactivates a short beep each time the screen is pressed (Default:off).
- **Reading done—**Activates/Deactivates a sound when a reading is complete (Default: short beep every time a reading is complete).
- **Timer—**Adjusts the length of the timer sound. Select Short or Long. Long beeps are recommended for noisy environments.



2. Select **Long** to change the number of audio signals.

   Use the alphanumeric keypad to enter/specify the number of audio signals (4–25).

   Note: *A high number of audio signals increases the duration of the tones and a small number of audio signals reduces the duration of the tones.*

3. Press **OK** to confirm. The selected number of the audio signals sounds as a corresponding acoustic signal.
4. Press **OK** to return to Instrument Setup.

5.2.5 Lamp control

The tungsten lamp produces light in the wavelength spectrum 320 to 1100 nm.

The life span of the halogen lamp depends on the burning duration. In order to extend the life span of the lamp, switch on the Lamp control:

- If the instrument is not used during a longer period (1–12 hours).
- If the instrument will never be switched off.

1. Press **Lamp Control** in the Instrument Setup.
2. Select **On** to switch on the Lamp.
3. Select **Save:** in order to define a time interval for the burning time of the lamp.
4. Press the field below **Save** to select the lamp burning time.

5. Select the length of time the lamp will be switched on.

   Note: *After this period of time the lamp will automatical turn off, after no measurement has been made.*

   Note: *The lamp will be restarted automatically for measurements.*

6. Press **OK** to confirm.

5.2.6 PC and printer

The LICO 500 is provided with 2 USB interfaces, which are located on the back of the instrument (see Figure 2 on page 11). These interfaces can be used for exporting data and graphics to a printer, updating data and for data communication to a personal computer. These interfaces can be used for the connection of a USB stick, an external USB keyboard or a USB Barcode handset scanner.

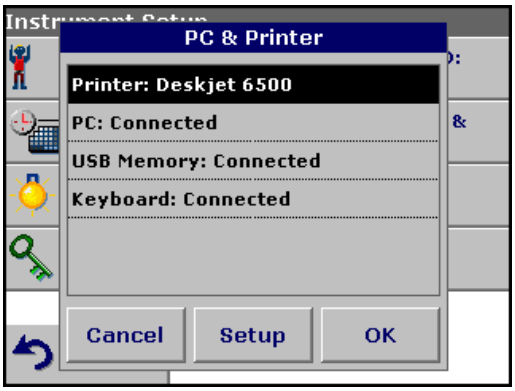
Note: *A USB hub may be used to connect several accessories at a time.*

A USB memory stick is used to upgrade data, see section 6.1.2 on page 76.

Important Note: *A screened* ***USB cable*** *must not be longer than* ***3 m****!*

Table 3 USB connector

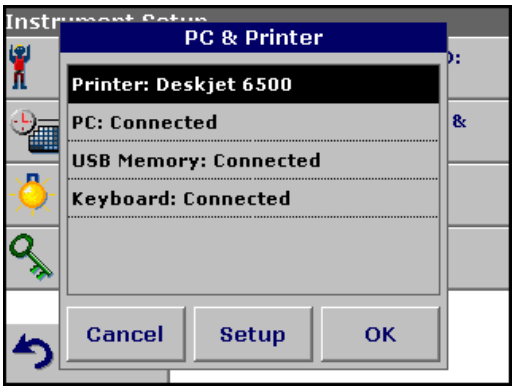
USB Interfaces	Description
USB (Type B)	This USB interface is only intended for the LICO 500 to PC connection (with installation of the HACH Data Trans Software).
USB (Type A)	This USB port can be used to connect a printer, a USB memory stick and keyboard.



1. Press **PC & Printer** in the Instrument Setup.

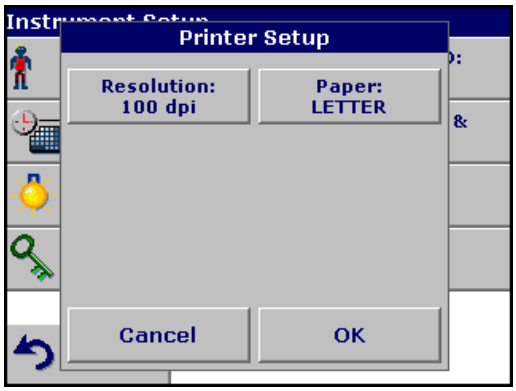
A list with information about the connections opens.

5.2.6.1 Printer setup



For reasons of compatibility, the printer language must be **HP PCL 3**.

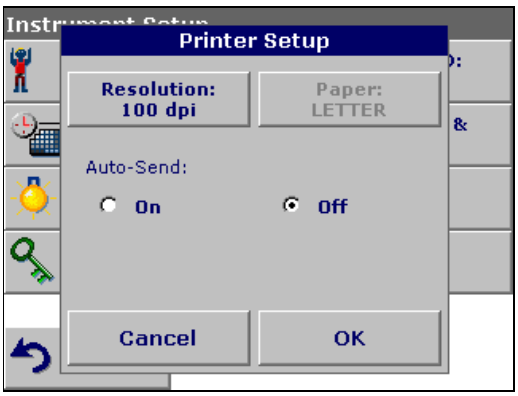
1. Press **Printer**.
2. Press **Setup** to display the Printer Setup screen.



Printer Setup:

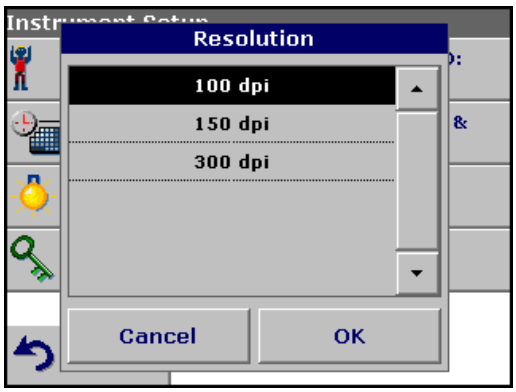
- Resolution: Font size
- Paper: Paper size

Note: *If an optional Thermal Printer is connected, the function "Auto Send" on/off is available.*



3. Select **Auto-Send: On** to send all measured data automatically to the Thermal printer.

Note: *The option Auto-Send is **not** available for any other printer (e.g. ink jet printer).*



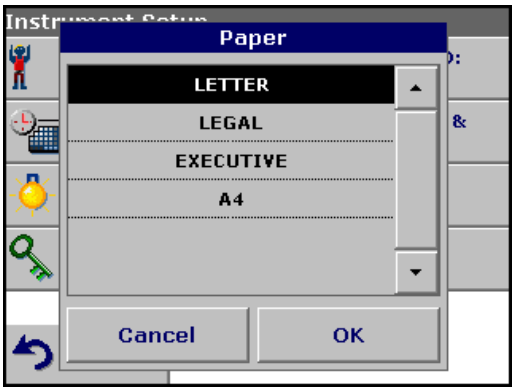
4. Press **Resolution** to select the print quality.

   Select between

   - 100 dpi
   - 150 dpi
   - 300 dpi

5. Press **OK** to confirm.

Note: *Press **OK** again to return to the **Instrument Setup** menu.*



6. Press **Paper** to select the paper size.

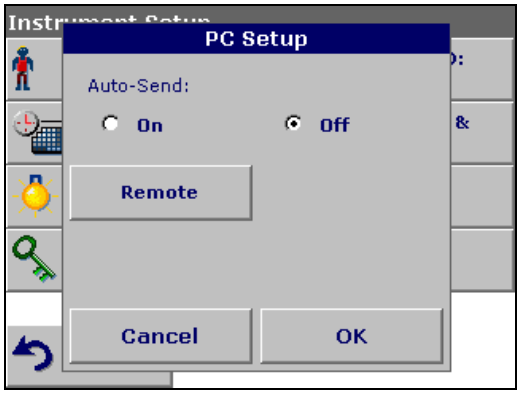
   Select between

   - Letter
   - Legal
   - Executive
   - A4

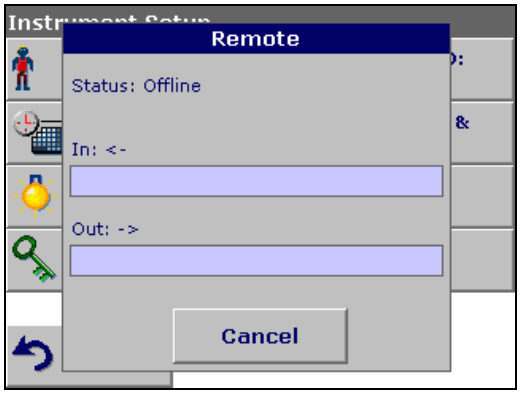
7. Press **OK** to confirm.

Note: *Press **OK** again to return to the **Instrument Setup** menu.*

5.2.6.2 PC setup

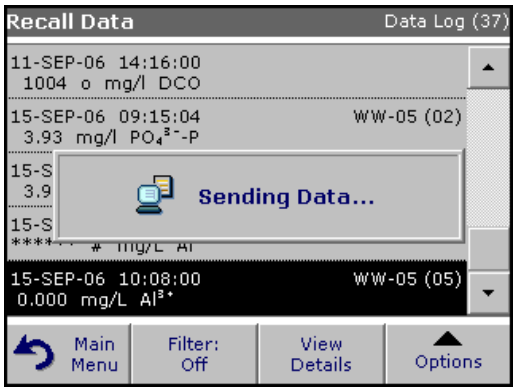


1. Press **PC**.
2. Press **Setup** to display the PC Setup screen.
3. With Auto-Send **ON** selection each measurement result will be automaticly sent to a PC.



4. Select **Remote** to etablish a bi-directional PC connection to send and receive commands and data (reserved for advanced application).

5.2.6.3 Print data

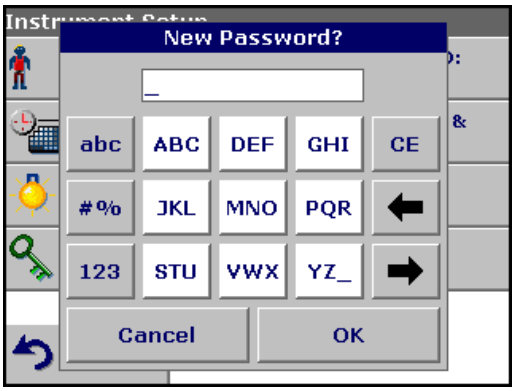


1. Press **Recall Data** in the Main Menu.
2. Select the data source, where the data to be printed are stored.
3. A list is displayed. Data can be filtered. For more information see 5.3.1.2 Recall stored data from the color log or the data log on page 31.
4. Press the **Printer** icon.
5. Highlight **Single point** or **Filtered data** or **All data** and press **OK** to confirm.
6. **Sending Data** is displayed until the data have been printed.

5.2.7 Password

The Password menu contains a variety of security settings to control access to various functions. For example, prevent unauthorized changes to stored programs or instrument configurations.

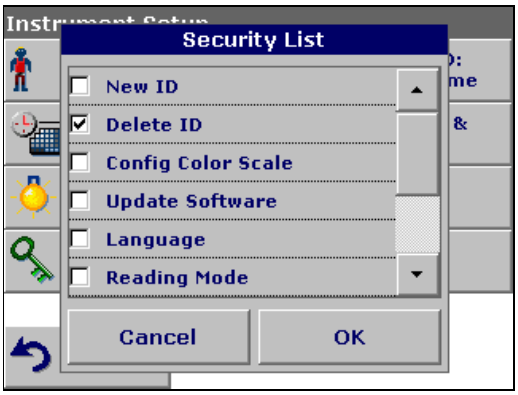
1. Press **Password** in the Instrument Setup menu.
2. In order to highlight the **Security List** assign a password. Press **Set Password**.



3. Use the alphanumeric keypad to enter a new Password (up to 10 characters each) and press **OK** to confirm.

   The access to the Security List is activated.

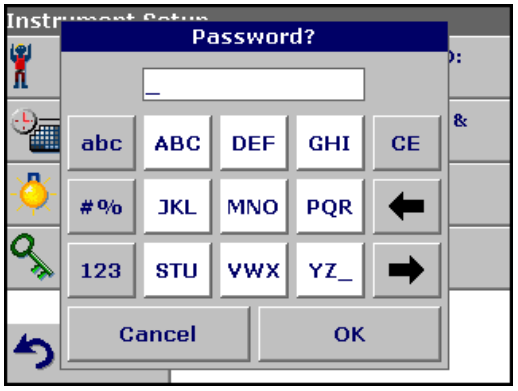
4. Press **Security List** to lock various functions for unauthorized users.



5. Highlight the desired functions to control.
6. Confirm the **Security List** with **OK** to return to the Password menu.
7. Press **On** to highlight the new settings of the Security List.
8. Enter the new Password again to confirm.
9. Press **OK** to return to Instrument Setup.

Note: *The alphanumeric keypad to the Password inquiry appears when a user tries to reach a locked setting.*

5.2.7.1 Deactivate a password



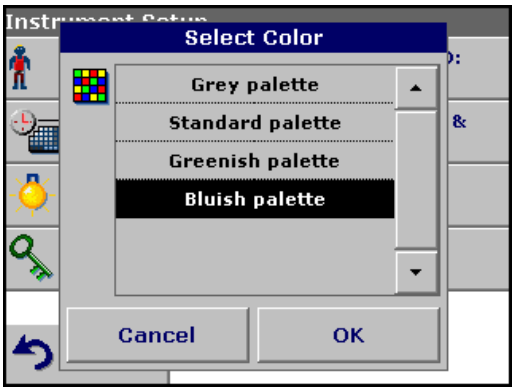
1. Press **Password** in the Instrument Setup.
2. Use the alphanumeric keypad to enter the former Password and press **OK** to confirm.

3. Press **Off** to deactivate the settings of the Security List.
4. Press **OK** to return to Instrument Setup.

Note: *Use this function to delete the former Password or to enter a new one.*

5.2.8 Select color

Select one of the four preset color palettes in the Select Color menu.



1. Press **Select color** in the Instrument Setup.

   A color chart list will appear.

2. Select a color category to highlight the color for the display background.

3. Press **OK** to return to Instrument Setup.

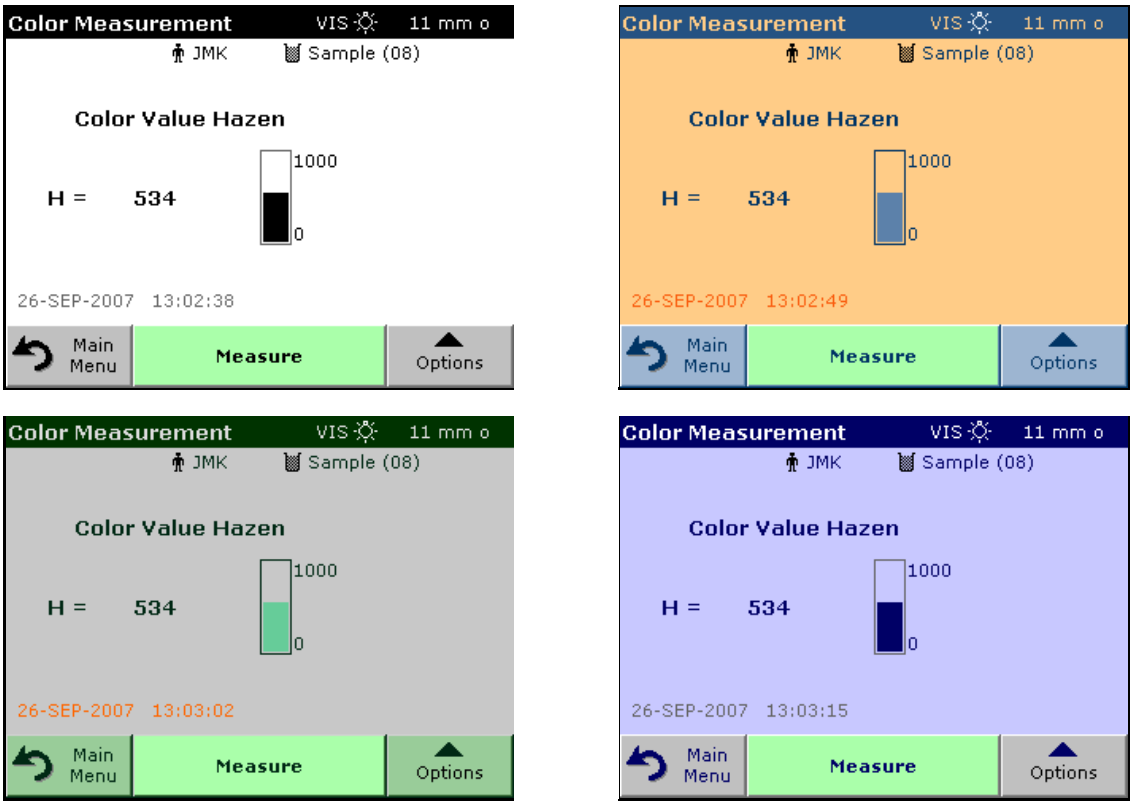
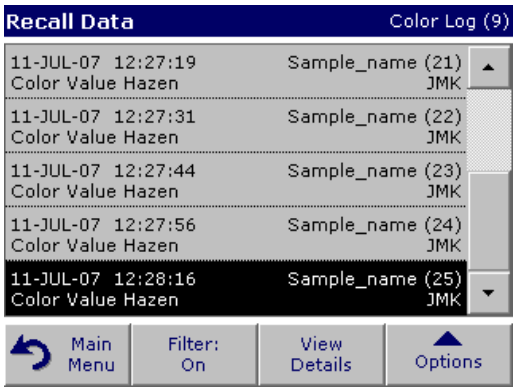


Figure 6 Select color

1	Grey palette	**2**	Standard palette
3	Greenish palette	**4**	Bluish palette

5.3 Store, recall, send and delete data



The data log of the instrument is seperated in 4 segments: Color Log, Wavelength Scan, Time Course and Data Log.

The **Color Log** will store up to 500 color measurments taken in the Color Measurements and Color Difference Measurement modes.

The **Wavelength Scan** log will store up to 20 scans.

The **Time Course** log will store up to 20 time course data sets.

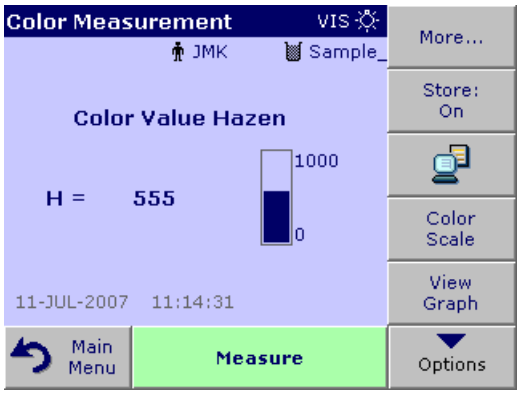
The **Data Log** will store 500 additional readings in the Photometry (Single Wavelength and Multi Wavelength mode).

A complete record of the analysis is stored, including the Date, Time, Results, Sample ID and Operator ID.

5.3.1 Store, recall, send and delete data from the color log and data log

5.3.1.1 Auto/manual data storage

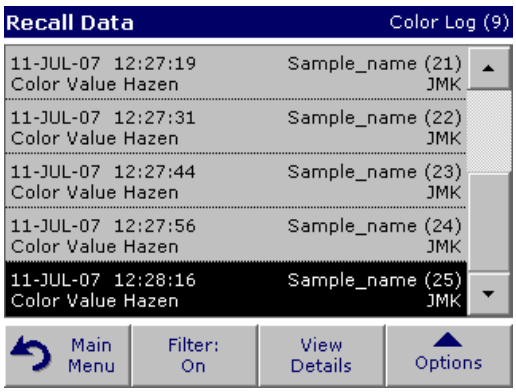
The data storage parameter indicates whether data are to be stored automatically or manually (in which case the user has to decide which data to store).



1. Press **Store: On/Off** in the Options menu.
   - **Store On** setting: All measurement data are stored automatically.
   - **Store Off** setting: No measurement data are stored. However, this setting can be changed to **Store On** in the result display through Configuration. The reading currently shown in the display is then stored.

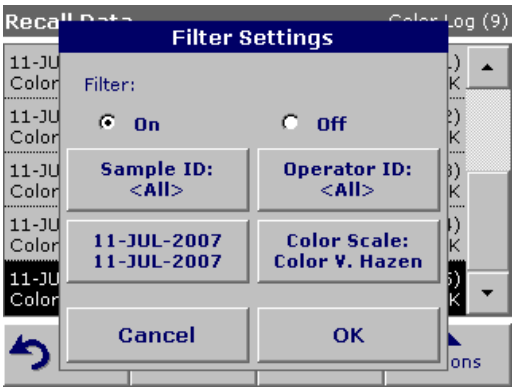
Note: *When the instrument memory (data log) is full, the oldest data are automatically deleted allowing the new data to be stored.*

5.3.1.2 Recall stored data from the color log or the data log



1. Press **Recall Data** in the Main Menu.
2. Press **Color Log** or **Data Log**.

   A listing of the stored data is displayed.
3. Press **Filter: On/Off**.

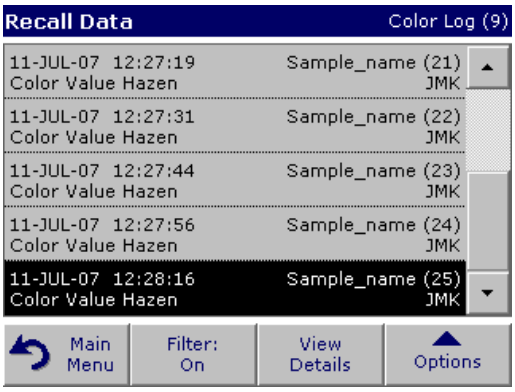


4. The function **Filter Settings** is used to search for specific items.

5. Highlight **On** to turn on the filters to select data by

   - Sample ID
   - Operator ID
   - Start Date
   - Color Scale

   or any combination of the four.

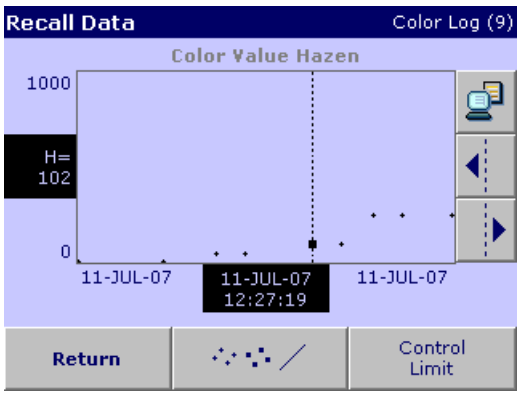


6. Press **OK** to confirm the selection. The selected items are listed.

7. Press **View Details** to get more information.

8. Turn on the filter to select data by **Color Scale**.

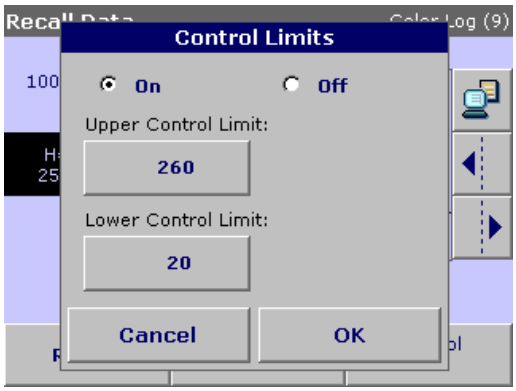
9. Press **Options** and **Graph Data**.



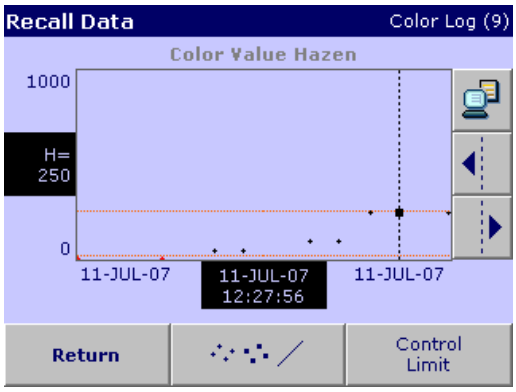
10. A graphic trend of all color values stored in the selected period and color system is displayed. The trend shows a visual impression of the measured value process, e.g. during production supervision in the shift operation.

11. Press the **arrow** buttons on the right of the graph to move the dotted cursor line inside of the trend graph to the different measurement values. The color value of the marked measurement is shown on the left vertical axis and the date/time of this measurement is shown below the horizontal axis.

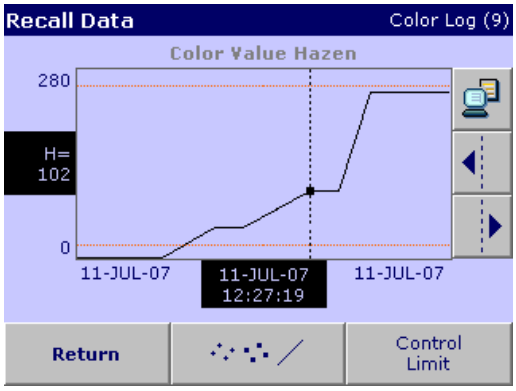
12. Press **Control Limit**.



13. Highlight **On** to change the **Upper Control Limit** and the **Lower Control Limit**.



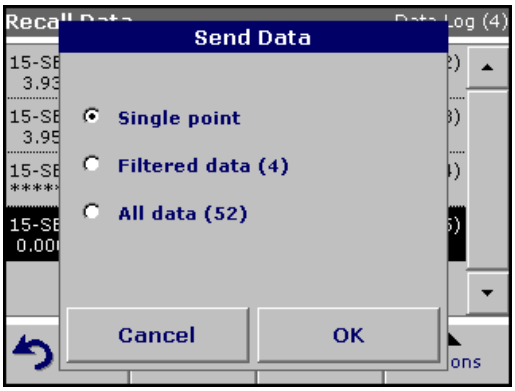
14. The middle Button represents the measuring points for the change-over.



5.3.1.3 Send data from the color log or the data log

Data is sent from the data log as CSV (Comma Separated Value) files through a USB memory stick to a file named DATALOG. The file can then be processed using a spreadsheet program. The file name will be formatted as: DLYear_Month_Day_Hour_Minute_Second. CSV.

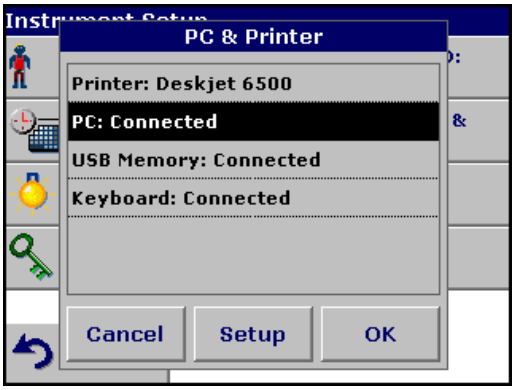
To send data to a Printer, see section 5.2.6.3 on page 27.



1. Plug in the USB device (Figure 2 on page 11).
2. Press **Recall Data** from the Main Menu. Press **Options** and then the **PC & Printer** icon.
3. Select the data to send to the memory stick and press **OK**.

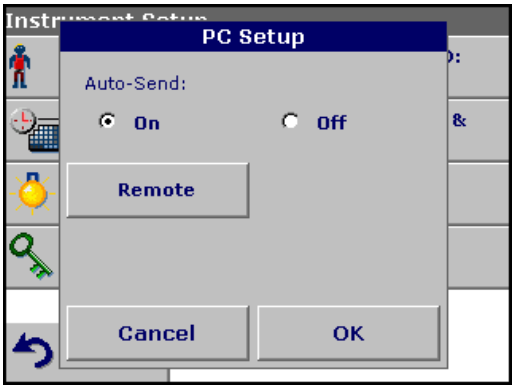
   Note: *The number in parenthesis is the total number of data sets assigned to this selection.*

To send measurement data to a PC:
The optional HACH Data Trans software must be installed on the PC for the subsequent to process for measurement data.



1. Press **PC & Printer** in the Instrument Setup.
2. Select **PC**.
3. Press **Setup** to display the PC Setup screen.

   For further installation instructions, refer to the HACH Data Trans user manual.

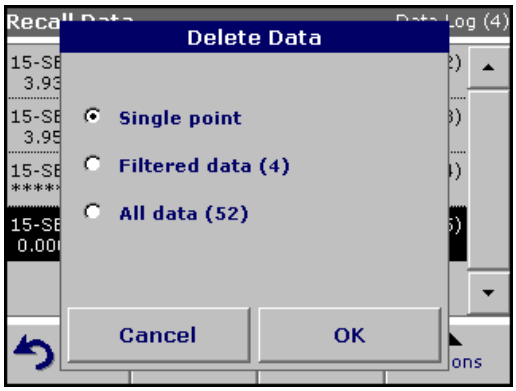


4. Select **Auto-Send: On** to send all measured data automatically to the PC.

   Note: *If **Auto-Send: Off** is selected, the "PC & Printer" key must be pressed, in order to send data to the PC.*

The remote function is only for monitoring the data transfer.

5.3.1.4 Delete stored data from the color log or the data log



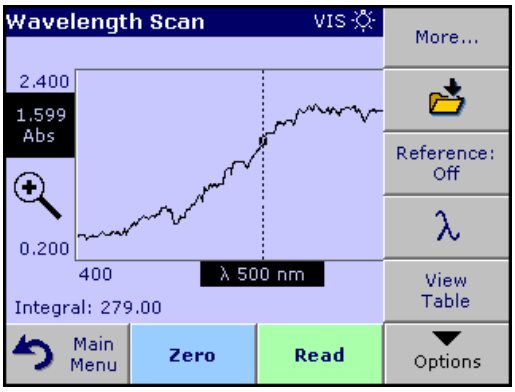
1. Press **Recall Data** in the Main Menu.
2. Press **Color Log** or **Data Log,** then **Options>Delete**.
3. Highlight **Single Point** or **Filtered data** or **All data** and press **OK** to confirm.

   Note: *The number in parentheses is the total number of data sets assigned to this selection.*

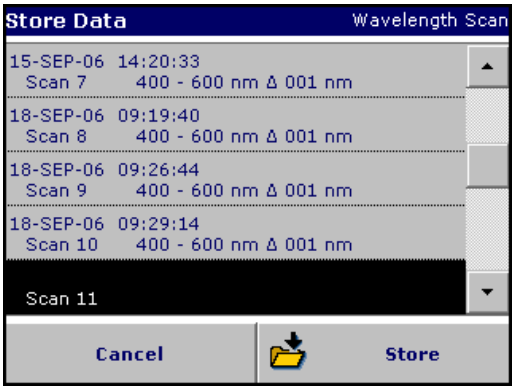
5.3.2 Store, recall, send and delete data from wavelength scan and time course

The instrument can store 20 Wavelength Scans and 20 Time Course Data sets.The data can be stored manually at the user's discretion after viewing the data.

5.3.2.1 Data storage from wavelength scan or time course



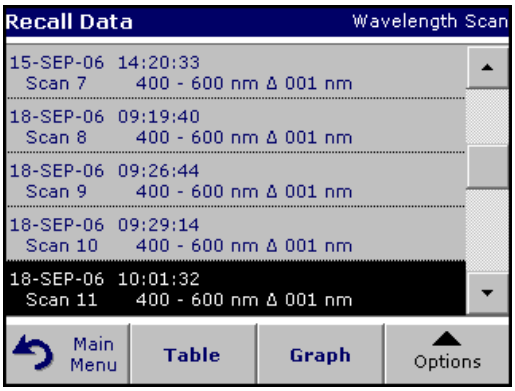
1. Press **Options** then the **Store icon** after a reading is taken.



The Store Data list will be displayed.

2. Press **Store** to save the current scan to the highlighted numbered line. A scan can also be overwritten.

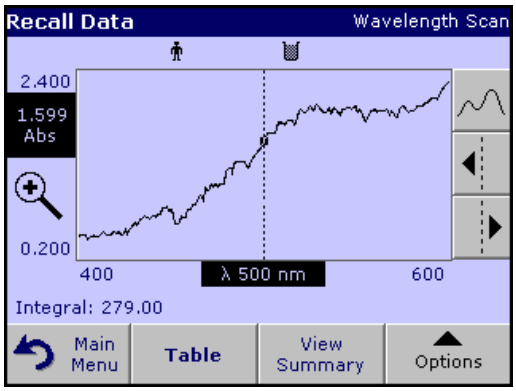
5.3.2.2 Recall stored data from wavelength scan or time course



1. Press **Recall Data** in the Main Menu.

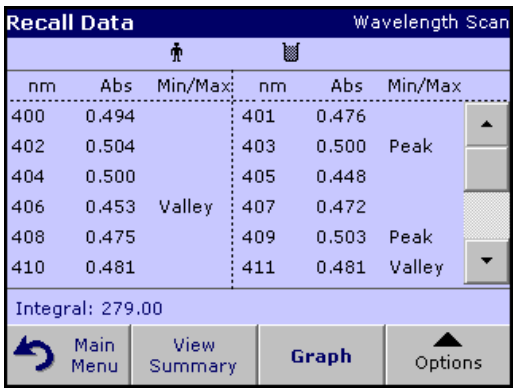
   a. Select **Wavelength Scan** or **Time Course** to recall data.

   b. If a program is already in progress, press **Options > More > Recall Data**.



2. Press **Graph** to look at the details.

   Note: *Press* ***View Summary*** *to return to the Recall Data list.*

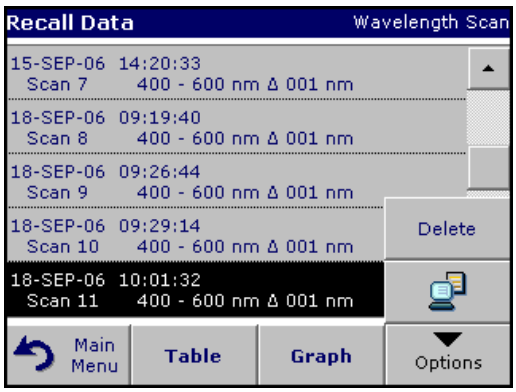


3. Press **Table** to look at the details.

   Note: *Press* **View Summary** *to return to the Recall Data list.*

5.3.2.3 Send data from wavelength scan or time course

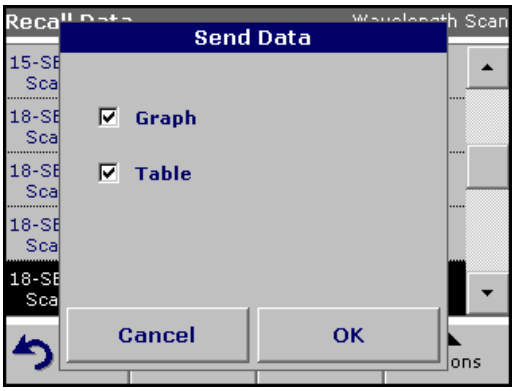
There are two ways to recall sent data to a USB memory stick, printer or PC with Hach Data Trans.



Option1:

1. Press **Recall Data** in the Main Menu and then **Wavelength Scan** or **Time Course**.

2. Press **Options** and then the **PC & Printer** icon to send the data to a USB memory stick, to a printer or to a PC with Hach Data Trans.

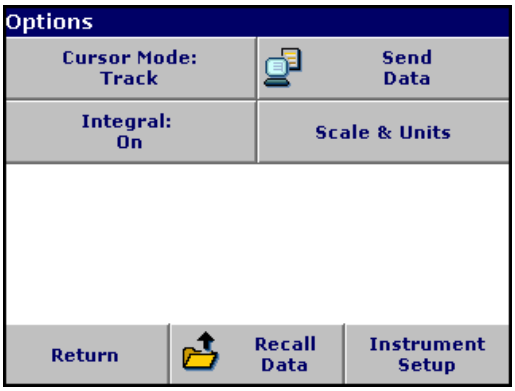


- When a printer is connected, select how to send the data to the printer (graph, table or both graph and table).
- When a USB memory stick is connected, the files will be automatically sent as CSV files (Comma Separated Value) to a file ”WLData“ (Wavelength Scan Data) or ”TCData“ (Time Course Data) to the USB memory stick.

The file name will be formatted as: ”ScanData_X.csv“ (Wavelength Scan Data) or ”TCData_X.csv” (Time Course Data).
X = number of scans (1–20)

For further processing use a spreadsheet program.

Note: *The advice ”Data already exist. Overwrite?“ appears when the files were already stored. Press* ***OK*** *to overwrite the stored data.*



Option 2:

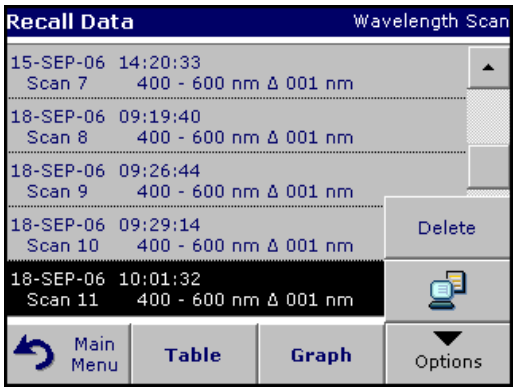
1. Press **Wavelength Scan** or **Time Course** and then **Options>More>Send Data** to send the data to a USB memory stick or to a printer.

   - When a printer is connected, select how to send the data to the printer (graph, table or both graph and table).
   - When a USB memory stick is connected, the files will be automatically sent as CSV files (Comma Separated Value) to a file ”WLData“ (Wavelength Scan Data) or ”TCData“ (Time Course Data).

   The file name will be formatted as: ”ScanData_Year_Month_Day_Hour_Minute_Second.CSV“ (Wavelength Scan Data) or
   The file name will be formatted as: ”TCYear_Month_Day_Hour_Minute_Second.CSV“ (Time Course Data).

   For further processing use a spreadsheet program.

5.3.2.4 Delete stored data from wavelength scan or time course



1. Press **Recall Data** from the Main Menu and then **Wavelength Scan** or **Time Course** or **Options>More>Recall Data**.

   A listing of the stored data is displayed.

2. Highlight any data to delete.

3. Press **Delete** in the Options menu and press **OK** to confirm.

5.4 Sampling and sample preparation

Take a representative sample from the product you want to measure in accordance with DIN EN ISO 15528 (or ASTM D3925-02).

If the material shows any visual haziness, remove the haze by either filtration, centrifugation, heating, ultrasonic treatment or suitable means.

Heat partly solid samples before measuring in order to dissolve the solid material in the liquid. The preparation must not cause any chemical changes in the sample.

Make sure that during the measurement are no bubbles in the sample.

There are three cuvette/sample cell types available for color measurement with the LICO 500, differing by material (glass, PS and PMMA) and path length (10 mm,11 mm and 50 mm). Fill the cuvette/sample cell to approximately 2 cm. The light beam passes through the cuvette/sample cell around 0.5 cm to 1.5 cm above the base of the cuvette/sample cell.

The program calculates and displays Iodine, Hazen, Gardner, Saybolt, Klett and ASTM D 1500 color values automatically, taking into account the cuvette/sample cell type.

A dry thermostat is available for the 11 mm disposable round glass cuvettes/sample cells. The dry thermostat heats the cuvettes/sample cells to any temperature between ambiant and 150 °C.

Important Note: *The samples must be clear and free of turbidities. If products in paste or solid form cannot be measured directly, the product must be melted before being transferred to the cuvettes/sample cells. Make sure the cuvettes/sample cells do not contain any air bubbles.*

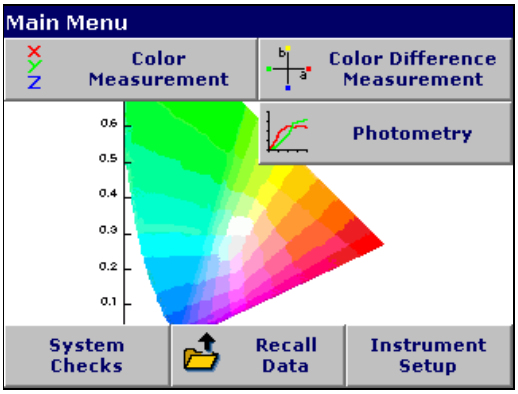
- Always hold the cuvette/sample cell close to the top, to make sure that there are no fingerprints in the measurement zone of the cuvette/sample cell. Use suitable transfer pipettes to introduce samples into the cuvettes/sample cells.
- Slowly add samples to the cuvettes/sample cells cells to make sure air bubbles do not form on the cuvette/sample cell wall and in the sample. Air bubbles will cause false readings.
- If air bubbles are entrapped, remove them by heat, vacuum, ultrasonic treatment or other suitable means.
- Clean the outside of the cuvettes/sample cells thoroughly before inserting them in the cell compartment.

Note: *Before using disposable cuvettes/sample cells made by PS (Polystyrene) or PMMA (Polymethyl methacrylate) be sure that the cuvettes/sample cells will not be destroyed by samples, otherwise the cell compartment can be damaged.*

5.5 Color measurement

Proper sample preparation is extremely important for accurate color measurement. To make sure an accurate measurement is taken, refer to the following sample preparation guidelines:

- Always clean the glass cuvettes/sample cells immediately after use.
- Only use optically preferred samples for measurement. Make sure the cuvette/sample cell are clean and show no signs of opaqueness.
- Slowly fill the liquid into the cuvette/sample cell to prevent air bubbles in the sample.
- Refer to section 5.4 on page 40 for more sample and sampling preparation information.



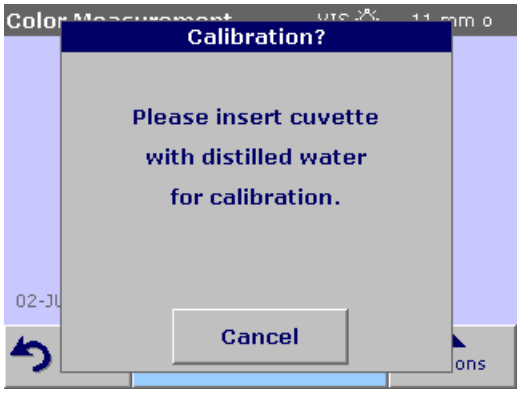
The Color Measurement mode is used to determine absolute color values in the Hazen, Gardner, CIE Lab or European Pharmacopoeia ranges.

The LICO 500 uses an independent calibration data set for each type of cuvette/sample cell size (11 mm round vial and 50 mm rectangular cells).

It is possible to calibrate the instrument with one, two or three types of cuvettes/sample cells and to use these different cuvette/sample cell types in parallel.

For the use of the 10 mm square cuvette/sample cell and 11 mm round vials it is necessary to insert the adapter Z into the cell compartment #2. For measurements with 50 mm rectangular cuvettes/sample cells please remove the adapter.

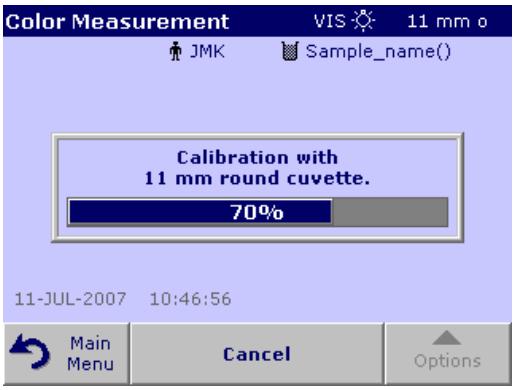
5.5.1 Take a color measurement



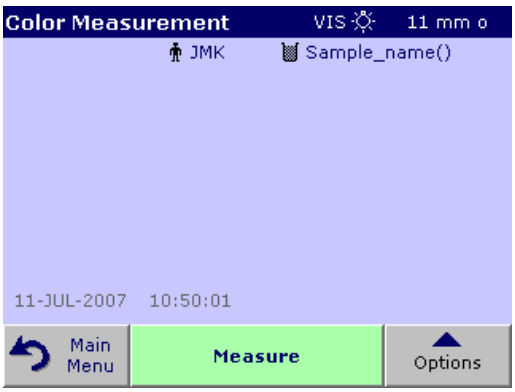
1. Press **Color Measurement**.

2. Insert a cuvette/sample cell with distilled water to calibrate.

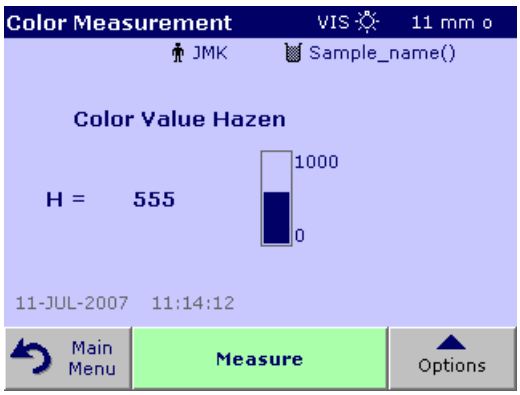
Important Note: *Carried out the calibration always very carefully, as a faulty calibration can cause inaccurate results to be obtained.*



3. The calibration starts when the LICO 500 automatically recognizes the cuvette/sample cell.
   The type of cuvette/sample cell and the actual progress of calibration is shown in a seperat window.



4. After the calibration is done the screen shows an empty measurement window. In the upper right corner of the window the selected cuvette/sample cell size is displayed. The middle button changes to **Measure** and the color is changed to green.



5. Insert the sample cuvette/cell.
6. The result of the color calculation is displayed.

   Note: *The control bar displayed on the right of the displayed result shows the relationship of the measurement result to the measuring range.*

7. For the next measurement, remove the cuvette/sample cell and insert the next sample cuvette/cell or press **Measure** to measure the same sample again.

5.5.1.1 Touch-sensitive areas on the measurement window

On the screen are touch-sensitive areas where the user has immediate access to special software options.

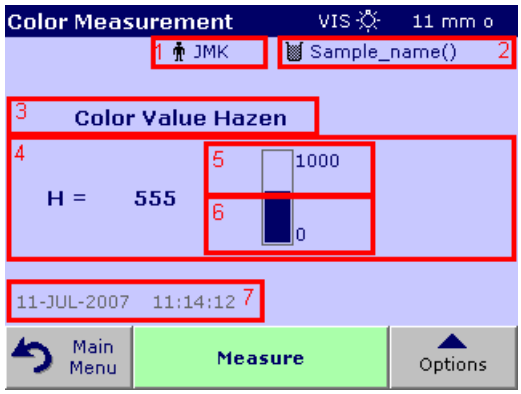
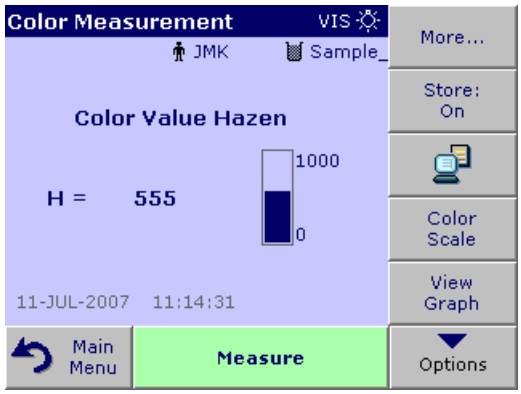


Figure 7 Touch-sensitive areas on the measurement window

1	Open **Operator ID** to change or add operator ID (see section 5.2.1 on page 19)	**5**	Change **Upper Limit** of color range (see section 5.5.1.4 on page 46)
2	Open **Sample ID** to change or add sample ID (see section 5.2.2 on page 20)	**6**	Change **Lower Limit** of color range (see section 5.5.1.4 on page 46)
3	Open **Select Color Scale** and select scale for display (see section 5.5.1.3 on page 45)	**7**	Change **Date & Time** (see section 5.2.3 on page 22)
4	Change the displayed color scale to the next color system which is selected in the Operator ID color scale list for display. (see section 5.5.1.3 on page 45)		

5.5.1.2 Parameter setup options

Press **Option** for Parameter Setup.



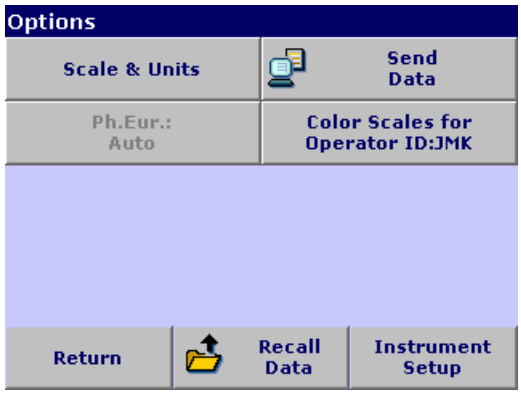
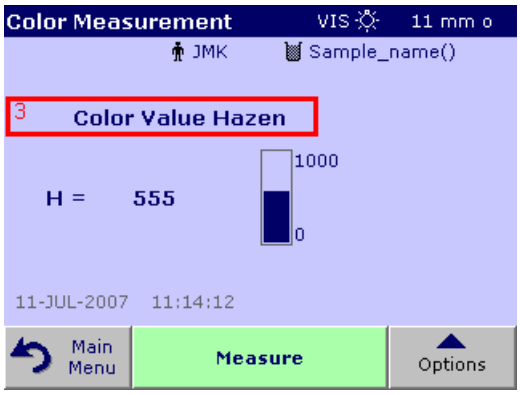


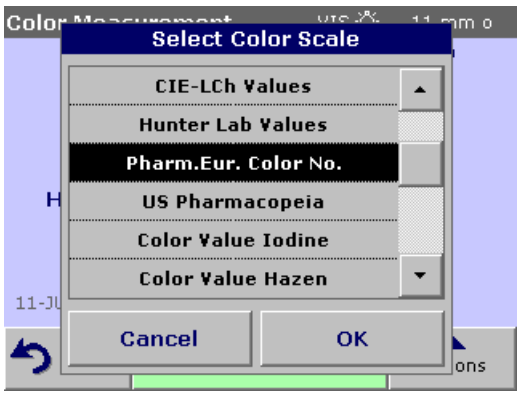
Table 4 Stored programs options

Options	Description
More	For further Options
Store: On	With the **STORE ON** setting, all measurement data are stored automatically. With the **STORE OFF** setting, no measurement data are stored.
Send Data	To send data to a printer, computer or USB memory stick (Type A)
Color Scale	Select the color scale
View Graph **View Table** **View Value**	**VIEW GRAPH** show the spectral graph of the transmission or absorbance curve. ***Note:*** *View Graph is activated after the first reading.* **VIEW TABLE** shows the spectral transmission values T% from 380 nm to 720 nm. **VIEW VALUES** show the result of the last color calculation.
Scale & Units	**UNITS**: Select absorbance or transmittance. **SCALE**: In the automatic scaling mode, the y-axis is automatically adjusted so that the total scan is displayed. The manual scaling mode allows sections of the scan to be displayed.
Ph.Eur.: Auto	European Pharmacopoeia Select **AUTO** or **SPECIFIED SCALE**
Send Data	To send data to a printer, computer or USB memory stick (Type A)
Color Scales for Operator ID	Configure the color scale for the display and for print.

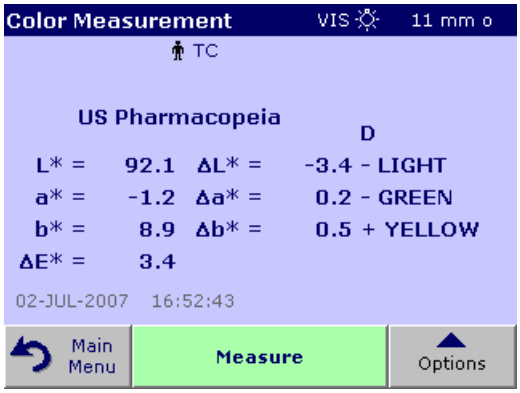
5.5.1.3 Change the color scale after a measurement



1. Press the touch-sensitive area 3, e.g. **Color Value Hazen**.

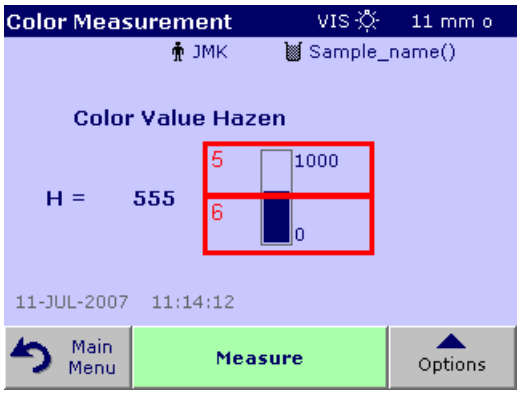


2. A list of all color scales is displayed.
3. Select the required scale.
4. Press **OK** to confirm.



5. The current result of the actual reading and all further measurements will be displayed in the selected color scale.

5.5.1.4 Change the measuring range after a measurement

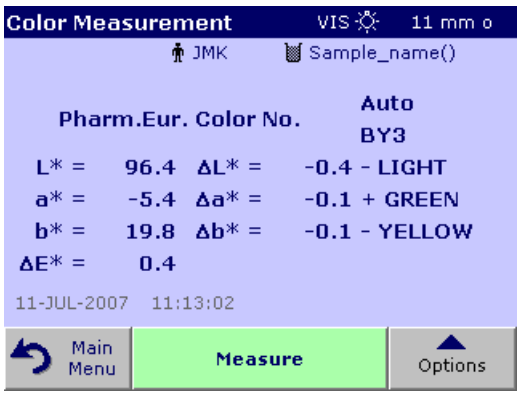


1. Press the upper or lower limit of the bar graph (touch-sensitive area 5 or 6).
2. Enter the new limit and press **OK** to confirm.

Note: *It is only possible to change the limits inside the measuring range of the color scale. It is not possible to extend the range, e.g. to Hazen 2000.*

The current result and all further measurements will be displayed with the new measuring range.

5.5.2 Take a Pharm. Eur. color measurement



The LICO 500 method of determining color in accordance with the European Pharmacopoeia (Ph.Eur) corresponds to the specifications in Chapter 2.2.2 of the pharmacopoeia "Degree of coloration of liquids ", in which a total of 37 color reference solutions (CRS) are defined for the hues yellow (Y1-Y7), greenish-yellow (GY1-GY7), brownish-yellow (BY1-BY7), brown (B1-B9) and red (R1-R7). Each color reference solution is unambiguously defined in the CIE Lab color space in terms of its brightness, hue and saturation.

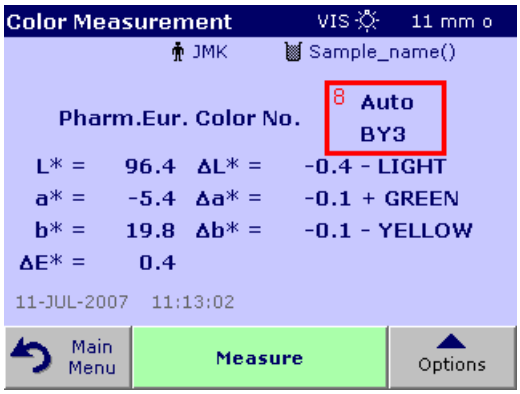
There are two ways of color matching of a sample with the Ph.Eur. system:

- **Automatic**: The color of the solution is compared to the colors of the 37 color reference solutions. The identifier of the reference solution whose color is closest to that of the sample (i.e. the reference solution with the smallest color difference DE* to the sample) is displayed.
- **Specified scale**: A scale is specified (e.g. BY). The identifier of the reference solution whose color is closest to that of the sample within the specified scale (i.e. the reference solution with the smallest color difference DE* to the sample within the specified scale) is displayed.

If a scale is specified (e.g. BY scale), one of the following five signs is used to define the correlation between the measurement results and the scale (see Table 5).

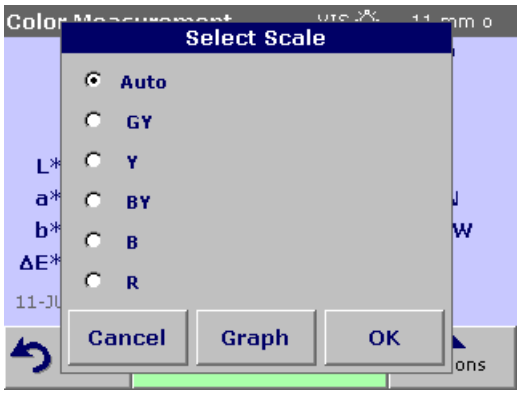
Table 5 Specified scale

Sign	Description
= equal	The color number of the sample is equal to that of the reference solution
< less	The color number of the sample is less than that of the reference solution
> greater	The color number of the sample is greater than that of the reference solution
<> between	The color number of the sample is between those of two reference solutions
->nearest	The sample does not match any reference solution in this scale, but the indicated reference solution is nearest in color

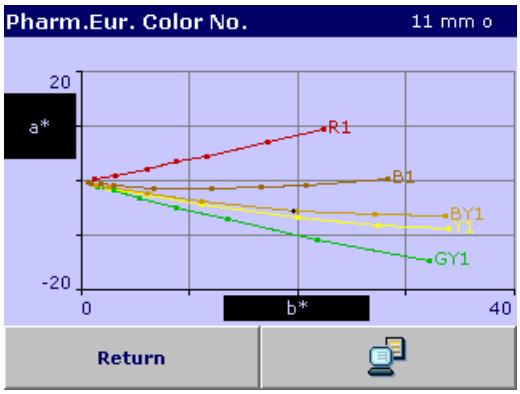


The .ΔL*,.Δa*and .Δb* values are the numerical differences between the L*,a* and b* values of the sample and those of the displayed PHARMA color solution. The measurements can be carried out with cuvettes/sample cells with path lengths of 10 mm,11 mm or 50 mm. The CIE L*a*b*values depend on the path length and are always related to the type of cuvette/sample cell employed. The longer the path length, the better the measuring accuracy.

1. Press **Pharm.Eur. Color No.**
2. Insert the sample cuvette/cell.
3. The result of the color calculation is displayed.



4. Press **Auto BY3** (touch-sensitive area 8).
5. Select **Auto**.



6. Press **Graph**.

The additional color matching result of the Pharm. Eur. Color is displayed.

The upper value shows the actual option for the color matching calculation which can be **Auto** for matching in all 5 Pharm. Eur. Scales or **B**, **BY**, **Y**, **GY** or **R** for matching only inside of the selected color scale.

The lower entry shows the result of the color matching, e.g. brownish-yellow 3 (BY3) in this example.

The ΔLab* - values shows the color difference of the measured sample in relation to the Pharm. Eur. Color No. BY3.

The ΔE* - value shows the three dimensional color difference of the measured sample in relation to the Pharm. Eur. Color No. BY3.

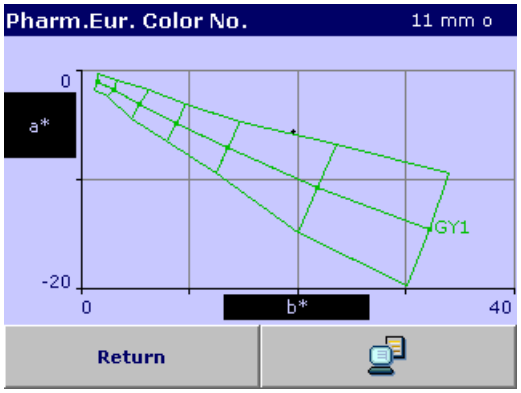
7. Press **Return** to change the option for the color matching function**.**
8. **Select Scale** is displayed.
9. The option for color matching to a special scale can be changed.

10. **Graph** offers a visualisation of the matching result in the selected matching option.

11. Depending on the scale selection the appropriate curve of the color scale will be displayed.

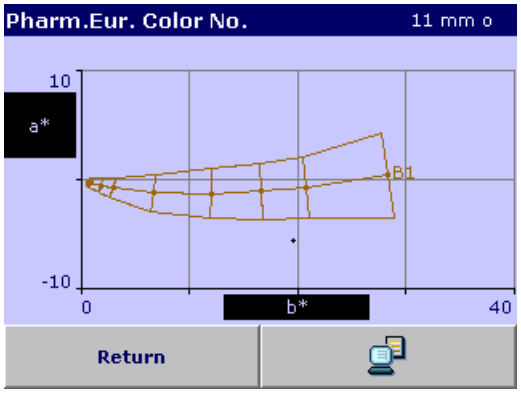
When option **Auto** is selected the a*, b* color locus of the measured sample will be displayed in all 5 color scales of the Pharm Eur.

12. Press **Print** to print the graph.

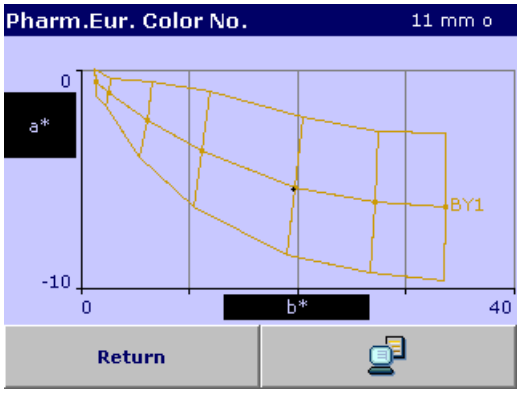


The CIE L*a*b* values depend on the path length of the cuvette/sample cell. Therefore the scale of the a*, b* axis in the graph depends also on the cuvette/sample cell size.

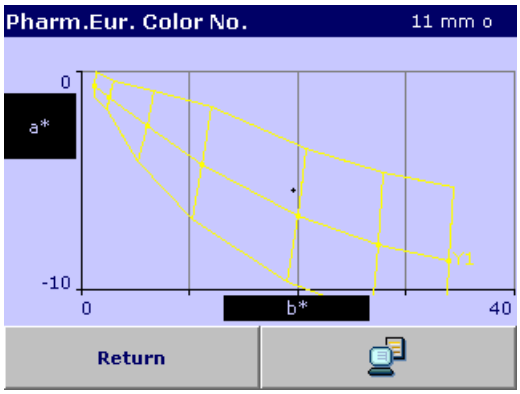
Graph for the greenish yellow scale GY.



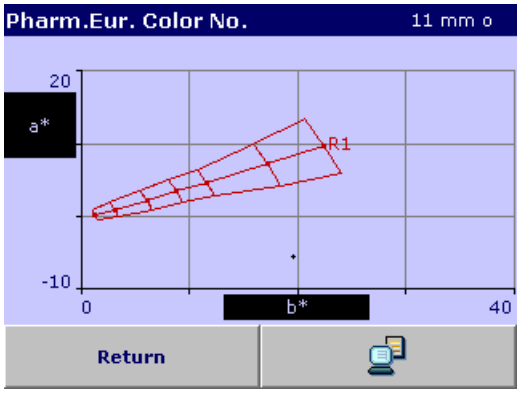
Graph for the brownish scale B.



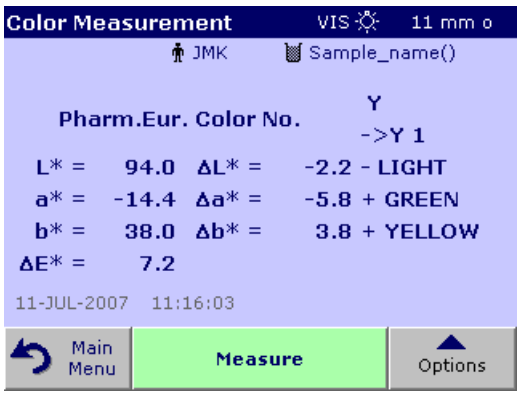
Graph for the brownish yellow scale BY.



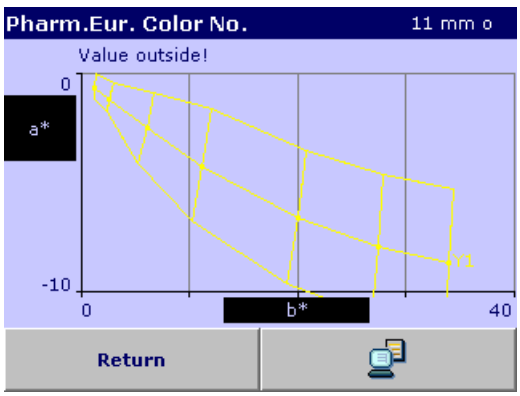
Graph for the yellow scale Y.



Graph for the red scale R.



If the CIE-L*a*b* color locus of the sample does not match any reference solution in a selected scale, the sign **->** nearest will appear followed by the name of the reference solution with the lowest color difference ΔE*. In this case select **Auto** for a color matching in all scales to see which color scale and color reference solution is the closest to the sample color.

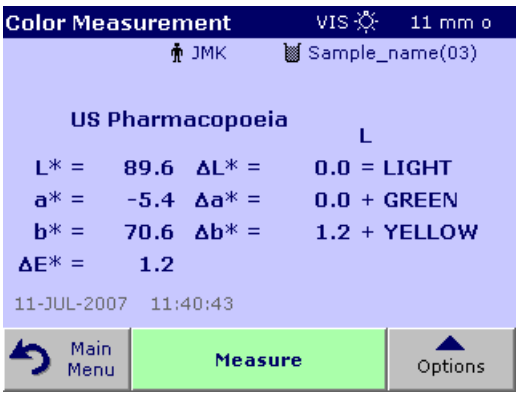


If the color locus of the sample is outside the graph of a standard scale, the error message **Value outside!** will be displayed above the graph.

5.5.3 Take a US Pharmacopoeia color measurement

The LICO 500 method of determining color in accordance with the U.S. Pharmacopoeia corresponds to the specifications in Chapter 631 "Color and Achromicity " and Chapter 1061 "Color - Instrumental measurement ". A total of 20 color reference solutions (identified sequentially by the letters A to T) are defined in the U.S. Pharmacopoeia. The color of the measured sample is automatically correlated to the color reference solutions. This means that the color reference solution that is closest to the sample (i.e. the reference solution with the smallest color difference ΔE* to the color of the sample) is displayed. The ΔL*, Δa* and Δb* values give the quantitative differences between the L*,a* and b* values of the sample and those of the displayed USP solutions.

The measurements can be carried out with cuvettes/sample cells with a path length of 10 mm,11 mm or 50 mm. The use of a longer path lengths increase the accuracy associated with the measurement.

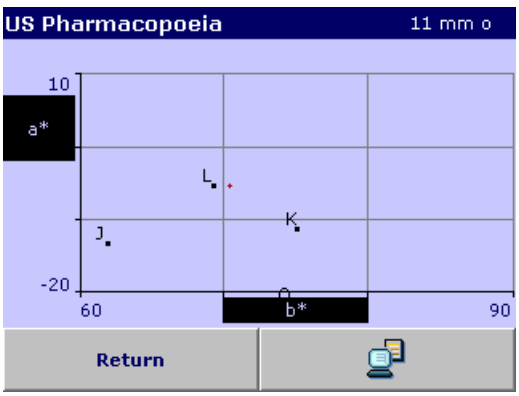


The CIE L*a*b* values depend on the path length and are always related to the type of cuvette/sample cell used.

1. Select **US Pharmacopeia**.
2. Insert the sample cuvette/cell.
3. The result of the color calculation is displayed.

The ΔLab* - values shows the color difference of the measured sample in relation to the nearest USP - Color standard which is shown above the color difference values (here color standard L).

The ΔE* - value shows the three dimensional color difference of the measured sample in relation to the USP Color standard L.



The touch-sensitive area around the matching result (touch-sensitive area 8) is active.

4. Press the area around the matching result. The color axis a*, b* and the loci of the sample (+) is displayed as well as the USP color standards.
5. Press **Printer** for printout or **Return** for exit the window.

5.5.4 Determine the Iodine color value

DIN 6162 defines the Iodine color value as mg of iodine per 100 mL of potassium iodide solution. Color matching with the Iodine color determines the depth of color of clear liquids like solvents, plasticisers, resins, oils and fatty acids, whose color is similar to that of a solution of iodine and potassium iodide of the same thickness.

For iodine color values of less than or approximately 1, the determination of the Hazen value according to DIN-ISO 6271 is to be preferred. Sampling and preparation are described in section 5.4 on page 40 .The Iodine value can be accurately determined using an 11 mm round glass cuvette/sample cell.

5.5.5 Determine the Hazen color value (Pt-Co or APHA-method)

The Hazen color value (ISO 6271, also known as "AHPA-method " or Platinum-Cobalt Scale) is defined as mg of platinum per 1 litre of solution. The Hazen parent solution is composed of 1.246 g of potassium hexachloroplatinate (IV) and 1.00 g of cobalt(II)chloride dissolved in 100 ml of hydrochloric acid and filled up to 1000 ml with distilled water.

The Hazen-color scale is used to evaluate the colors of nearly water-clear products. It has narrower gradations in the light yellow range than the Iodine scale and extends to water-clear color casts.

Note: *Samples with Hazen values between 50 and 1000 can be measured with sufficient accuracy in 10 mm square and 11 mm round cuvettes/sample cells. Hazen values below 50 are measured in 50 mm cuvettes/sample cells. Hazen values below 10 are only be measured with the 50 mm cuvette/sample cell used for calibration, because nearly water-clear products can easily give faulty measuring results due to cuvette/sample cell tolerances.*

5.5.6 Determine the Gardner color value

The Gardner color value is defined in DIN-ISO 4630.The lighter Gardner color values (1 to 8) are based on potassium-chloroplatinate solutions, while the darker ones (9 to 18)are based on solutions of iron(III)chloride, cobalt(II)chloride and hydrochloric acid. The LICO 500 can determine Gardner values at all cuvette/sample cell path lengths (only values 0 to 4 in 50 mm cuvettes/sample cells).

The 10 mm and 11 mm cuvettes/sample cells provide sufficient accuracy.

5.5.7 Determine the Klett color number

The Klett color number is used in the cosmetics industry to evaluate surfactants and detergents. The Klett color number is conventionally measured in 4 cm cuvettes/sample cells with a Summerson photometer, employing a blue filter (no.42).

The measuring range starts at Klett color number 0 and ends at Klett color number 1000.

The LICO 500 can measure the Klett color number with all types of cuvette/sample cell (10,11 and 50 mm), although the 50 mm cuvette/sample cell gives the highest precision. However, the measurement result is always calculated for the Klett 4 cm cuvette/sample cell and blue filter no.42.

5.5.8 Mineral oil color value (ASTM D 1500 and ISO 2049)

The mineral oil color scale is used to evaluate the color of mineral oil products such as lubricating oils, fuel oil, diesel fuel and paraffin. The color scale starts at color value 0 for water-white, non-colored oils and ends at 8 for very dark brown oils. Substances are visually

evaluated in multiples of 0.5 (0.5 1.0 1.5 etc.).The LICO 500 displays the results in multiples of 0.1. For samples whose color value is higher than 8,***is displayed.

Note: *Because of the intensive color of the ASTM D 1500 color value, it is calculated only for 11 mm round or 10 mm square cuvettes/sample cells. No calculation is carried out for the 50 mm path length.*

5.5.9 Determine the Saybolt color number (ASTM D 156)

The Saybolt color scale is used to evaluate refined oil products such as petrol and kerosene, as well as for petroleum waxes and pharmaceutical white oils.

The Saybolt color properties are comparable to those of the Hazen scale (APHA). The Saybolt color scale starts at color number +30 (lightest color, equivalent to approximately 8 to 10 Hazen) and ends at -16 (strongest color, equivalent to approximately 350 Hazen).

Note: *The measurements can be carried out with 10 mm,11 mm or 50 mm cuvette/sample cell path lengths. A longer path length increases the degree of accuracy associated with the measurements (50 mm recommended).*

5.5.10 AOCS Cc 13 e (Lovibond®) scale

The calculation of the Lovibond color values in the LICO 500 is derived from the AOCS Cc 13e or BS 684 -1.14 method and is based on the 5 1 /2 inch or 1 inch yellow/red values of the AF900/AF960 instruments. On the printout the 1" values are identified with 1.

5.5.11 Determine the Yellowness-Index (ASTM D 1925)

The Yellowness Index is calculated and displayed in accordance with ASTM D 1925 for illuminant C and a 2 ° standard observer. This color value can be measured by using 10 mm,11mm or 50 mm cuvettes/sample cells.

The Yellowness Index is calculated as follows:

$$Y i = 100 * (1.277* X 1.059 * Z) / Y$$

5.5.12 Hess-Ives color number

The Hess-Ives color number is used in the cosmetics industry to evaluate the color of fat derivatives. It combines in one number the weighted color intensities that represent the red, green and blue fractions of the sample transmission spectrum at 3 wavelengths. It is defined in DGK 8 method no.F 050.2 and is calculated and displayed by the LICO 500 in accordance with this method. The Hess-Ives color number is calculated from:

$$H - I = ((R + G + B) * 6) / Pathlength$$

where R,G and B are the color components for the red (640 nm), green (560 nm)and blue (464 nm)fractions. For R,G and B:

$$R = 43,45 * E_{640}$$

$$G = 162,38 * E_{560}$$

$$B = 22{,}89 * (E_{460} + E_{470}) / 2$$

5.5.13 The ADMI color number

The ADMI color number is used to measure the color of water and wastewater having color characteristics significantly different from platinum-cobalt standards, as well as to those similar in hue to the standards.

The American Dye Manufacturers Institute (ADMI) has adopted the Platinum-Cobalt standard of the American Public Health Association (APHA) as the standard for color value. Although this standard is yellow, the ADMI method works for all hues.

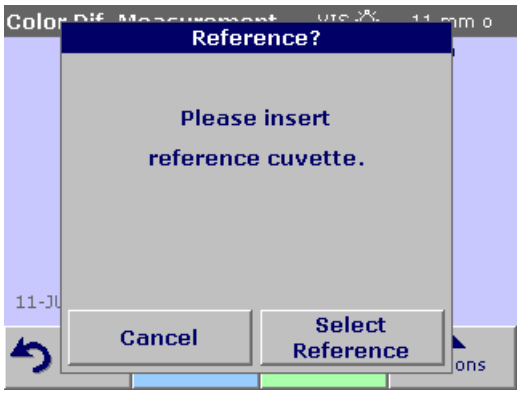
The measurements can be carried out with 10 mm,11 mm or 50 mm cuvette/sample cell path lengths. A longer path length increases the degree of accuracy associated with the measurements (50 mm path length is recommended).

Turbid samples must be filtered prior to analysis.

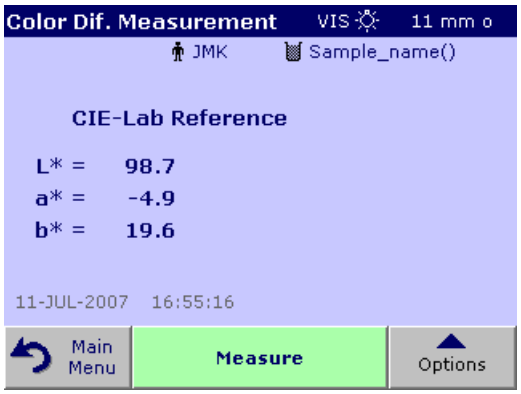
5.6 Color difference measurement

The color difference measurement mode is used to determine a quantitative color difference between a reference (R) and a sample (S) in the three-dimensional color space (CIE L*a*b* or Hunter Lab). In this mode, an additional reference memory for up to 50 references is available.

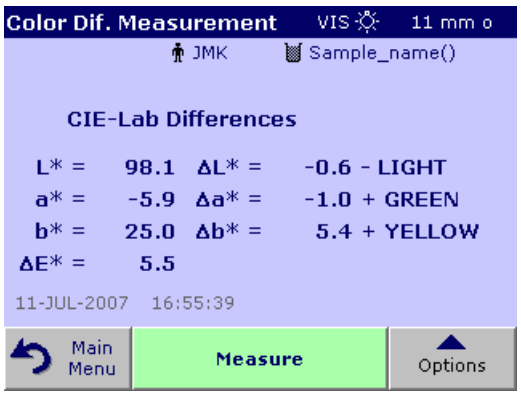
5.6.1 Take a color difference measurement



1. From the Main Menu, press **Color Difference Measurement**.
2. Insert a reference cuvette/cell.

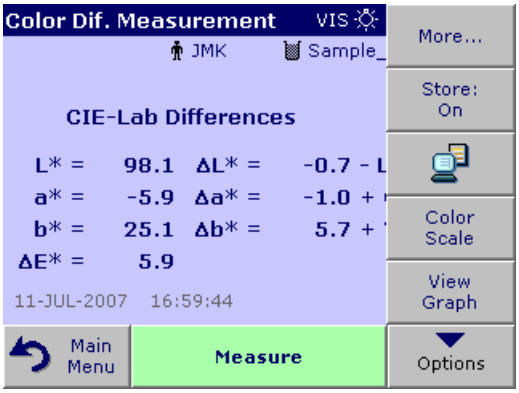


3. The CIE-Lab Reference value of the sample is displayed.
4. Remove the reference cuvette/cell.



5. Insert the sample cuvette/cell or press **Measure** to measure the reference cuvette/cell once again.
6. The color values of the sample and the color differences between the sample and the reference are displayed.

7. Press **Option** for Parameter Setup. Refer to Table 6 for more details on the stored program options.



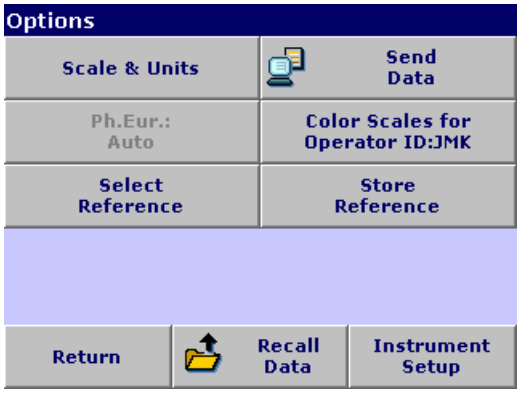
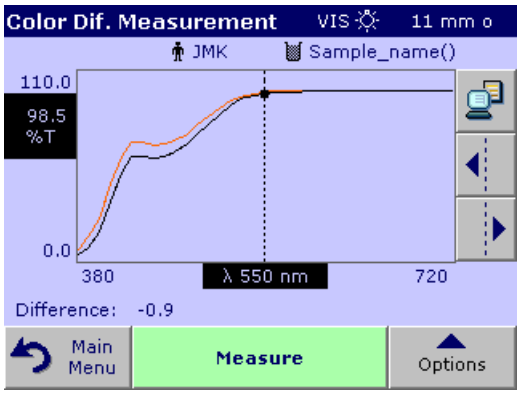


Table 6 Stored programs options

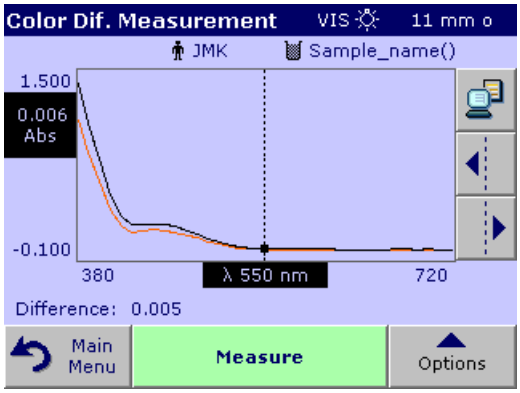
Options	Description
More	For further Options
Store: On	With the **STORE ON** setting, all measurement data are stored automatically. With the **STORE OFF** setting, no measurement data are stored.
Send Data	To send data to a printer, computer or USB memory stick (Type A)
Color Scale	Select the color scale
View Graph **View Table** **View Value**	**VIEW GRAPH** show the spectral graph of the transmission or absorbance curve. View Graph will be activated after the first reading. **VIEW TABLE** show the spectral transmission values T% from 380nm to 720nm. **VIEW VALUES** show the result of the last color calculation.
Scale & Units	**UNITS**: Select absorbance or transmittance. **SCALE**: In the automatic scaling mode, the y-axis is automatically adjusted so that the total scan is displayed. The manual scaling mode allows sections of the scan to be displayed.
Ph.Eur.: Auto	European Pharmacopoeia Select **AUTO** or **SPECIFIED SCALE**
Select Reference	Select stored reference data.
Send Data	To send data to a printer, computer or USB memory stick (Type A)
Color Scales for Operator ID	Configure the color scale to siplay resp. to print
Store Refernece	Stored new reference data.

5.6.1.1 View graph/table/values

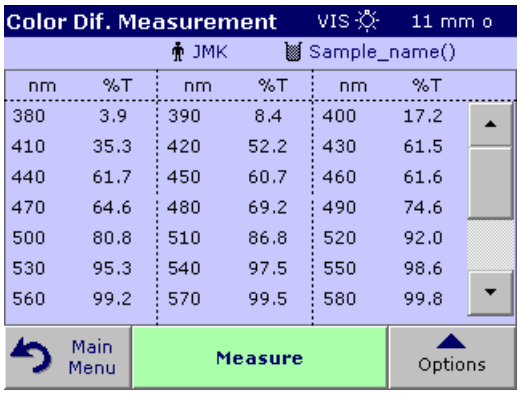


1. Press **Options>View Graph** to display the transmission curve of the sample (black line) and the reference (red line) with the wavelength range from 380nm to 720nm on the x-axis and the %transmission on the y-axis.
   In the middle of the graph a dotted cursor line is displayed. Below the graphic, the transmission difference between reference and sample on the actual cursor position is displayed.

2. Press the appropriate button on the right screen to move the cursor line left or right or touch any position inside of the graph area. In the middle of the x-axis the wavelength at the actual cursor position is displayed.



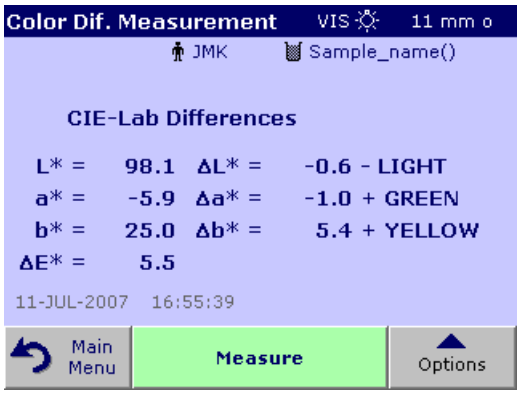
3. Press **Options > More > Scale & Units > %T.** A graph is displayed showing the absorbance curve of the measurement. Below the graph, the absorption difference is displayed.



4. Press **Options > View Table** to switch to the table of the transmission values or absorbance value (depending on the selection in "Scale & Units").

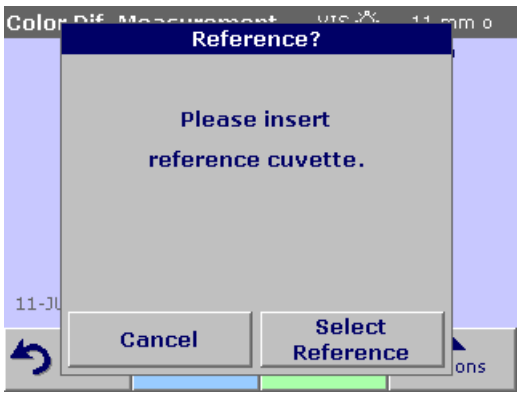
There are three columns that show the wavelength 380 nm to 580 nm and the adequate transmission/absorbance.

Scroll down to show transmission and absorbance wavelengths to 720 nm.

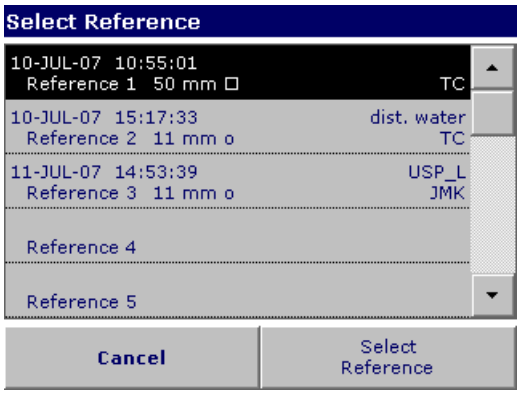


5. Press **Options > View Values** the color value of the sample is displayed.

5.6.2 Take a color difference measurement with stored reference values

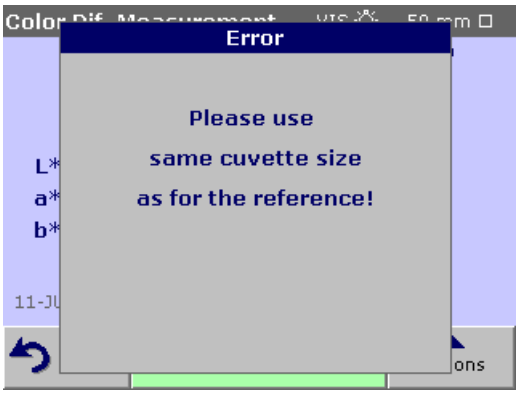


1. Press **Color Difference Measurement** from the Main Menu,
2. Press **Select Reference**.



3. A list of available references is displayed.
4. Press the required reference.
5. Press **Select reference** to confirm.
6. Insert the sample cuvette/cell.

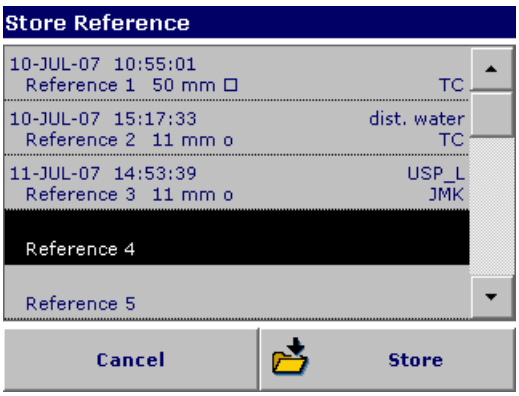
Important Note: *For color difference measurement, it is absolutly necessary that the type of cuvette/sample cell used for sample measurment is identical to the type of cuvette/sample cell which was used for reference measurement.*



Example:

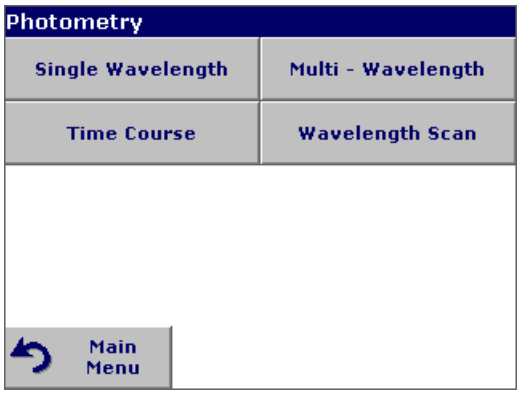
It is not possible to select a reference measured in 10 mm and perfom a difference measurment with 50 mm cuvette/sample cell.

5.6.3 Add a reference to the reference list



1. Press **Color Difference Measurement** from the Main Menu**.**
2. Insert a reference cuvette/cell.
3. Press **Options > More > Store Reference**. The Reference Data list is displayed.
4. Press a free reference number.
5. Press **Store**.

5.7 Photometry



In the photometry mode, photometric measurements can be carried out as:

- Single wavelength measurements
- Multi wavelength measurements
- Time course
- Wavelength Scans

5.7.1 Single Wavelength (absorbance, concentration and transmittance measurements)

The Single Wavelength mode can be used in three ways. For sample measurements at a single wavelength, the instrument can be programmed to measure the absorbance, % transmittance or concentration of the analyte.

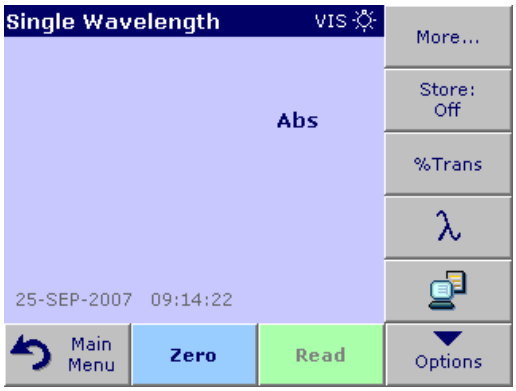
Absorbance measures the amount of light absorbed by the sample, in units of Absorbance.

% transmittance measures the percent of the original light that passes through the sample and reaches the detector.

Turn the concentration factor on to select a specific multiplier for converting absorbance readings to concentration. In a graph of concentration versus the absorbance, the concentration factor is the slope of the line.

5.7.1.1 Set up single wavelength mode

Press **Single Wavelength** in the Main Menu. Press **Options** for Parameter Setup. Table 7 describes the single wavelength setup options.



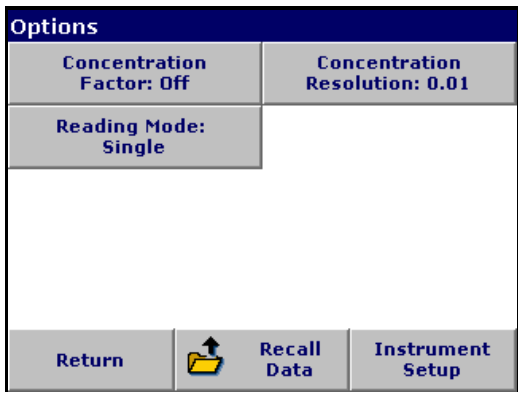
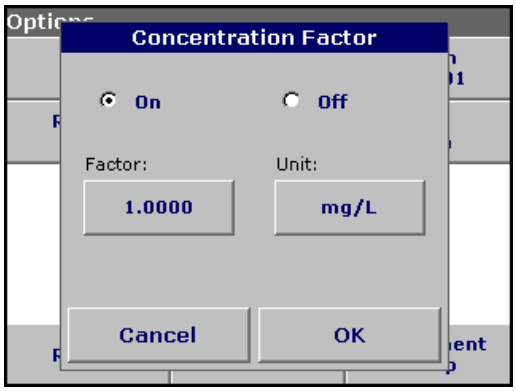


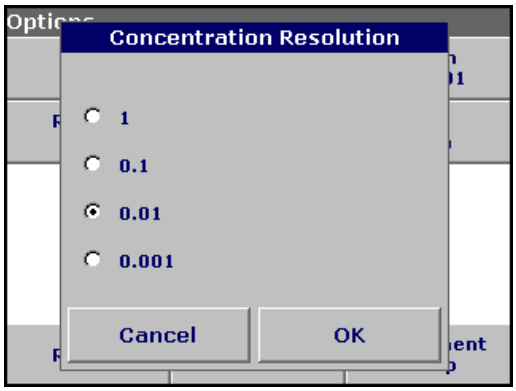
Table 7 Single wavelength setup options

Options	Description
More	For further Options
Store Off/On	With the **Store On** setting, all measurement data are stored automatically. With the **Store Off** setting, no measurement data are stored.
% Trans/Abs	To switch to % transmittance, concentration or absorbance readings
λ **Wavelength**	To enter the measurement wavelength. Use the alphanumeric keypad to enter the measurement wavelength. The entered wavelength must be in the range from 320–1100 nm.
Send Data	To send data to a printer, PC or USB memory stick
Concentration Factor	Multiplication factor for converting absorbance values into concentration values.
Concentration Resolution	To select the position of the decimal point in the calculated concentration readings.
Reading Mode	**Single Reading Mode:** A reading is only displayed after a measurement has been carried out (press Read; standard setting) (see section 5.7.1.2 on page 62). **Continuous Reading Mode:** After the zero measurement, all readings are displayed automatically and continuously (see section 5.7.1.3 on page 62).
Recall Data	Call up saved measurement data, wavelength scans or time courses, see section 5.3 on page 31.
Instrument Setup	Basic data of the instrument, see section 5.2 on page 19.



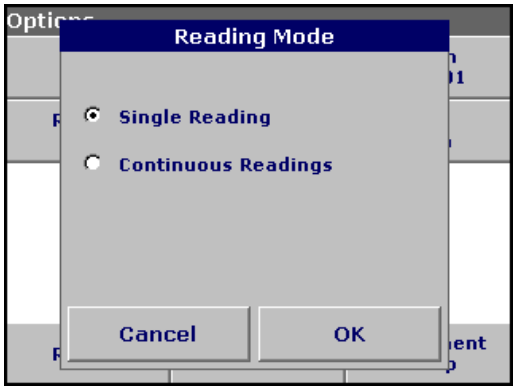
Concentration factor:

1. Press **Concentration Factor: Off** in the Options menu. Press **On** to highlight this feature.
2. Press the ”Factor“ key and use the alphanumeric keypad to enter the factor by which absorbance readings are to be multiplied. Press the ”Unit“ key to select the units for concentration measurements or to create a new unit.
3. Press **OK** to confirm.



Concentration resolution:

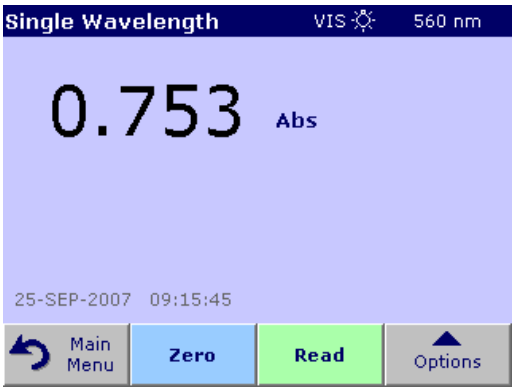
1. Press **Concentration Resolution** in the Options menu.
2. Select the resolution and press **OK** to confirm.



Reading mode:

1. To highlight the required mode, start by pressing **Reading mode**.
2. Select the required mode, then press **OK,** then **Return** to return to the result display.

5.7.1.2 Take single wavelength measurements (single reading)



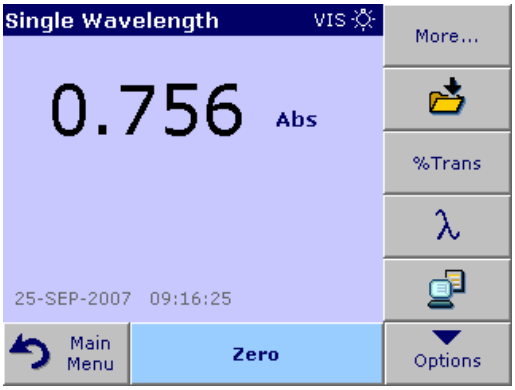
1. Insert the blank cuvette/cell into the cuvette/sample cell holder. Press **Zero**.

   Note: *The **Read** key is only active after the zero measurement has been completed.*

2. Insert the sample cuvette/cell into the cuvette/sample cell holder. Press **Read**.

3. For data storage, see section 5.3.1 on page 31.

5.7.1.3 Take single wavelength measurements (continuous readings)



1. Insert the blank cuvette/cell into the cuvette/sample cell holder. Press **Zero**.

   Note: *In the reading mode "Continuous" only the Zero key is shown to start the reading. The reading sequence is started automatically.*

2. Insert the sample cuvette/cell into the cuvette/sample cell holder.

3. Press **Options** and then the **Store** icon to store the displayed data in the Data Log.

   Note: *For data storage, see section 5.3.1 on page 31.*

5.7.2 Multi-Wavelength mode – measurements at more than one wavelength

In the multi-wavelength mode, absorbance values can be measured at up to four wavelengths and the results can be mathematically processed to obtain sums, differences and relationships.

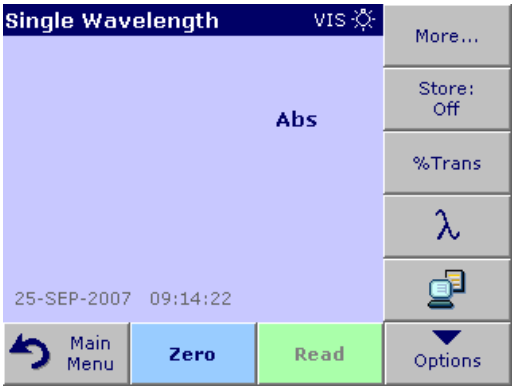
Absorbance measures the amount of light absorbed by the sample, in units of Absorbance.

% Transmittance measures the percent of the original light that passes through the sample and reaches the detector.

Turning on the concentration factor allows selection of a specific multiplier for converting absorbance readings to concentration. In a graph of concentration versus the absorbance, the concentration factor is the slope of the line. Concentration is calculated using a single factor for each wavelength, which is input by the user.

5.7.2.1 Set the reading mode at different wavelengths

Press **Multi Wavelength** in the Main Menu. Press **Options** for Parameter Setup. Table 8 on page 63 describes the multi wavelength setup options.



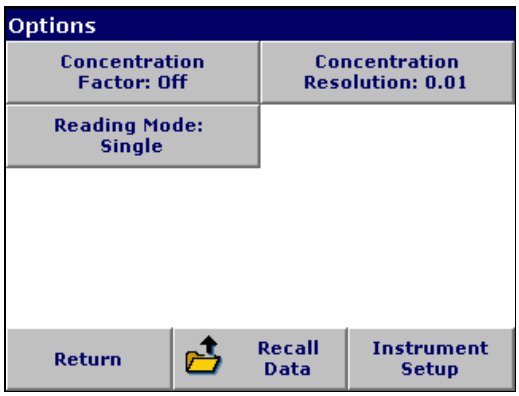
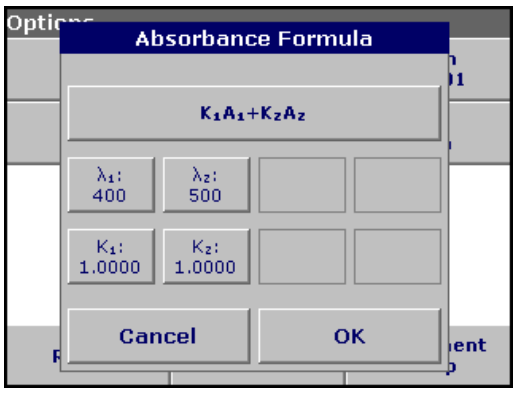


Table 8 Multi-wavelength setup options

Options	Description
More	For further Options
Store Off/On	With the **Store On** setting, all measurement data are stored automatically. With the **Store Off** setting, no measurement data are stored.
% Trans/Abs	To switch to % transmittance, concentration or absorbance readings
λ Wavelength	To enter the measurement wavelength. Use the alphanumeric keypad to enter the measurement wavelength. The entered wavelength must be in the range from 320–1100 nm.
Send Data	To send data to a printer, PC or USB memory stick
Concentration Factor	Multiplication factor for converting absorbance values into concentration values.
Concentration Resolution	To select the position of the decimal point in the calculated concentration readings.
Absorbance Formula	Calculation basis for evaluating samples
Recall Data	Call up saved measurement data, wavelength scans or time courses, see section 5.3 on page 31.
Instrument Setup	Basic data of the instrument, see section 5.2 on page 19.



λ / Absorbance formula:

1. Press **Absorbance Formula**.
2. The formula selected in the top key determines the number of wavelength and coefficent keys that will appear below. To change the absorbance formula, press the top key, select a formula from the displayed list and press **OK.** When a new formula is selected, the number of variables below changes to match.

The following formulas are available:

$K_1 A_1 + K_2 A_2$
$K_1 A_1 + K_2 A_2 + K_3 A_3$
$K_1 A_1 + K_2 A_2 + K_3 A_3 + K_4 A_4$
$K_1 A_1 / K_2 A_2$
$(K_1 A_1 + K_2 A_2) / K_3 A_3$

$(K_1 A_1 + K_2 A_2) / (K_3 A_3 + K_4 A_4)$

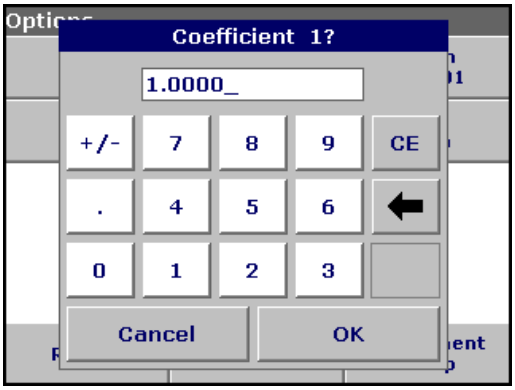
A_1 refers to the absorbance at wavelength 1

A_2 refers to the absorbance at wavelength 2, etc.

K_1 refers to the coefficient at wavelength 1

K_2 refers to the coefficient at wavelength 2, etc.

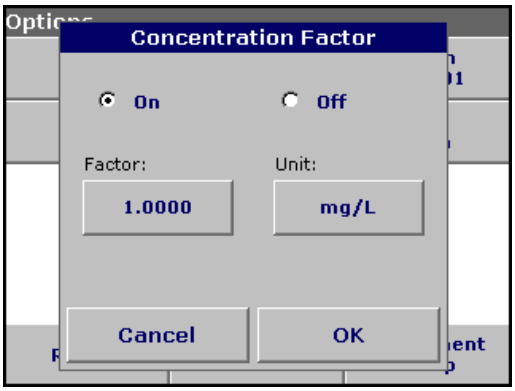
Coefficients can be set negative where subtraction is required.



3. To change a wavelength, press one of the ”λx:“ keys. Enter the desired wavelength coefficient into the numeric keypad. Press **OK** to confirm.

4. To change a coefficient, press one of the ”K_X:**“** keys. Enter the desired coefficient into the numeric keypad. Press **OK** to confirm.

   Note: *The instrument allows entry of up to 5 significant digits, with a maximum of 4 significant digits after the decimal point.*

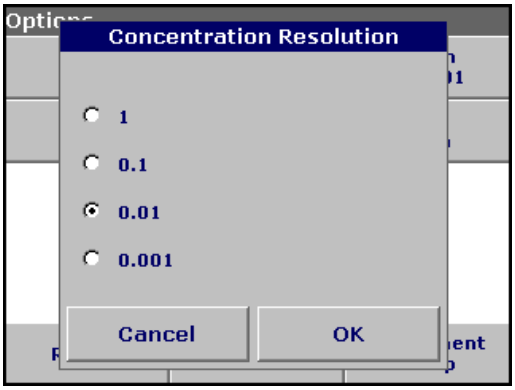


Concentration factor:

1. Press **Concentration Factor: Off** in the Options menu. Press **On** to highlight this feature.

2. Press the ”Factor“ key to enter the factor by which absorbance readings are to be multiplied. Press the ”Unit“ key to select the units for concentration measurements or to create a new unit.

3. Press **OK** to confirm.

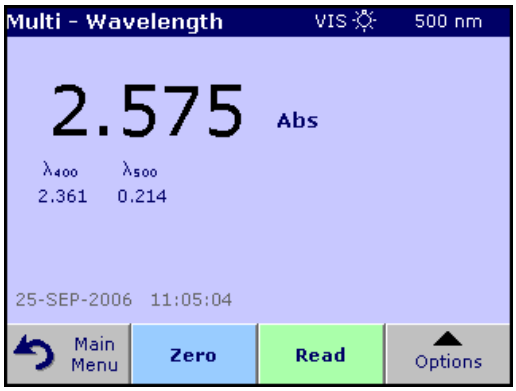


Concentration resolution:

1. Press **Concentration Resolution** in the Options menu.

2. Select the resolution and press **OK** to confirm.

5.7.2.2 Complete a measurement in the multi wavelength mode



1. Insert the blank cuvette/cell into the cuvette/sample cell holder. Press **Zero**.

   Note: *The **Read** key does not become active until the zero measurement has been completed.*

2. Insert the sample cuvette/cell into the cuvette/sample cell holder. Press **Read**.

3. For data storage, see section 5.3.1 on page 31.

5.7.3 Wavelength scan mode – recording of absorbance and transmission spectrums

In the wavelength scan mode, the absorbance of the light in a solution over a defined wavelength spectrum is measured.

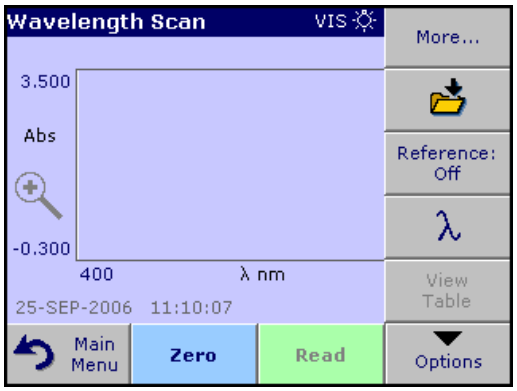
The measurement results can be displayed as a curve, as percentage transmittance (%T) or as Absorbance (Abs). The collected data can be printed as a table or a curve.

The data are available for formatting changes. These include automatic scaling and zoom functions. Maximum and minimum values are determined and shown as a table.

The cursor can be moved to any point on the curve for the purpose of reading off the absorbance or transmittance value and the wavelength. The data associated with each data point can also be shown as a table.

5.7.3.1 Set up the wavelength scan

Press **Wavelength Scan** in the Main Menu. Press **Options** for Parameter Setup. Table 9 describes the parameter setup options.



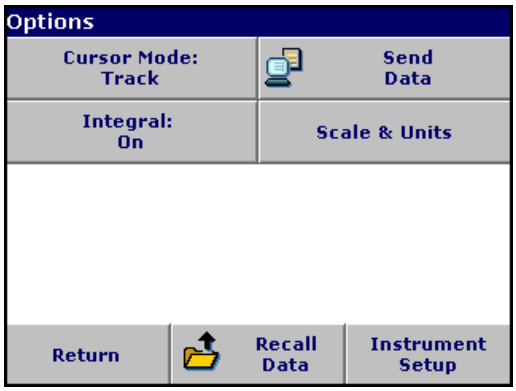
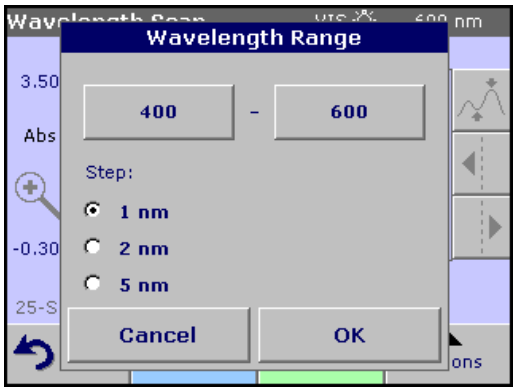


Table 9 Wavelength scan setup options

Option	Description
More	For further Options
Store icon	To store the scan data
Reference Off/On	From the displayed list of stored scans, a record is selected for use as a reference scan/superimposed scan. This can be highlighted or shown in the background in comparison with the actual measured scan. ***Note:*** *This option is only available when there are stored scans with the same wavelength range and step.*
λ	To enter the wavelength spectrum and the scan interval
Select View	Enables the user to switch the display back and forth between the scan data tables (wavelength/absorbance) and the graph of the curve. ***Note:*** *Select View will be activated after the first reading.*
Cursor Mode	To select **Track** or **Peak/Valley**. The selection for this menu item determines to which points on the graph the cursor moves.
Send Data	To send Data to a printer, computer or USB memory stick (Type A)
Integral: On/Off	The integral gives the area and the derivative of the integral gives the original function
Scale & Units	**Scale:** In the automatic scaling mode, the y-axis is automatically adjusted so that the total scan is displayed. The manual scaling mode allows sections of the scan to be displayed. **Units:** Choice of absorbance or transmittance.
Recall Data	Call up saved measurement data, wavelength scans or time courses, see section 5.3 on page 31.
Instrument Setup	Basic data of the instrument, see section 5.2 on page 19.



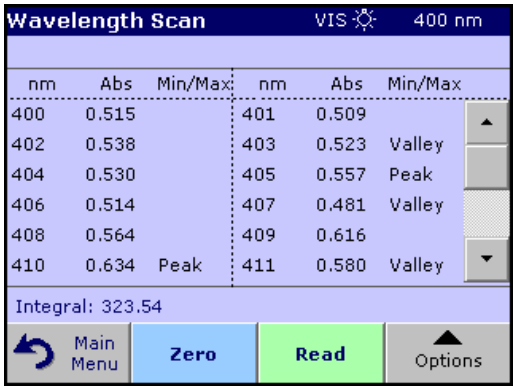
λ Setting wavelength

1. Press the λ key in the Options menu to select the wavelength range and the wavelength step.
2. Press the upper left key to open the numeric keypad and select the minimum wavelength. Press **OK** to confirm.
3. Press the upper right key to open the numeric keypad and select the maximum wavelength. Press **OK** to confirm.

   Note: *Do not select the same wavelength for minimum and maximum.*
4. Highlight the required wavelength step.

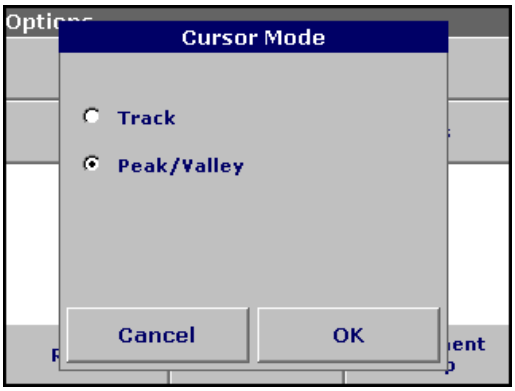
   Note: *Scan recordings of high resolution data take a longer time than recordings of low resolution data.Selecting a larger step allows the instrument to scan faster, but decreases the resolution of the collected data.*
5. According to the selected wavelength range, select the interval from the actively displayed wavelength steps. In summery maximally 780 measuring steps can be accomplished during a Scan.

   Note: *The maximum wavelength adjust automatically if the difference between the maximum and minimum wavelength is not a multiple of the interval.*
6. Press **OK** to return to the scan mode. Selected parameters are displayed along the graph‘s x-axis.



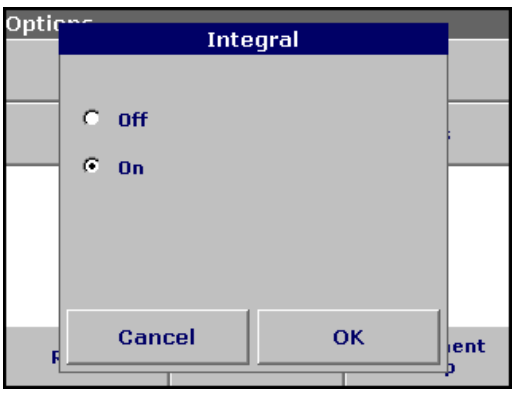
Select view (displaying table)

1. Press **Select View** in the Options menu after a reading is taken.
2. A table with the results is displayed.
3. To return to the graph press **Options** and then **View Graph**.



Cursor mode

1. Press **Cursor Mode: Track** in the Options menu.
2. The selection for this menu item determines what data are displayed in the table. Highlight **Track** or **Peak/Valley.**
3. Press **OK** to confirm.
4. Press **Return** to return to the scan mode.

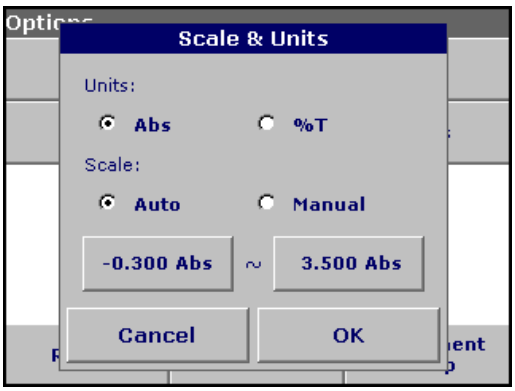


Integral
The Integral applies to the whole wavelength range of the scan.

1. Press **Integral: Off** in the Options menu.
2. Highlight **On** to show the Integral. To find the integral of other wavelength ranges, change the wavelength range and scan again.
3. Press **OK** to confirm.
4. Press **Return** to return to the scan mode.

Note: *The Integral is shown instead of the date on the display.*

Note: *For the next scan measurement the setting for the Integral will be* ***On****.*



Scale & units

1. Press **Scale & Units**.
2. Highlight the required units (**Abs** or **%T**).
3. Highlight **Auto** or **Manual** scaling on the graph´s y-axis .

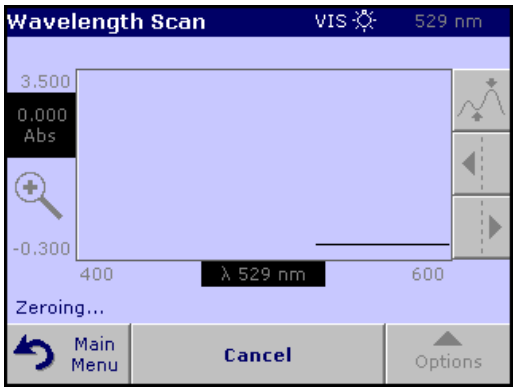
Note: *If manual scaling is selected, use the alphanumeric keypad to set the limits* $y_{min.}$ *and* $y_{max.}$*. The graph is adjusted to display only the values in the selected range. If automatic scaling is selected, the instrument sets the limits automatically so that the total range can be displayed.*

4. Press **OK**.
5. Press **Return** to return to the scan mode.

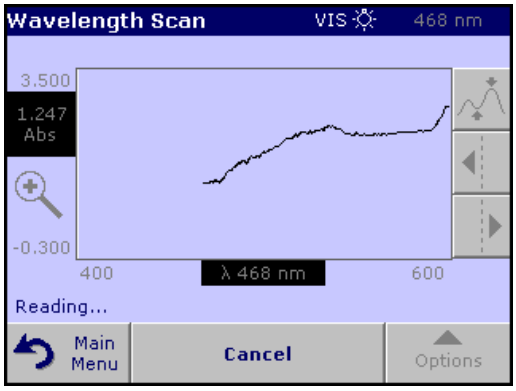
5.7.3.2 Wavelength scan reading

After the scanning parameters have been selected, the baseline must be scanned. Changing any of the scanning parameters

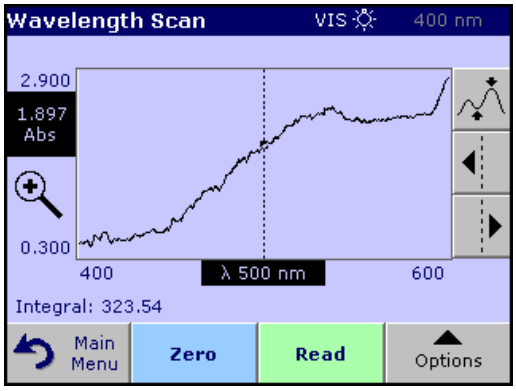
requires a new baseline scan. When the baseline has been scanned, the instrument is ready to scan one or more samples.



1. Press **Wavelength Scan** in the Main Menu.
2. Insert the blank cuvette/cell into the cuvette/sample cell holder.



3. Press **Zero**. ”Zeroing“ appears below the graph as the baseline scan begins.
4. Insert the prepared sample cuvette/cell into the cuvette/sample cell holder.
5. Press **Read**. Below the graph ”Reading“ appears and a graph of the absorbance or transmittance values at the scanned wavelengths is displayed continuously.



The Wavelength Scan is complete, if

- the graph is shown full size,
- the scaling of the x-axis fits automatically,
- the Cursor functions in the vertical navigation bar are highlighted.

The navigation functions of the wavelength scan graph or a wavelength scan analysis are described in Table 10.

Table 10 Navigating the wavelength scan

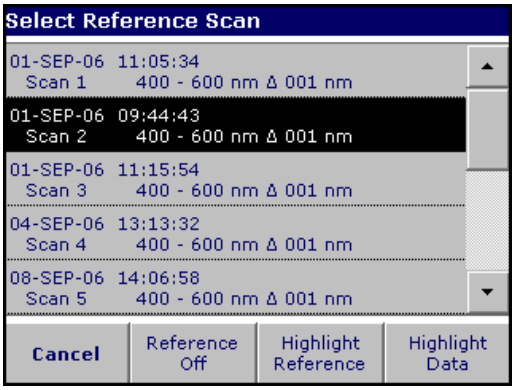
Cursor Function/ Zoom Function	Description
Curve Icon (Choice of Cursor Mode)	Choice of Cursor Mode **Peak/Valley** (cursor moves between minimum/maximum absorbance values) or Cursor Mode **Tracking** (cursor moves over each data point of the scan).

Table 10 Navigating the wavelength scan

Cursor Function/ Zoom Function	Description
Arrow keys	The arrow keys are used (right/left) to move the cursor (depending on the selected mode) to the next data point. The data of the data point (wavelength/absorbance or transmittance value) are highlighted on the x and y axes. ***Note:*** *Press any point on the curve to display the associated data.*
Zoom Icon	This function is used to magnify the section of the curve in the vicinity of the cursor. The original curve size can be restored by pressing the zoom icon again.

5.7.3.3 Work with reference scans

There are two options to work with **Reference Scan**:



First option:

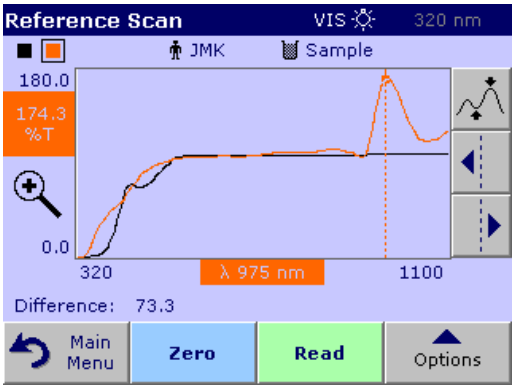
1. Press **Reference: Off** in the Options menu to select another scan to display on the same screen with the current scan. Highlight the required scan number and press **Highlight Reference**.

   Note: *After selecting a reference scan the* ***Reference: Off*** *key in the Options menu turns into* ***Reference: On****.*

   Note: *Only scans that have the same wavelength range and step can be displayed using the overlay option. This process can be repeated until all matching scans are displayed.*

2. The reference curve is shown in orange. The absorbance or transmittance value and the associated wavelength are highlighted in grey.

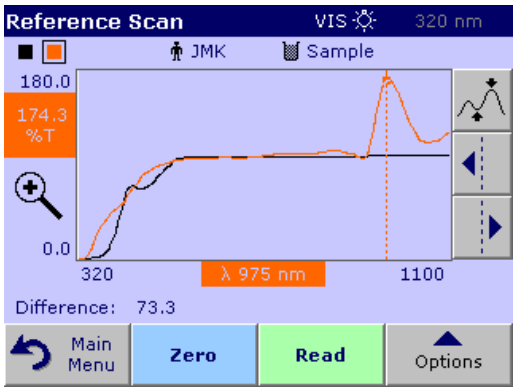
   Note: *A black and an orange box are shown in the left corner of the display. The orange box relates to the reference scan and the black one relates to the current wavelength scan.*



3. To complete the wavelength scan reading, see section 5.7.3.2 on page 68.

   - The newly plotted wavelength scan curves and the absorbance or transmittance value are highlighted in black.
   - In addition, the display shows the difference between the wavelength scan curve and the reference curve against the wavelength.

4. Press the black or orange small box in the left upper corner on the screen to switch between the actual wavelength scan and reference scan.



Second option:

1. Insert the blank cuvette/cell into the cuvette/sample cell holder. Press **Zero**.

2. Insert the sample cuvette/cell into the cuvette/sample cell holder. Press **Read**.

   - The newly plotted wavelength scan curves are shown in black.
   - The absorbance or transmittance value and the associated wavelength are highlighted in black.

3. Press **Options** and then **Reference: Off** in the Options menu to select another scan to display on the same screen with the current scan. Highlight the required scan number and press **Highlight Reference**.

   Note: *After selecting a reference scan the* ***Reference: Off*** *key in the Options menu turns into* ***Reference: On****.*

   Note: *Only scans that have the same wavelength range and step can be displayed using the overlay option. This process can be repeated until all matching scans are displayed.*

4. The reference curve is shown in orange. The absorbance or transmittance value and the associated wavelength are highlighted in orange.

   - Additionally the difference of the extinction and/or transmission value between the two Scans (measured Scan and reference Scan) is indicated/highlighted at each position of the cursor.

   Note: *A black and an orange box are shown in the left corner of the display. The orange box relates to the reference scan and the black one relates to the current wavelength scan.*

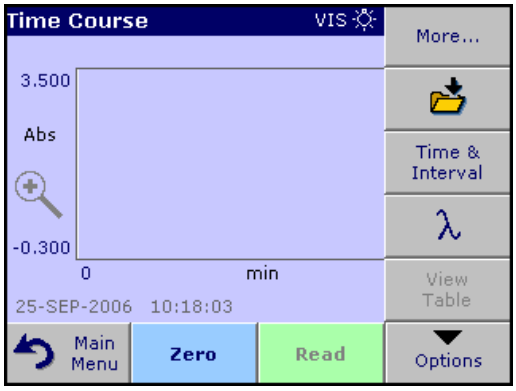
5. Press the black or orange small box in the left upper corner on the screen to switch between the actual wavelength scan and reference scan.

5.7.4 Time course of absorbance/transmittance

The Time Course Mode is used to collect data in either absorbance or transmittance for a user-specified length of time. After the data are collected, they can be displayed in either graphic or tabular format.

5.7.4.1 Time course setup parameters

Press **Time Course** mode in the Main Menu. Press **Options** to configure parameters. Table 11 describes the configure parameter options.



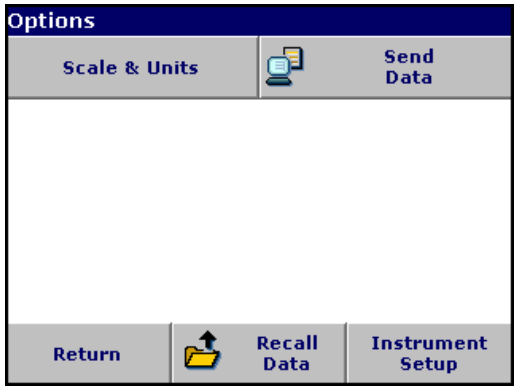
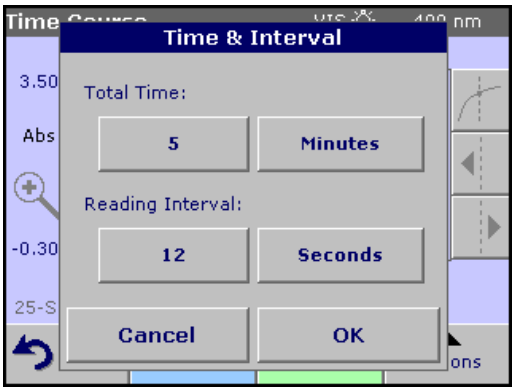


Table 11 Time course setup options

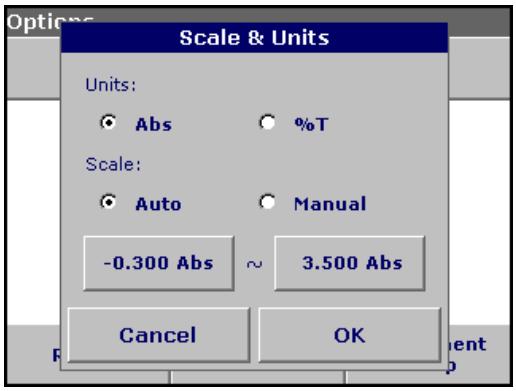
Option	Description
More	For further Options
Store icon	To store the scan data
Time & Interval	To input the total time for data collection and the time interval between the collection of data points
λ	To input the wavelength setting
View Table	To display readings in absorbance, transmittance or concentration. This can be changed after sample data are collected
Scale & Units	**Scale:** In the automatic scaling mode, the y-axis is automatically adjusted so that the total scan is displayed. The manual scaling mode allows sections of the scan to be displayed. **Units:** Choice of absorbance or transmittance.
Send Data	To send Data to a printer, computer or USB memory stick (Type A)
Recall Data	Call up saved measurement data, wavelength scans or time courses, see section 5.3 on page 31.
Instrument Setup	Basic data of the instrument, see section 5.2 on page 19.



Time & interval:

1. Press **Time & Interval** in the Options menu.
2. Input the total time and the reading time and press **OK** to confirm.

Note: *In total 500 measuring steps are possible. To select a total time and a time interval that would cause this number of measurements to be exceeded, the time interval is defined automatically and the* ***OK*** *key is inactivated.*



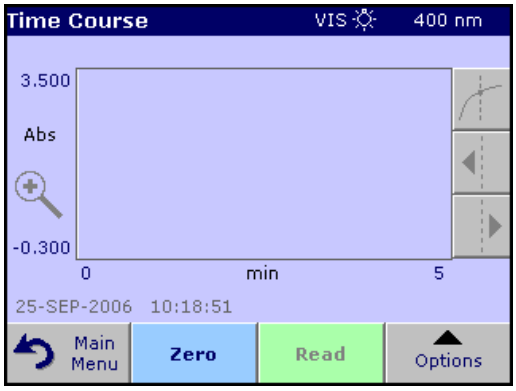
Scale & units:

1. Press **Scale & Units** in the Options menu.
2. Highlight **Abs** or **%T** as the required units.
3. Highlight **Auto** or **Manual** scaling on the graph´s y-axis.

Note: *If manual scaling is selected, use the alphanumeric keypad to set the limits* $y_{min.}$ *and* $y_{max.}$*. The graph is adjusted to display only the values in the selected range. If automatic scaling is selected, the instrument sets the limits automatically so that the total range can be displayed.*

4. Press **OK** to confirm.
5. Press **Return** to return to the scan mode.

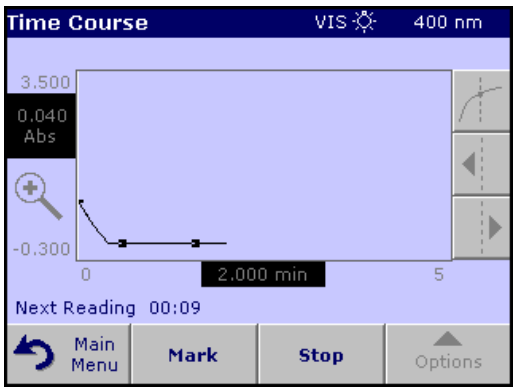
5.7.4.2 Time course scan reading



After the parameters have been selected, the instrument must be blanked, then the sample can be analyzed.

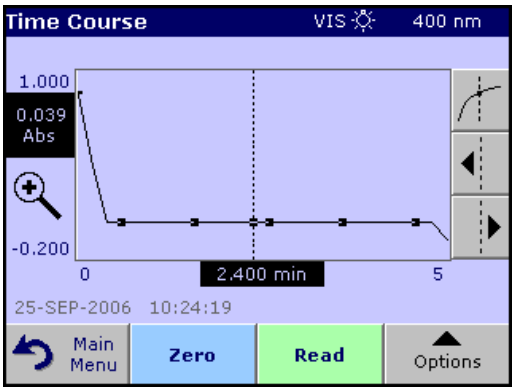
1. Insert the blank cuvette/cell into the cuvette/sample cell holder. Press **Zero**. The blank reading is shown on the display.
2. Insert the sample cuvette/cell into the cuvette/sample cell holder. Press **Read**. Start collecting time course (kinetic) data.

   Note: *During the measurement the* ***Zero*** *and* ***Read*** *keys change to* ***Mark*** *and* ***Stop****.*



- Select **Mark** to mark the next data point collected. This mark is not used by the instrument, but is available for the user and may indicate a significant event, such as the addition of a sample or other reagent. The mark is also shown in the table.
- Select **Stop** to end the sample readings.

5.7.4.3 Analysis of time course data



The **Time Course** Program is complete, if

- the sound is turned on, the instrument beeps when the readings are done
- the graph is shown fullsize,
- the x-axis is scaled automatically,
- the Cursor functions in the vertical navigation bar are highlighted.

5.7.4.4 Navigation of a time scan or a time scan analysis

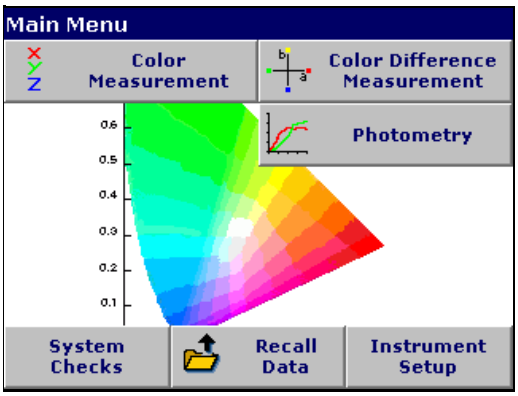
After a time scan has been completed, the time and the absorbance/transmittance data are displayed as a curve.

Where the cursor is positioned on the curve, the elapsed time up to this point and the corresponding absorbance are highlighted. The navigation functions of a time scan or time scan analysis are described in Table 12.

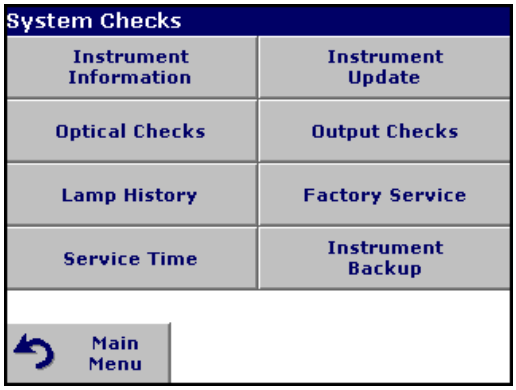
Table 12 Navigating the time scan

Cursor Function/ Zoom Function	Description
Curve Icon (Choice of Cursor Mode)	**Delta mode:** A second cursor is highlighted. The position of the fixed cursor was previously defined in Cursor Mode Single. Use the active cursor to select any point on the measurement curve. The difference to the fixed cursor is shown on the curve. The delta values are correspondingly highlighted and displayed on the x and y axes. The gradient of the curve and the correlation coefficient (r^2) between the cursor points in the Delta mode are shown under the curve.
	Cursor Mode Single: The cursor moves to each selected measurement point of the scan.
Arrow keys	The arrow keys (right/left) are used to move the cursor (depending on the selected mode) to the next data point. The data of the data point (wavelength/absorbance or transmittance value) are highlighted on the x and y axes. ***Note:*** *Press any point on the curve to display the associated data.*
Zoom Icon	This function is used to magnify the section of the curve in the vicinity of the cursor. The original curve size can be restored by pressing the zoom icon again.

6.1 System checks



1. Press **System Checks** in the Main Menu.



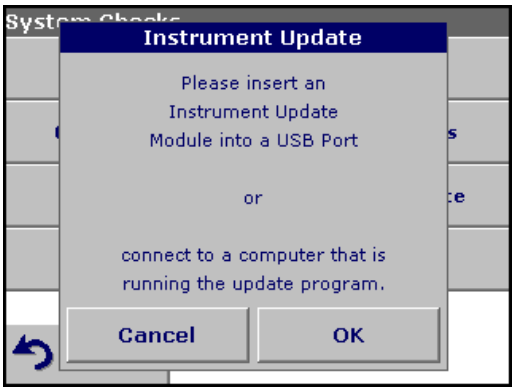
The System Checks menu contains instrument information and various performance tests.

6.1.1 Instrument information

1. Press **Instrument Information** in the System Checks menu.
2. The model, serial number and software version are displayed.

6.1.2 Upgrade of the instrument software

To obtain the software for the update from the Internet at **www.hach-lange.com**.

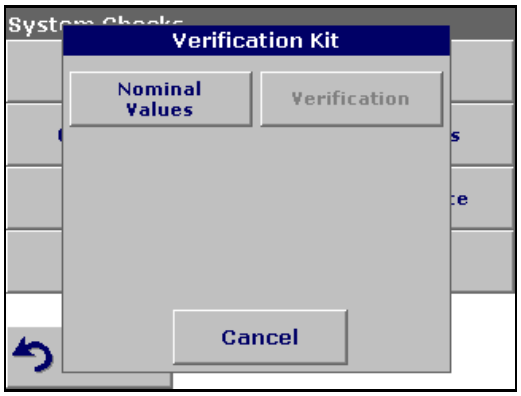


1. Go to **http://www.hach-lange.com**
2. Select the country and go to **Download>Software**.
3. Enter **LICO 500** in ”Search for documents“.
4. Locate the appropriate download and follow the prompts for saving the file(s) to the USB memory stick (Section 9 on page 93) or to the PC.
5. Unpack the ZIP file and save the files to the USB memory stick.
6. Press **Instrument Update** in the System Checks menu.
7. Connect the USB memory stick to the USB interface (type A) on the instrument, see section 3.4 on page 11.
8. Press **OK**. The link is established automatically and the software is updated.
9. Press **OK** to return to the System Checks menu.

Note: *When the instrument software has been updated, a prompt to restart the instrument is displayed.*

6.1.3 Optical checks

1. Press **Optical Checks** in the System Checks menu.



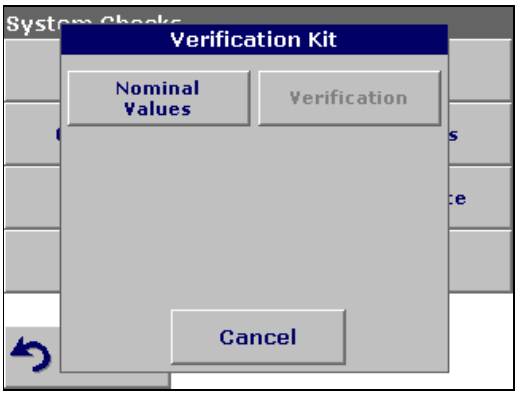
The Optical Checks menu for checking the wavelength accuracy, stray light and photometric accuracy.

An test filter set (Verification Kit) (Section 9 on page 93) containing four precision glass filters, target values and instructions is available as an aid for carrying out comprehensive in-house instrument checks.

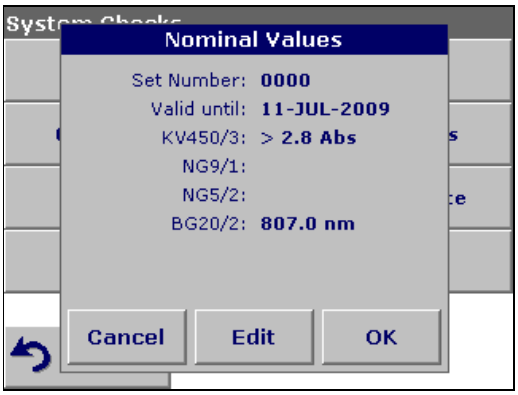
6.1.3.1 Verification kit

The Verification Kit (see Section 9 on page 93) is designed for periodic monitoring of scattered light, photometric accuracy and the wavelength accuracy of the spectrophotometers.

When results exceed allowable tolerances (given in the quality control certificate to the test record), contact the manufacturer.



1. Press **Nominal Values**.

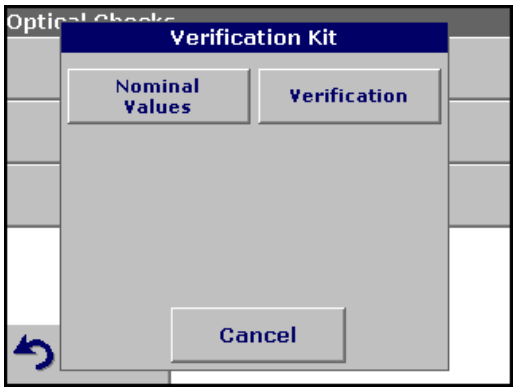


2. Press **Edit**.

   An automatic menu guidance queries values (filters, wavelength, nominal values and tolerances) given in the quality control certificate, to the following specifications:

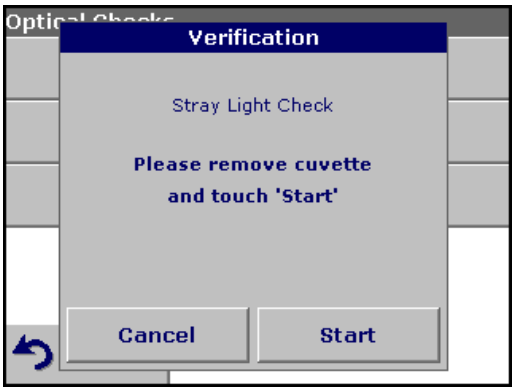
   - Stray Light
   - Photometrical accuracy
   - Wavelength accuracy

3. Press **OK** when all values are entered and the overview is displayed.

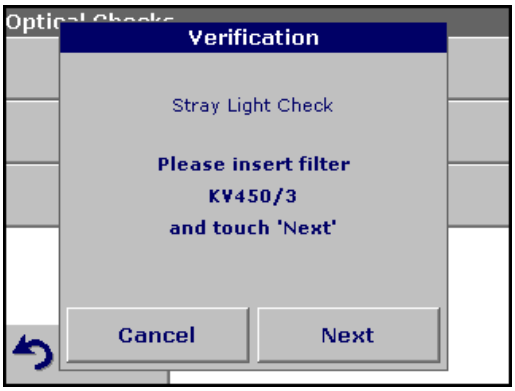


4. Press **Verification**.

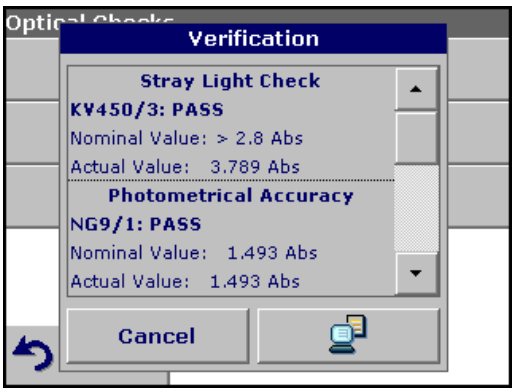
5. Insert the adapter Z (Figure 4 on page 13) in cell compartment #2.



6. Remove any cuvettes/sample cells from the cell compartment and press **Start**.



7. Insert the different filter in the given order one after the other. Press **Next** after inserting a filter.



After the last measurement the results are displayed.

8. Press **PC & Printer** icon to send the data to a USB memory stick, PC or to a printer.

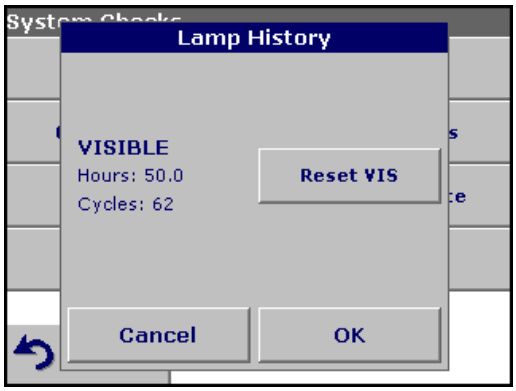
The files will be stored automatically as CSV file (Comma Seperated Value). The file name will be formatted as “Verification.csv“.

6.1.4 Output checks

If a printer is connected a test printing of the current screen will be printed.

6.1.5 Lamp history

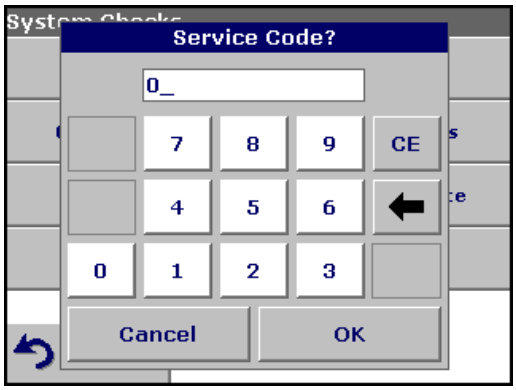
The Lamp History menu provides the amount of time that the lamp has been on (Hours).



After a lamp is replaced, the display of the total operating time is reset to 0.

1. Press **Lamp History** in the System Checks menu.
2. Press **Reset VIS** and the Visible Lamp will be reset.
3. Press **OK** to return to System Checks.

6.1.5.1 Factory service



The Factory Service menu is password protected. This menu is not intended for customer use.

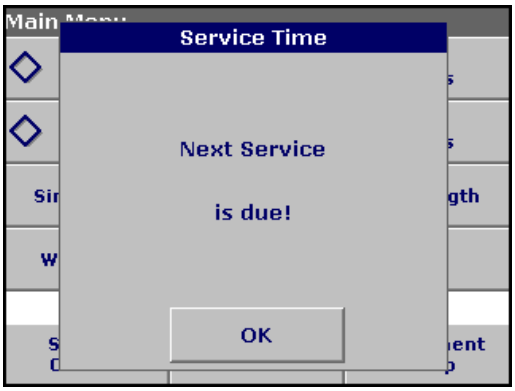
6.1.6 Service time

In order to make sure a regular inspection, an automatic memory reference for the service times can be entered. After switching the instrument on this memory reference will be activated and indicated at the appropriate time.

1. Press **Service Time** in the System Checks menu.
2. Select **On** and then **Last Service** to enter the date of the last inspection.
3. Press **OK** to confirm.

4. Select **Next Service** to determine a specific period of time up to the next inspection.

5. Press **OK** to confirm.



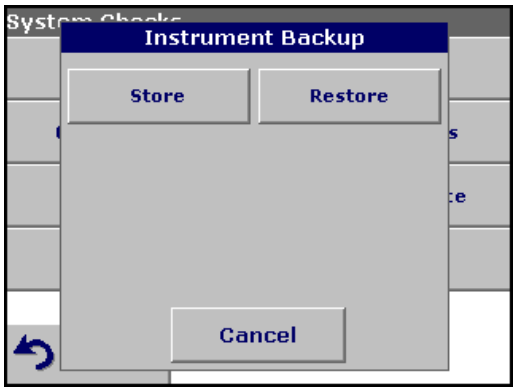
If the next service is due, the message "**Next service is due!**" is displayed after switching on the instrument.

6. Press **OK** to return to the Main Menu.

Contact the manufacturer to arrange an appointment for the next service.

6.1.7 Instrument backup

Before the next service date the Instrument Backup menu offers the possibility to store all programs, measuring data, Operator ID, Sample ID, passwords and all adjustable data on a USB stick.



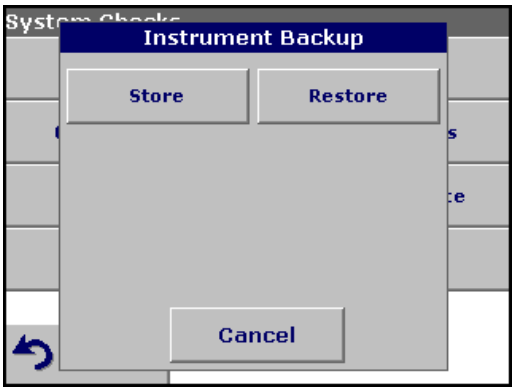
1. Press **Instrument Backup** in the System Checks menu.
2. Connect the USB memory stick (section 3.4 on page 11).
3. Press **Store** to start a Backup.

Note: *If the USB stick is not connected, the message "Please insert USB Memory" is displayed. Connect a USB stick, in order to store the data. Press* ***OK*** *to confirm and press* ***Store*** *again.*

Note: *If the Backup was already stored before, the message "Data already exists. Overwrite?" is displayed. Press* ***OK*** *to overwrite the data.*

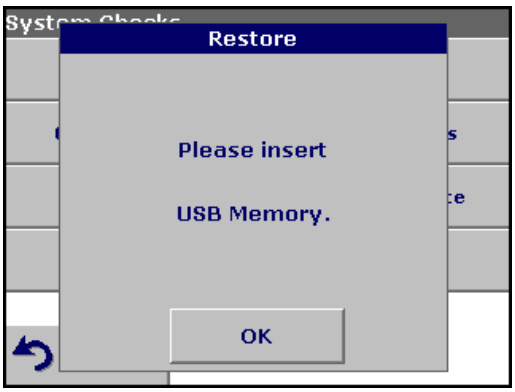
If the file was stored the message Instrument Backup is stored to USB stick will be displayed.

4. Press **OK** to return to the System Checks menu.



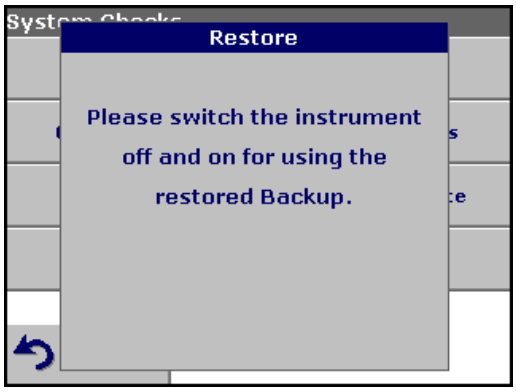
Restore backup data:
Important Note: *All current data will be overwritten when restoring the Backup file!*

1. Press **Instrument Backup** in the System Checks menu.
2. Connect the USB memory stick containing the Backup (section 3.4 on page 11).
3. Press **Restore** to pass back the data.



Note: *If the USB stick is not connected, the message "Please insert USB Memory" is displayed. Connect a USB stick, in order to store the data. Press **OK** to confirm and press **Restore** again.*

4. Press **OK** to confirm after the message “Instrument Backup from S/N XXXXXXX. Restore?“ is displayed.



5. After the backup start the instrument again.

CAUTION
Potential Chemical, Biological Eye and Skin Hazards.
Only qualified personnel should conduct the tasks described in this section of the manual.

Important Note: *Remove any cuvettes/sample cells that are still in the instrument and dispose of cuvettes/sample cells or its contents using an approved disposal method.*

7.1 Cleaning requirements

CAUTION
Potential Pinch, Eye, Burn and Chemical Hazards.
Always disconnect power from the instrument before attempting any cleaning operations.

Important Note: *Under no circumstances should the instrument, display or the accessories be cleaned with solvents such as white spirit, acetone, etc.*

7.1.1 Housing and cell compartment

- Clean the enclosure, cuvette/sample cell compartments and all accessories with a soft damp cloth. A mild soap solution can also be used. Do not get excess water in the cuvette/sample cell compartments. Do not insert a brush or sharp object into Cell Compartment #1 to avoid damaging the mechanical components.
- Dry the cleaned parts carefully with a soft cotton cloth.

7.1.2 Display

- Take care not to scratch the display. Do not touch the screen with ball pens, pencils or similar pointed objects.
- Clean the display with a soft, lint-free and oil-free cotton cloth. Diluted window cleaner liquid can also be used.

7.1.3 Cuvettes/sample cells

CAUTION
Potential Chemical/ Biological Exposure Hazards.
Use proper laboratory practices whenever there is a risk of chemical exposure.

1. After performing a procedure, clean glass cuvettes/sample cells with cleaning agents.

2. Afterwards, rinse the cuvettes/sample cells several times with tap water and then thoroughly with deionized water.

Important Note: *Glass cuvettes/sample cells that have been used for organic solvents (such as chloroform, benzene, toluene, etc.) must be rinsed with acetone before being treated with cleaning agents. In addition, another rinse with acetone is necessary as a final treatment step before the cuvettes/sample cells are dried.*

7.2 Lamp replacement

CAUTION
To avoid a possible electric shock, disconnect the instrument from the power source before servicing the lamp.

1. Switch the instrument off.

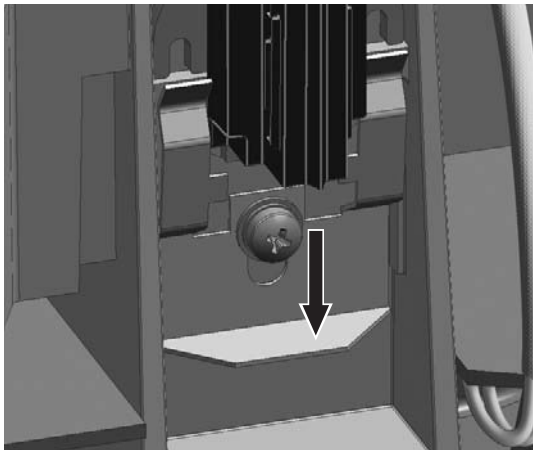
2. Unplug the power cord.

WARNING
Burn Hazard. Wait until the lamp cools down. Contact with the hot lamp can cause burns.

3. Use a screwdriver to remove the cover from the back of the instrument (the screws may be slotted or cross-head).

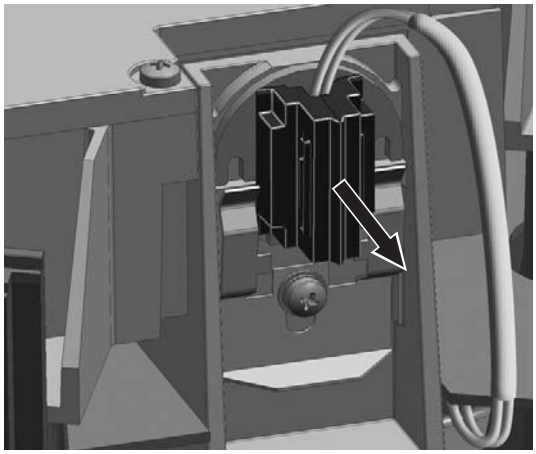
4. Remove the cover.

5. Carefully fold the fan forward (see instrument label 1).

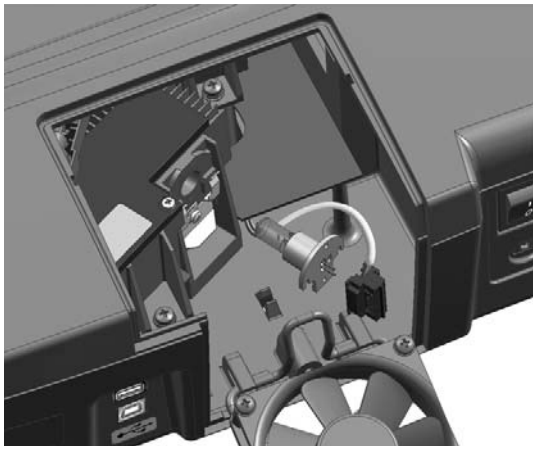


WARNING
Burn Hazard. Wait until the lamp cools down. Contact with the hot lamp can cause burns.

6. Push down on the pressure spring (see instrument label 2).



7. Remove the halogen lamp and the plug panel (see instrument label 3).



Important Note: *Hold the lamp by the fitting only. Avoid touching the glass, as substances on the skin can bake onto the lamp bulb and thus accelerate the ageing process of the lamp.*

8. Plug a new halogen lamp to the panel.

9. Insert the halogen lamp with the half rounded part pointing up.

10. Press the plug with slight pressure into the direction of the halogen lamp and push the pressure spring up, so that it will engage.

11. Fold the fan again, so that it engages.

12. Use a screwdriver to screw the back cover to the instrument.

13. Plug in the power supply.

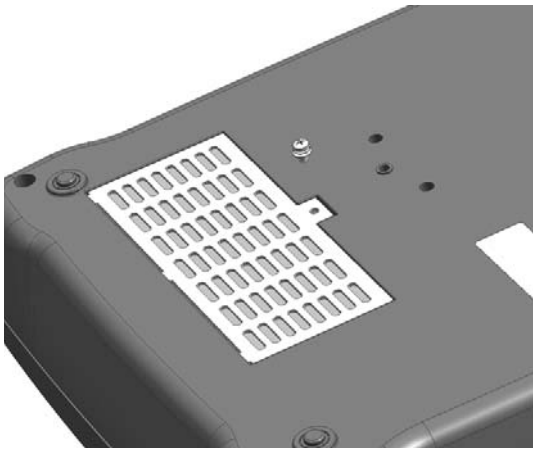
14. Reset the Lamp History, see section 6.1.5 on page 78.

7.3 Filter pad maintenance

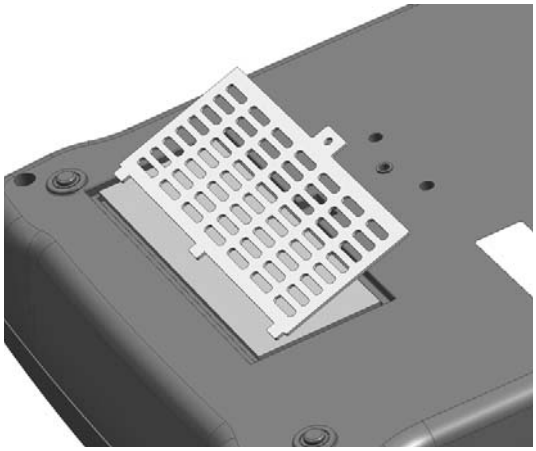
To determine when the filter pad needs to be replaced, inspect the filter pad every 3–6 months (in a relatively dust-free environment, this interval can be longer).

1. Remove any cuvettes/sample cells and cell adapter from the cell compartment.
2. Turn the instrument off.
3. Unplug the power cord.
4. Lift the instrument and check the color of the filter pad. Replace the filter pad if is dark gray or black.

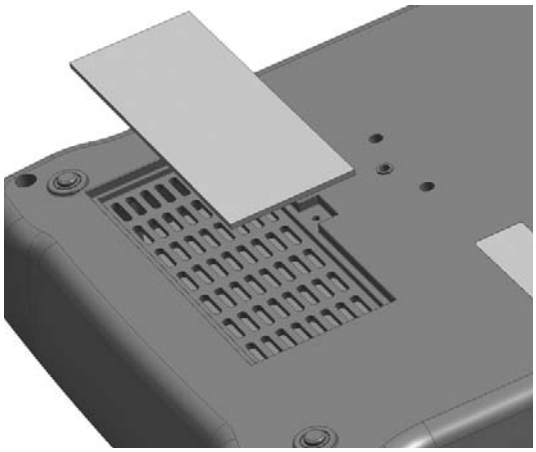
7.3.1 Filter pad replacement



5. Turn the instrument over and place it on a soft surface.
6. Use a screwdriver (standard or cross-head) to open the filter grid (Figure 8, item 1).



7. Lift the filter grid (Figure 8, item 1).



8. Remove the old filter pad (Figure 8, item 3) and replace it with a new one.
9. Screw the grid back in place.
10. Carefully stand the instrument upright.
11. Plug the instrument in.

Figure 8 Base of LICO 500 with filter grid

1	Filter grid	**3**	Filter pad
2	Phillips screw		

Section 8 Troubleshooting

Problem/Display screen	Likely Cause	Action
Please insert adapter Z.	For measurements with 11mm round cells the adapter Z is required.	Insert the adapter Z into cell compartment #2. Press **OK**.
Color = ***	Spectrum locus outside the measuring range.	Dilute the sample or select appropriate color scale.
Absorbance > 3.5!	The measured absorbance exceeds 3.5	Dilute the sample and repeat the measurement
Concentration too high!	Calculated concentration is higher than 999999	Dilute the sample and repeat the measurement
Error **Selfcheck stopped.** **Please check the lamp.** **Please close the lid.** **Error [xx]**	Self-Check Test stops while starting the instrument	Check the lamp and replace, if necessary. Close the lid. Press **Start Again**.
Error **Selfcheck stopped. Please remove the cuvette** **Please close the lid.**	Self-Check Test stops while starting the instrument	Remove the cuvette/sample cell from the cell compartment. Press **OK**.
Error **Selfcheck stopped.** **Hardware error.** **Error [x]**	Electronic defect	Contact the manufacturer or a sales representative and indicate the error number
Error **Too much ambient light!** **Move device into shade** **or close the lid!**	The instrument sensors detects too much ambient light.	Reduce ambient light. (Avoid direct sun light.) Close the lid.
Negative result!	The calculated result is negative	Check the concentration of the sample
No evaluation!	Error in the test database / user database	Check the programming Contact the manufacturer or a sales representative
Over measuring range	The measured absorbance is above the calibration range of the test	Dilute the sample and repeat the measurement
Under measuring range	The measured absorbance is below the calibration range of the test	If possible, select a test with a lower measurement range or use a cuvette/sample cell with a longer path length

Section 9 Replacement Parts

9.1 Replacement parts

Description	Catalog No.
Tungsten Lamp	LZV565
Adapter Z	LZM353
Power supply, external	LZV610
Power line EU	LZV739
Power line UK	LZV740
Power line USA	LZV741
Power line China/Australia	LZV742
USB-Memory Stick	LZV568
USB-Interface Cable (1 m)	LZV567
USB-Keyboard (keyboard layout: US)	LZV582
USB-Barcode Scanner (hand-held scanner)	LZV566
Hach Data Trans (PC software for data transfer)	LZY274
Certified test filter set for self-checks (Verification Kit) 4 precision glass filters with nominal values	LZM339
Dust cover	HYH020
Filter pad	A23766
Thermo printer PD 24, power line EU, USB cable, 1 roll of paper	5835900.00
Thermo printer PD 24, power line UK, USB cable, 1 roll of paper	5835900.82
Thermo printer PD 24, power line CH, USB cable, 1 roll of paper	5835900.51
Certified Testing solution set " Addista-color", consisting of 6 certified test solutions	LZM282
Round cuvettes/sample cells 11 mm, glass, disposable, pk/500	LYY621
Rectangular cuvette/sample cell 50 x 10 mm, plastic , disposable, pK/50	LZM130
Rectangular cuvette/sample cell 50 x 10 mm with caps, plastic , disposable, pK/10	LZP341
Rectangular cuvette/sample cell 50 x 10 mm, glass, pK/1	LZP167
Rectangular cuvette/sample cell 10 x 10 mm, glass, pk/3	LZP045

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The manufacturer warrants that the product supplied is free of material and manufacturing defects and undertakes the obligation to repair or replace any defective parts at zero cost.

The warranty period for instruments is 24 months. If a service contract is taken out within 6 months of purchase, the warranty period is extended to 60 months.

With the exclusion of the further claims, the supplier is liable for defects including the lack of assured properties as follows: all those parts that can be demonstrated to have become unusable or that can only be used with significant limitations due to a situation present prior to the transfer of risk, in particular due to incorrect design, poor materials or inadequate finish will be improved or replaced, at the supplier's discretion. The identification of such defects must be notified to the supplier in writing without delay, however at the latest 7 days after the identification of the fault. If the customer fails to notify the supplier, the product is considered approved despite the defect. Further liability for any direct or indirect damages is not accepted.

If instrument-specific maintenance and servicing work defined by the supplier is to be performed within the warranty period by the customer (maintenance) or by the supplier (servicing) and these requirements are not met, claims for damages due to the failure to comply with the requirements are rendered void.

Any further claims, in particular claims for consequential damages cannot be made.

Consumables and damage caused by improper handling, poor installation or incorrect use are excluded from this clause.