Catalog Number DOC022.53.00654

DR 5000 Spectrophotometer

USER MANUAL

May 2005, Edition 1

eac/dk

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Section 1 Specifications

Specifications are subject to change without notice.

Performance Specifications	
Operating Mode	Transmittance (%), Absorbance and Concentration
Source Lamp	Gas-filled Tungsten (visible) and Deuterium (UV)
Wavelength Range	190–1100 nm
Wavelength Accuracy	± 1 nm in Wavelength Range 200–900 nm
Wavelength Reproducibility	< 0.5 nm
Wavelength Resolution	0.1 nm
Wavelength Calibration	Automatic
Wavelength Selection	Automatic, based on method selection
Scanning Speed	900 nm/min at 1 nm steps 1 complete scan/min
Spectral Bandwidth	2 nm
Photometric Range	± 3.0 Abs in Wavelength Range 200–900 nm
Photometric Accuracy	5 mAbs at 0.0 - 0.5 Abs 1% at 0.50 - 2.0 Abs
Photometric Linearity	< 0.5% at 2 Abs < = 1% at > 2 Abs
Stray Light	Potassium Iodide-solution at 220 nm > 3.3 Abs / < 0.05%
Physical and Environmental	
Width	450 mm (17.7 in.)
Height	200 mm (7.9 in.)
Depth	500 mm (19.7 in.)
Weight	15.5 kg (34.2 lb)
Operating Conditions	10 to 40 °C (50 to 104 °F), max. 80% relative humidity (non-condensing)
Storage Conditions	–25 to 60 °C (–13 to 140 °F) max. 80% relative humidity (non-condensing)
Power Requirements	
Power Connection	100–120 V; 200–240 V; 50/60 Hz; automatic changeover
Interfaces	1 x USB for PCs only 2 x USB 1.1 for printer, USB reading device for memory cards and keyboard
Enclosure Rating	IP 31
Installation Category (after power connection)	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 and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure 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, could result in death or serious injury.

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

Important Note: *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.

	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 for proper disposal.*
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists.
	This symbol, if noted on the product, indicates the need for protective eye wear.
	This symbol, when noted on the product, identifies the location of a fuse or current limiting device.
	This symbol indicates a laser device is used in the equipment.
	This symbol, when noted on the product, indicates elevated, potentially dangerous, levels of non-ionizing radiation
	This symbol, when noted on the product, identifies a risk of chemical harm and indicates that only individuals qualified and trained to work with chemicals should handle chemicals or perform maintenance on chemical delivery systems associated with the equipment.
	This symbol, when noted on the product, indicates that the marked item can be hot and should not be touched without care.
	This symbol, when noted on the product, indicates the presence of devices sensitive to Electro-static Discharge (ESD) and indicates that care must be taken to prevent damage with the equipment.

2.1.3 Class 1 Laser

LASER CLASS 1	Using a laser diode module for reading barcodes/identifying cells Data: 0.2 mW; λ = 650 nm **Complies with 21 CFR 1040.10** **FDA accession number 0510555**

Class 1 lasers are products where the radiant power of the accessible laser beam (the accessible emission) is always below the Maximum Permissible Exposure value. Therefore, for Class 1 lasers the output power is below the level at which it is believed eye damage will occur. Exposure to the beam of a Class 1 laser will not result in eye injury. Class 1 lasers may therefore be considered safe. Class 1 laser products may contain laser systems of a higher Class. However, there are adequate engineering control measures to ensure that access to the beam is not reasonably likely. Examples of such products include laser printers and compact disc players.

2.2 Overview of Product

The DR 5000 Spectrophotometer is a scanning UV/VIS spectrophotometer with a wavelength range of 190 to 1100 nm. The instrument comes with a complete set of application programs and multi-language support.

The DR 5000 Spectrophotometer contains the following application modes: Stored Programs, User Programs, Favorite Programs, Single Wavelength Mode, Multi-Wavelength Mode, Wavelength Scanning Mode, and Time Course Mode.

The DR 5000 is used for testing in visible and ultraviolet wavelengths. A gas-filled tungsten lamp produces light in the visible spectrum (320 to 1100 nm), and a deuterium lamp produces light in the ultraviolet spectrum (190 to 360 nm).

The DR 5000 Spectrophotometer provides digital readouts in direct concentration units, absorbance, or percent transmittance.

When a user-generated or programmed method is selected, the on-screen menus and prompts direct the user through the test.

This menu system can also be used to generate reports, statistical evaluations of generated calibration curves, and to report instrument diagnostic checks.

Section 3 Installation

CAUTION
Only qualified personnel should conduct the tasks described in this section of the manual.

3.1 Unpacking the Instrument

The DR 5000 Spectrophotometer comes packaged with the following items:

- Instrument
- Power Cable
- Multi-Cell Holder
- 1-inch Matched Glass Sample Cell (2)
- 1-cm Matched Quartz Sample Cell (2)
- DR 5000 User Manual
- CD-ROM containing the procedure manual

If any of these items are missing or damaged, contact the manufacturer or a sales representative immediately.

Note: *Retain the original packaging materials. Instruments returned for recycling or service should be shipped in the original packaging material to protect against damage during transportation.*

3.2 Operating Environment

CAUTION
The lamp cover can become hot, especially when the deuterium lamp is used. Do not place anything on top of the cover.

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

The following conditions are necessary to ensure that the instrument runs accurately and has a long life span.

- Place the instrument firmly on an even table surface. Do not push any objects under the instrument, they can block the ventilation slits.
- Maintain an ambient temperature of 10 to 40 °C (50 to 104 °F) 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 inch) clearance at the top and on all sides for air circulation to avoid overheating of the electrical parts.

3.3 Cable Connections

3.3.1 Electrical Safety

To reduce risks of electric shock, this equipment is equipped with a three wire electrical cord and plug to connect the equipment to earth ground. To preserve this safety feature:

- Make sure the matching wall outlet receptacle is properly wired and earth grounded.
- Never use a three or two wire isolating plug adapter.
- Never use a two wire extension cord or a non-grounding type multiple outlet receptacle strip.

Any servicing of this equipment which requires the removal of any covers or panels can expose parts which involve the risk of electric shock or personal injury. Refer such servicing to qualified service personnel.

3.3.2 Power Connections

A UL/CSA-approved 115-VAC power cord with a NEMA 5–15 style plug is supplied with the North American DR 5000 model. A 230 VAC Harmonized power cord with a Continental European plug is supplied with the European DR 5000 model.

To power the North American DR 5000 model with 230 VAC, replace the supplied 115 VAC power cord with a UL/CSA approved 230 VAC power cord with a NEMA 6–15P style plug.

Plug the power cord into the back panel of the instrument. Connect the power cord to the proper outlet and press the power switch on the back of the instrument.

Note: *The equipment voltage setting is automatic, it is not necessary to select an equipment voltage setting.*

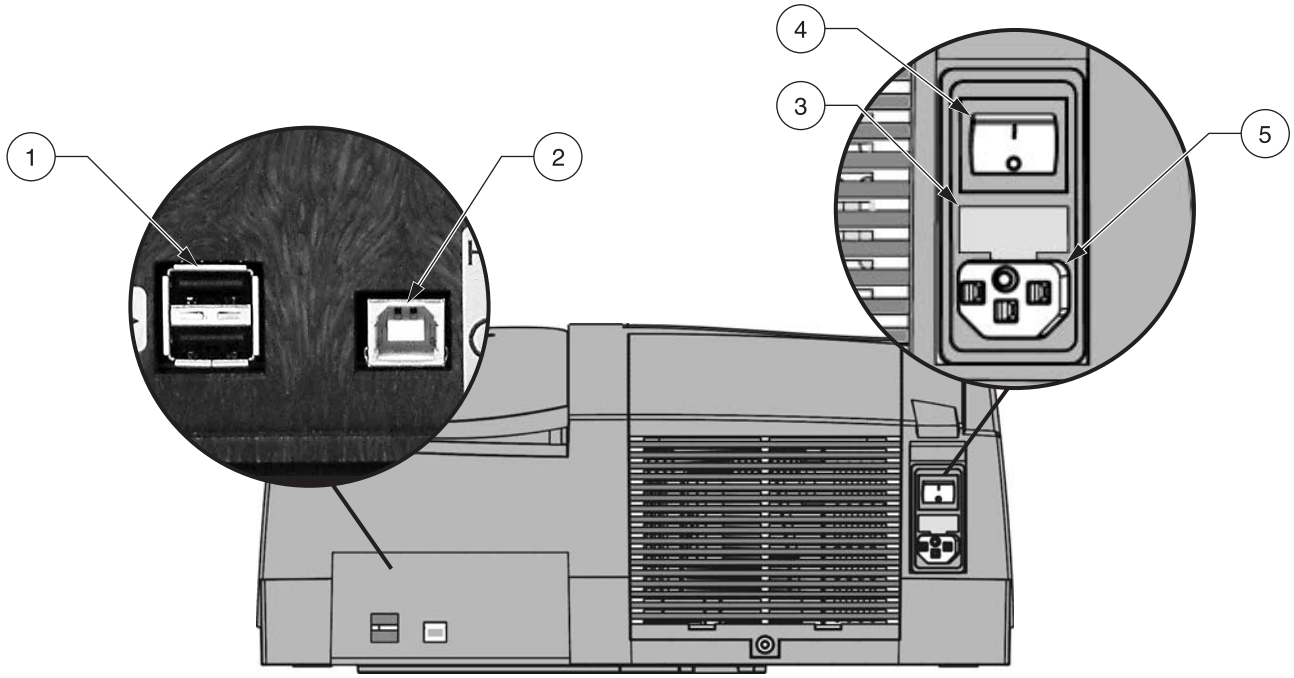
3.3.3 Serial Printer and Personal Computer (PC) Connections

The DR 5000 includes three USB interfaces (Table 1), which are located on the back of the instrument (Figure 1). These interfaces can be used to output data and graphics to printers, to update data, and to transfer data to a PC. A USB memory stick is used to update data, see section 6.8.2 on page 90.

Table 1 USB Connection Descriptions

Connector	Description
USB 2 and 3	These two USB ports can be used to connect a printer, keyboard, and a USB memory stick. These additional devices are controlled from the spectrophotometer.
USB for PC	This USB Port is for PCs only. The instrument is controlled through the PC.

Figure 1 Interfaces



1. USB for Printer, Keyboard, or USB Memory Stick	**4.** On/Off Switch
2. USB for PC	**5.** Power Supply Plug
3. Fuse	

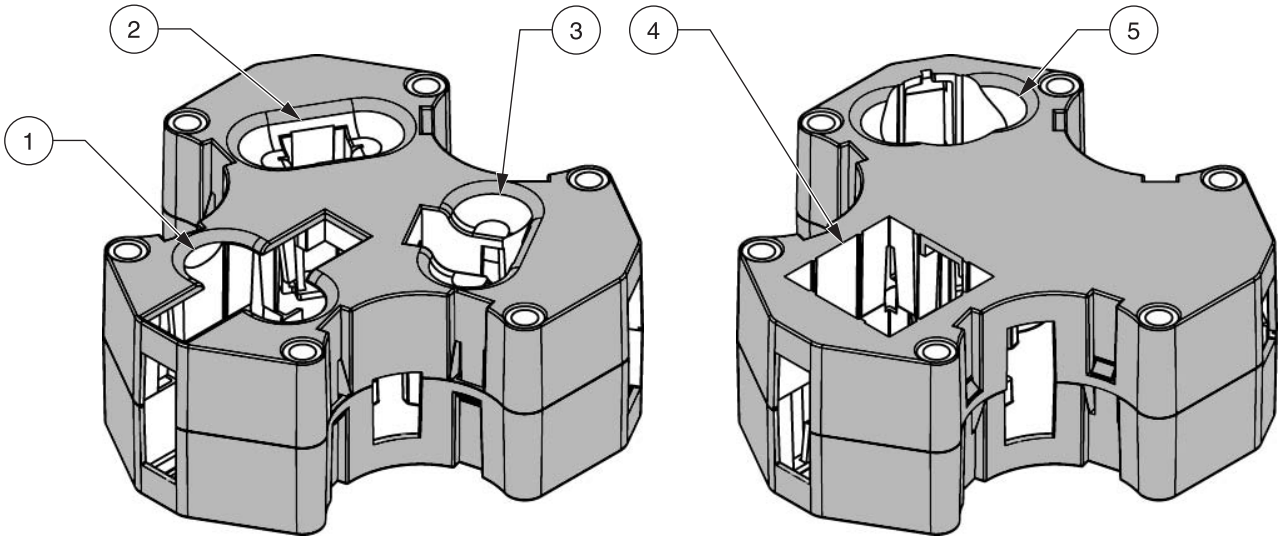
3.4 Multi-Cell Adapter

The DR 5000 Spectrophotometer comes equipped with a Multi-Cell Adapter (Figure 2) which is the standard holder supplied with each instrument. On the top and bottom of the Multi-Cell Adapter are a variety of openings to accommodate different types of cells. Each opening is labeled for the type of cell.The Multi-Cell Adapter can accommodate the following cell types:

- 10/20/50 mm rectangular cells
- 1-inch round cells
- 1-inch square cells

Only one cell type can be used for a measurement at one time.

Figure 2 Multi-Cell Adapter (Top and Bottom)

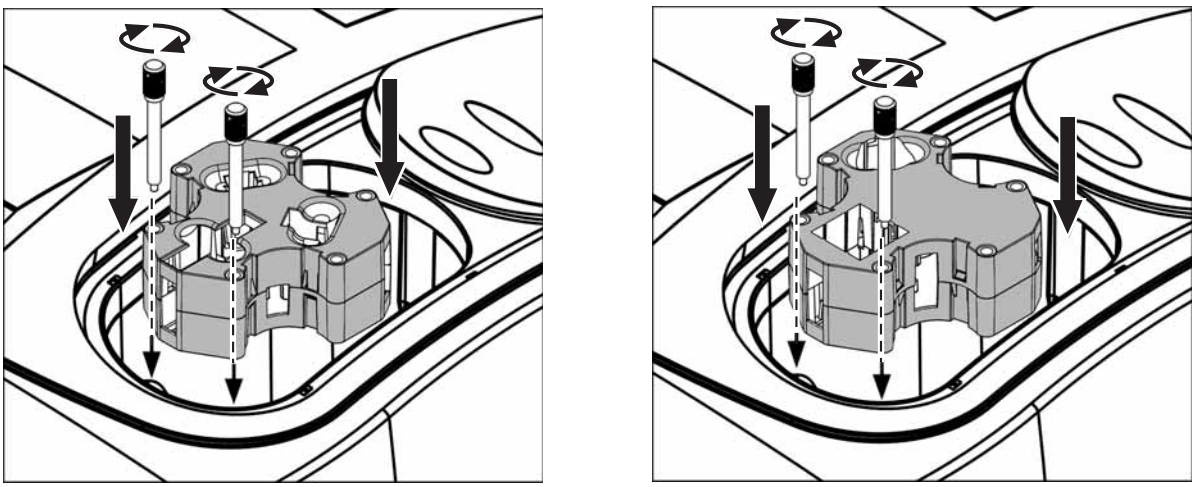


1. 50 mm Rectangular Cell	**3.** 20 mm Rectangular Cell	**5.** 1-inch Round Cell
2. 10 mm Rectangular Cell	**4.** 1-inch Square Cell	

3.4.1 Multi-Cell Adapter Installation

1. Open the cell compartment.
2. Identify the correct opening for the selected cell type in the Multi Cell Adapter.
3. Insert the Multi-Cell Adapter in the cell compartment in such a way that the name of the selected cell type can be read directly and the cell opening is at the front. Locate the adapter on the two conical pins, and secure with the two locking screws (Figure 3).

Figure 3 Multi-Cell Adapter Installation



4.1 Turning on the Instrument

1. Plug in the power supply cord.

2. Close the empty cell compartment.

3. Press the On/Off switch on the back of the instrument to power the instrument.

Do not switch the instrument off and on in rapid succession. Always wait at least **20 seconds** before switching the instrument on again, otherwise damage to the electronic and mechanical systems may occur.

4.2 Language Selection

The DR 5000 Spectrophotometer software includes several language options. The first time the instrument is powered on, the language selection screen will appear.

1. Select the desired language.

2. Press **OK** to confirm the language selection. The self check will start automatically.

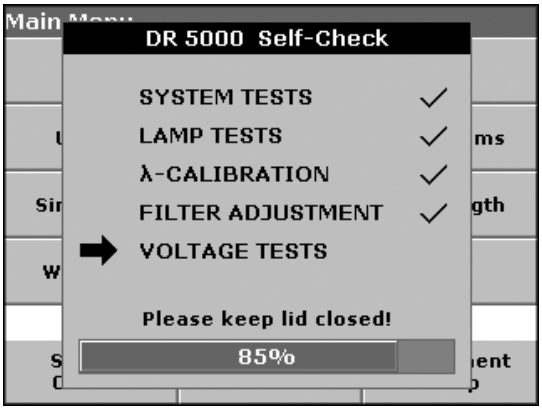
Once the language is selected, the instrument continues to power up in that language until a different language is selected. To change the language after initial installation, press any area of the display with the instrument off. Turn the instrument on, continue to press the display until the list of languages is displayed.

4.3 System Diagnostics

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

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

The Main Menu is displayed when the system diagnostics are complete. Refer to Section 8 on page 105 for troubleshooting information if any error messages are displayed during the system diagnostics.



5.1 Getting Started

5.1.1 Tips for Using the Touch Screen

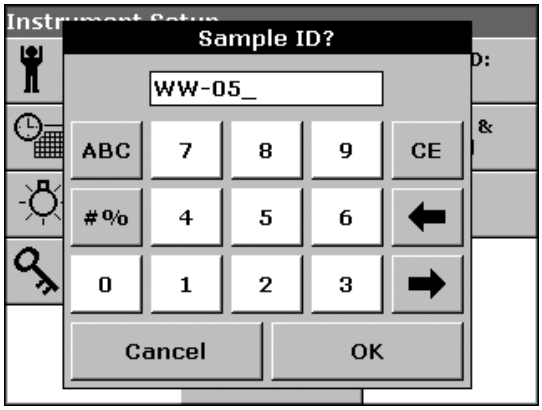
The entire screen is touch-activated. To make a selection, press the screen with a fingernail, fingertip, pencil eraser, or a stylus. Do not press the screen with a sharp object, such as the tip of a ball point pen.

- 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 Using 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 2.

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



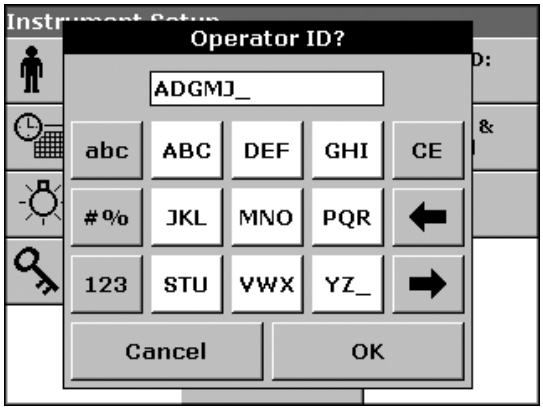


Table 2 Alphanumeric Keypad Functions

Icon	Description	Function
ABC	Alphabetic	When entering alphabetic characters (e.g. user-entered units), toggles between upper and lower case letters.
#%	Symbols	Punctuation, symbols, and numerical sub- and superscripts may be entered.
123	Numeric	Enters regular numbers.
CE	Clear Entry	Clears the entry.
LEFT ARROW	Backspace	Moves back one position. 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 DR 5000 Main Menu and Display

All current selection and input options, analysis results, and scans are shown in the graphic display. The display changes as different modes of operation are selected.

The Main Menu (Figure 4) appears when the instrument is powered on. A variety of options may be selected from the Main Menu. Table 3 briefly describes each menu option.

Figure 4 Main Menu

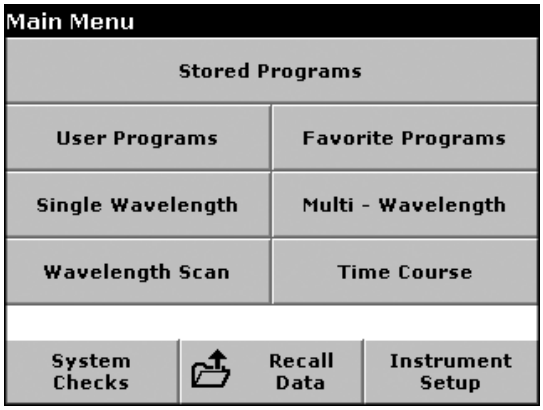


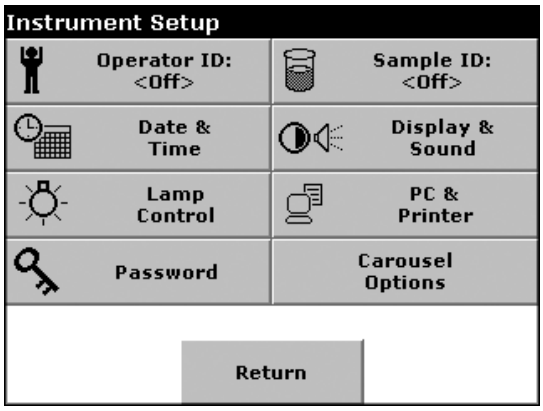
Table 3 Main Menu Options

Soft Key	Function
STORED PROGRAMS	Stored programs are pre-programmed methods that make use of reagents, cuvette tests, and pipette tests. Refer to the DR 5000 Procedure Manual for step-by-step procedures for analyses using stored programs.
USER PROGRAMS	User programs make "made to measure analysis" possible: Users can program custom methods. Stored methods can be saved as user programs. The tests can then be modified to suit the user's requirements.
FAVORITE PROGRAMS	List of frequently-used methods, placed in this area for easy access.
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	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 performed.
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.
TIME COURSE	The time scan records the absorbance or % transmittance at a wavelength over a defined time.
SYSTEM CHECKS	The system checks menu offers a number of options, including optical checks, output checks, lamp history, and instrument update.
RECALL DATA	Stored data can be recalled, filtered, transmitted, and deleted.
INSTRUMENT SETUP	User-specific or method-specific settings can be entered: Operator-ID, Sample-ID, Date & Time, Display & Sound, Lamp Control, Password, and PC & Printer.

5.2 Instrument Setup Mode

The Instrument Setup menu can be viewed from the Main Menu by selecting **INSTRUMENT SETUP**. From the reading mode, select Options.

A number of functions/options are displayed, which can be used to enter basic instrument settings. This display appears when the multi-cell holder is installed or the 13 mm/16 mm round vial compartment is used. Additional keys are displayed if optional modules are installed (i.e. carousel options).



5.2.1 Setting the Operator ID

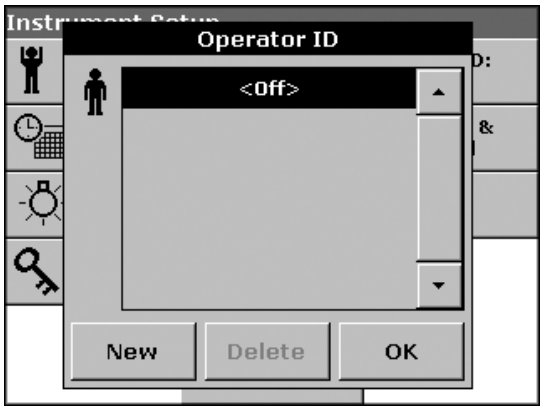
Spaces are not available in this function. Use the underscore symbol instead.

Use this option to enter up to 30 sets of operator initials (up to five characters each) into the instrument. This feature helps record which operator measured each sample.

1. From Instrument Setup, select **OPERATOR ID**.

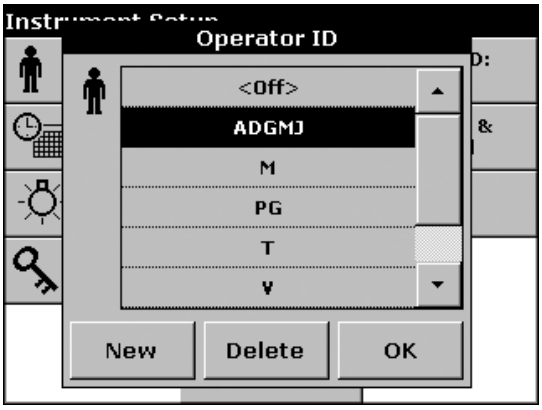
Press **DELETE** to remove an operator ID.

2. Press **NEW** to enter a new Operator ID.



3. Use the alphanumeric keypad to enter a new Operator ID. Press **OK** to confirm.

4. The display shows the chosen Operator ID. Press **OK**.



5. Instrument Setup will be displayed and show the selected operator identifier.

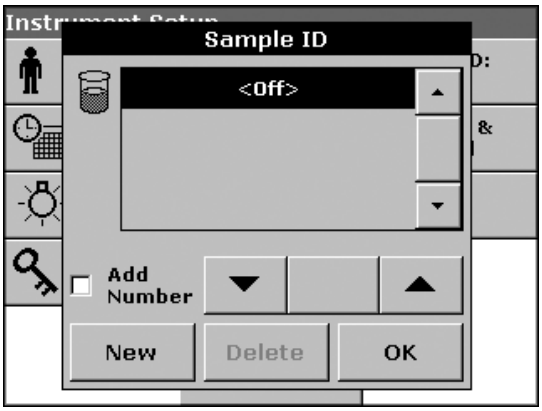
Alternatively, if an Operator ID is active, press the **OPERATOR ID** icon on the Measurement screen. The Operator ID screen will appear and allow changes to the ID.

5.2.2 Setting the Sample ID

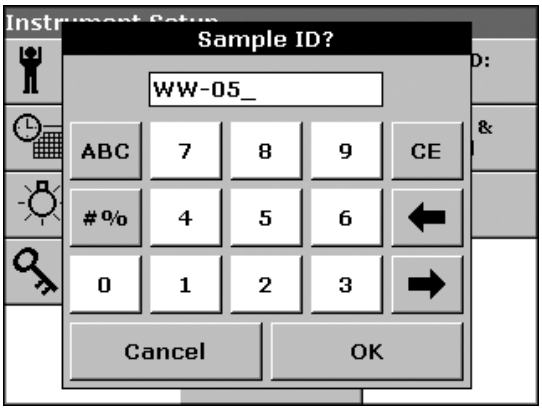
Use this option to enter up to 30 sample identifications (up to 13 characters each) into the instrument. Sample IDs can be used to specify the sample.

Press **DELETE** to remove a Sample ID.

1. From Instrument Setup, select **SAMPLE ID**.
2. Press **NEW** to enter a new Sample ID.



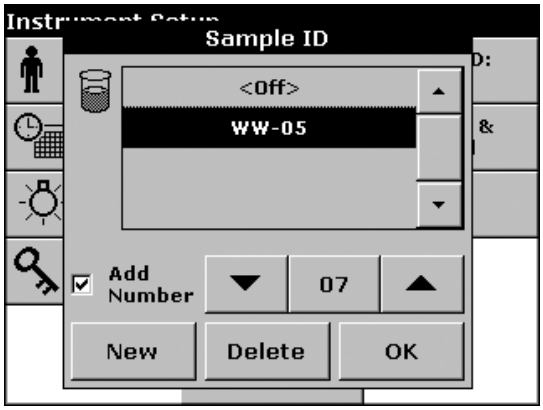
3. Use the alphanumeric keypad to enter a new Sample ID. Press **OK** to confirm.



4. To number the Sample IDs sequentially (e.g. Inflow 01...etc.), select **ADD NUMBER**.

   a. Use the arrow keys to specify the first number in the sequence.

   b. Use the key between the arrow keys to enter the first number of the sequence using the alphanumeric keypad.

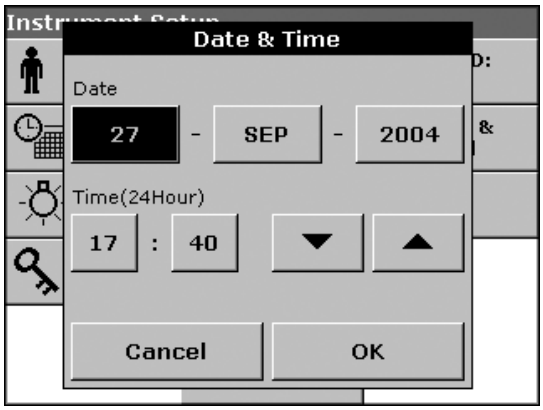


5. Press **OK** to confirm and return to the Instrument Setup. The Sample ID is activated. Each Sample ID is automatically numbered in ascending order after a measurement. The number is shown in parentheses behind the Sample ID.

Alternatively, if a Sample ID is active, press the **SAMPLE ID** icon on the Measurement screen. The Sample ID screen will appear to allow changes to the Sample ID.

5.2.3 Setting the Date and Time

1. From Instrument Setup, select **DATE & TIME**. The date and time are subdivided over a number of fields.

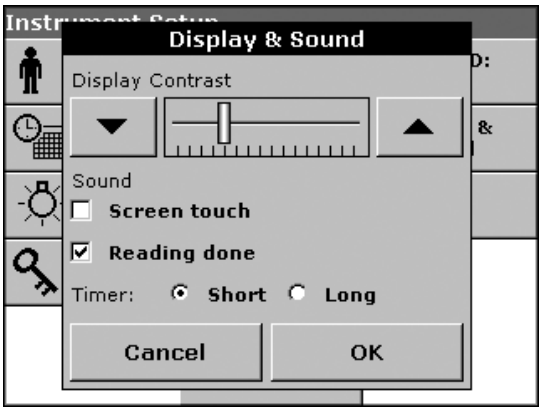


2. Select the appropriate field and use the arrow keys to change the value. Press **OK** to confirm and return to Instrument Setup.

5.2.4 Setting the Display and Sound Preferences

1. From Instrument Setup, press **DISPLAY & SOUND**. The following options will appear:

   - **Display/Contrast—**Adjusts the display contrast to suit lighting conditions and viewing angle.
   - **Screen Touch—**Activates 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. Press **OK** to confirm and return to Instrument Setup.

5.2.5 Lamp Control

The tungsten lamp produces light in the visible spectrum (320 to 1100 nm).

The deuterium lamp (UV-lamp) produces light in the ultraviolet spectrum (190 to 360 nm).

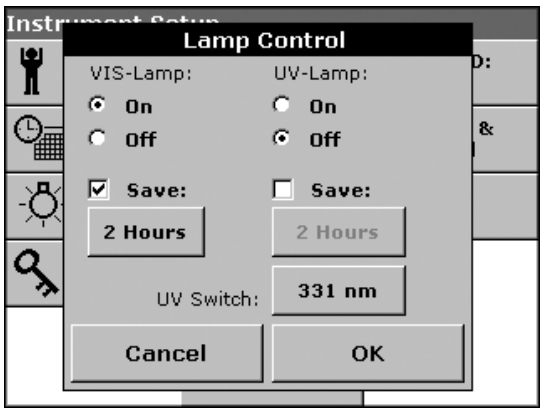
In the overlap zone from 320 to 360 nm, either the deuterium lamp (UV-lamp) or the tungsten lamp can be used for measurements.

The performance of the lamps is impacted by on-off operation and the length of use. For maximum performance, turn the lamp off only if it will remain off for at least 4-5 hours.

The lamp switches on automatically if a lamp is needed for the selected program or if the instrument is operating inside the lamp spectrum.

5.2.5.1 Setting the Lamp Control

1. From Instrument Setup, press **LAMP CONTROL**.



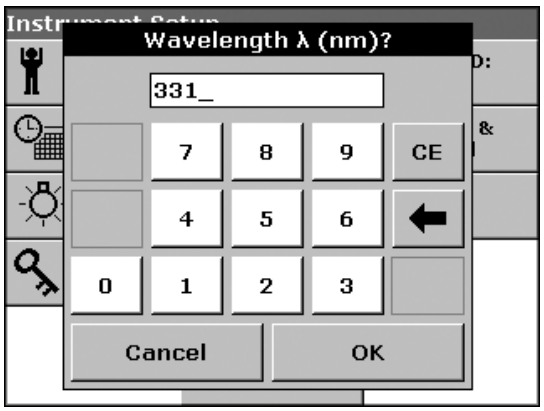
2. Select On to toggle on the VIS-Lamp or UV-Lamp, respectively.

3. Activate Save to define the length of time for which the VIS-Lamp or the UV-Lamp will be powered on.

4. Select the length of time the lamp will be switched on. After this period of time the lamp will automatically power off after no measurements are made outside the corresponding range. Press **OK** to confirm.

5. Press the **UV SWITCH** key to select the wavelength value between 320 nm and 360 nm, at which the instrument changes from the visible to UV source.

6. Use the alphanumeric keypad to enter the maximum wavelength for UV operation. Press **OK** to confirm and return to Lamp Control.

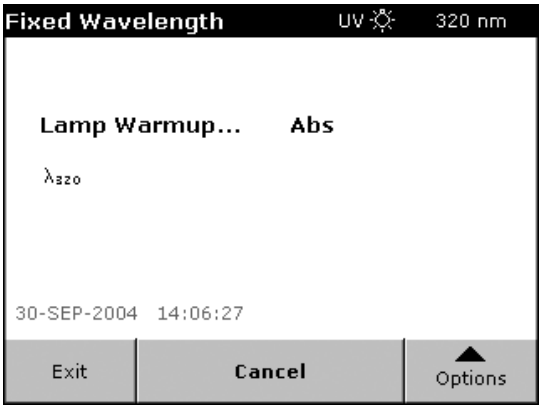


7. Press **OK** to confirm and return to Instrument Setup.

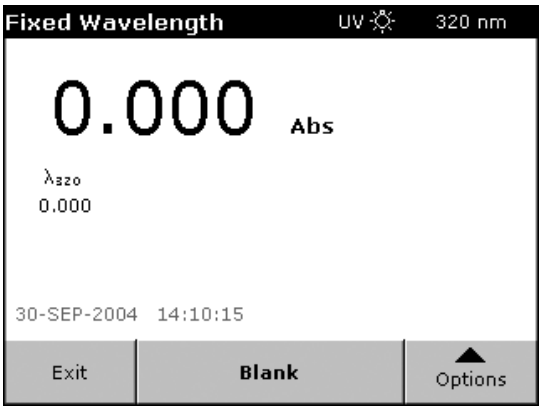
Note: *The selected program that requires a lamp has highest priority. If the lamp in the* ***Lamp Control*** *is turned off, the lamp will automatically power on if it is needed for the stored program.*

5.2.5.2 Lamp Settings in Measurement Mode

The UV-Lamp switches on manually. The UV Lamp icon appears in the display and flashes. The instrument will display “Lamp Warmup”. The warmup time takes approximately 3 minutes.



When the lamp is warm and ready, the UV Lamp icon stops flashing. If both lamps are on, the UV-VIS icon is displayed in the selected Measurement Mode.



Alternatively, press the **UV**- or **VIS-LAMP** icon on the Measurement screen to change the settings.

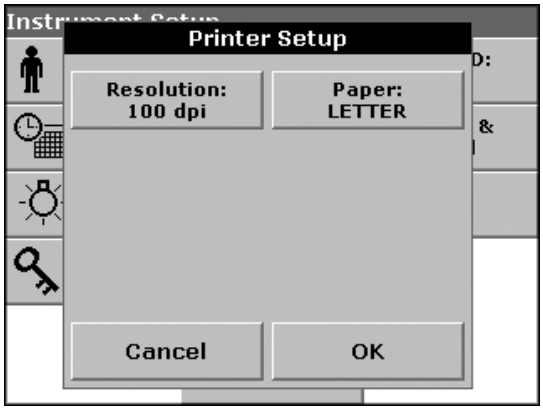
5.2.6 Communications with a Printer

5.2.6.1 Printer Setup

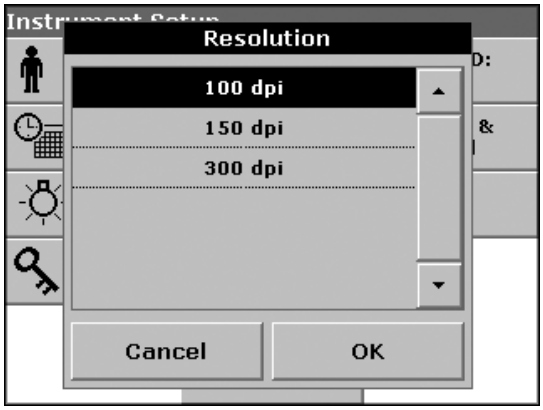
Note: *The printer must be compatible with PCL 3 language.*

1. From Instrument Setup, select **PC & PRINTER**. A list of connection information will be displayed.

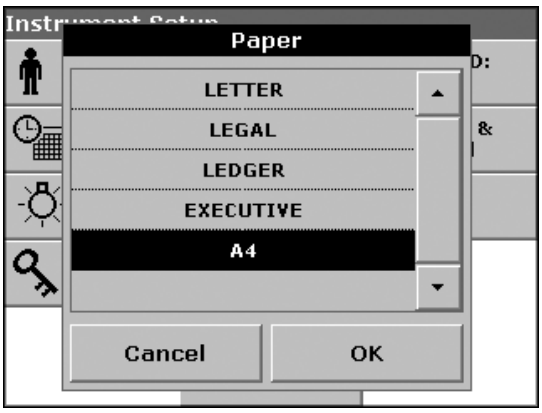
2. Press **PRINTER** and then press **SETUP** to display the Printer Setup screen. The Printer Setup screen allows the user to set the resolution and paper size.



a. Press **RESOLUTION** to select the print quality (100, 150, or 300 dpi). The higher the resolution, the better the print quality. Press **OK** to confirm. Press **OK** again to return to Instrument Setup.



b. Press **PAPER** to select the paper size (letter, legal, ledger, executive, and A4). Press **OK** to confirm. Press **OK** again to return to Instrument Setup.

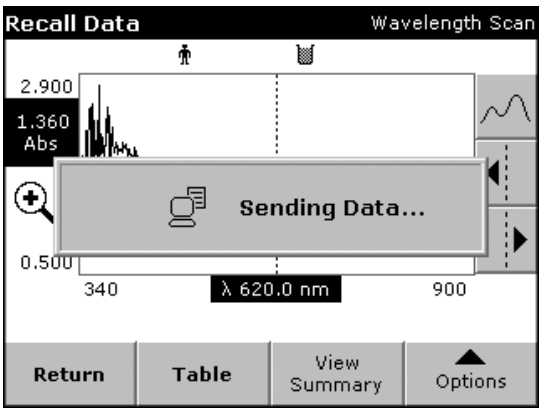


5.2.6.2 Printing Data

1. From the Main Menu, press **RECALL DATA**.

2. Select the data source (where the data are stored). A list is displayed. Select the data record to be printed.

3. Press the **PRINTER** icon to send the data (table, curve) immediately to the printer. “Sending Data” is displayed until printing is complete.



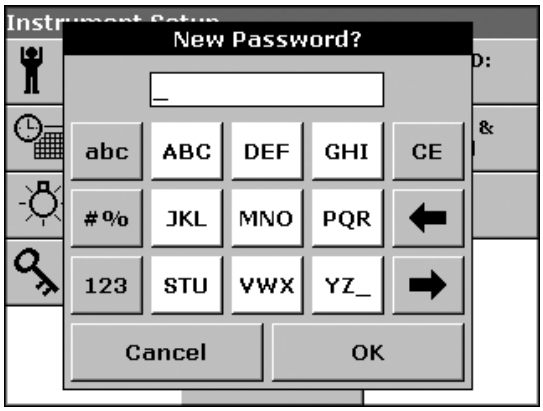
5.2.7 Setting Security Options (Password Protection)

The Password menu contains a variety of security settings to control access to various functions (i.e. to prevent unauthorized changes to stored programs or instrument configurations). After the password is set, the alphanumeric keypad will be displayed when a user tries to enter a protected setting.

1. From Instrument Setup, press **PASSWORD**.

2. Select **SET PASSWORD** (the Security List is only active after a password is assigned).

3. Use the alphanumeric keypad to enter a new password (up to 10 characters each), press **OK** to confirm. Access to the Security List is activated.



4. Press **SECURITY LIST** to lock various functions for unauthorized users.

5. Activate the desired functions for which access is to be controlled (New ID, Delete ID, New Program, Edit Program, Delete Program, Update Software). Press **OK** to confirm and return to the Password menu.

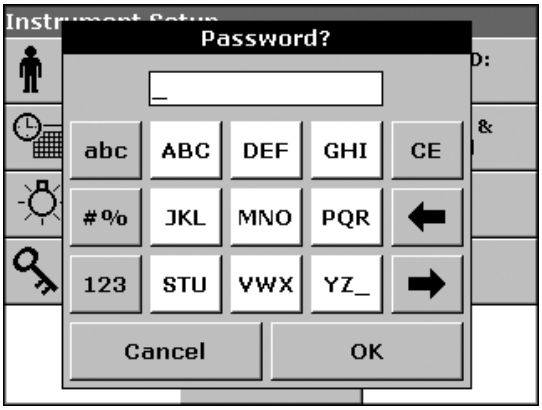
6. Enter the new password again to confirm and press **OK** to return to Instrument Setup.

5.2.7.1 Deleting or Changing a Password

Use this function to delete the former password or to enter a new password.

1. From Instrument Setup, press **PASSWORD**.

2. Use the alphanumeric keypad to enter the former Password and press **OK** to confirm.



3. Press **SET PASSWORD**.

4. Press **OK** to deactivate the former password and return to the Password menu. Set a new password, refer to section 5.2.7 on page 27.

5.3 Storing, Recalling, Sending, and Deleting Data

5.3.1 The Data Log

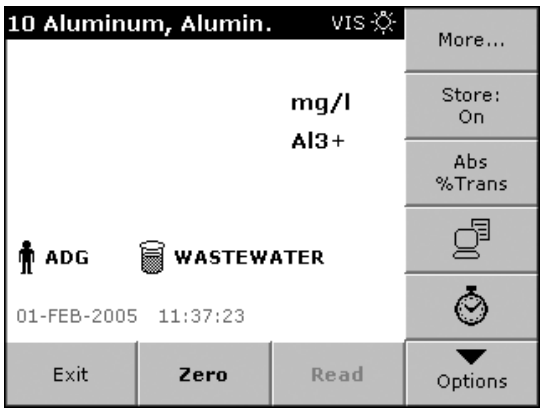
The Data Log will store up to 2000 readings taken in Stored Programs, User Programs, Favorite Programs, Single Wavelength, and Multi-Wavelength. A complete record of the analysis is stored, including the Date, Time, Results, Sample ID, and Operator ID.

5.3.1.1 Auto/Manual Data Storage

From Instrument Setup, select **STORE: ON/OFF**. To automatically store all measurement data, select **STORE ON**. No measurement data are stored with **STORE OFF** selected. However, **STORE OFF** can be changed to **STORE ON** in the result display via Configuration. The reading currently shown in the display is then stored.

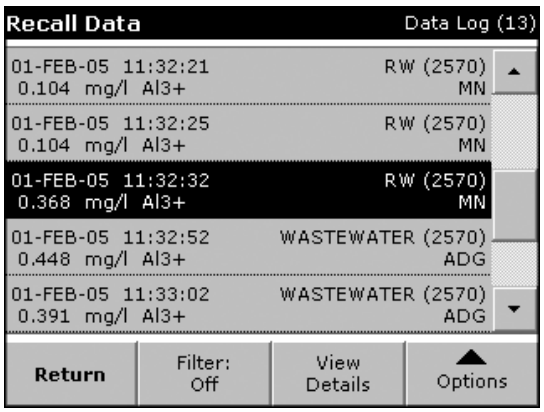
Note: *When the instrument memory (data log) is full, the oldest data are automatically deleted allowing the new data to be stored.*

When Single Reading is changed to Continuous Reading in the Single Wavelength Mode the **STORE: ON/OFF** key changes to the **STORE** icon.



5.3.1.2 Recalling Stored Data from the Data Log

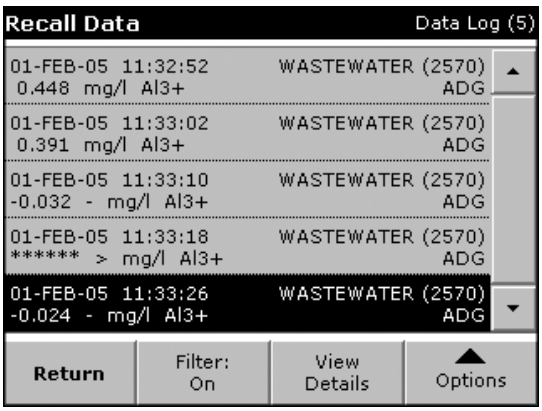
1. From the Main Menu, select **RECALL DATA**.
2. Press **DATA LOG**. A listing of the stored data is displayed.



3. Press **FILTER: ON/OFF**. The Filter Setting screen is displayed. The Filter Settings are used to search for specific items.

4. Select On to turn on the filters and select data by Sample ID, Operator ID, Start Date, Parameter, or any combination of the four.

5. Press **OK** to confirm. The chosen items are listed.



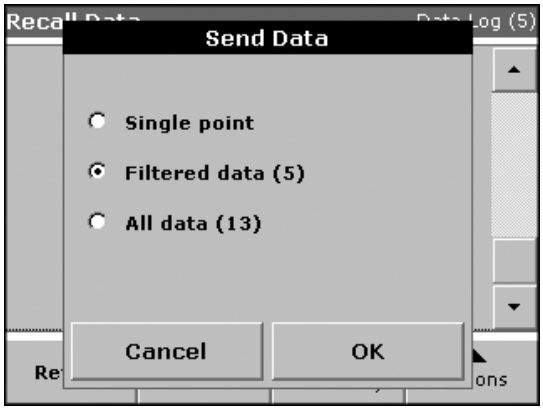
6. Press **VIEW DETAILS** to display more information.

5.3.2 Sending Data from the Data Log

Data is sent from the data log via a USB memory stick. The files will be sent automatically to the USB memory stick as CSV files (Comma Separated Value) 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“.

1. From the Recall Data menu, press **OPTIONS** and then the **PC & PRINTER** icon.
2. Select the data to send to the USB memory stick and press **OK**.

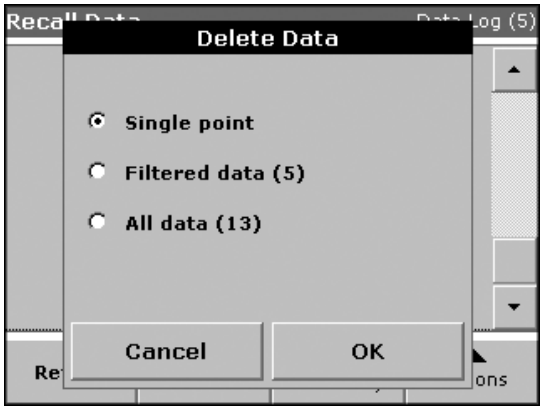
Note: *The number in parenthesis is the total number of data sets assigned to this selection.*



5.3.3 Deleting Stored Data from the Data Log

1. Highlight the data to be deleted. Press **OPTIONS** and then **DELETE**.
2. Select Single Point, 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.*

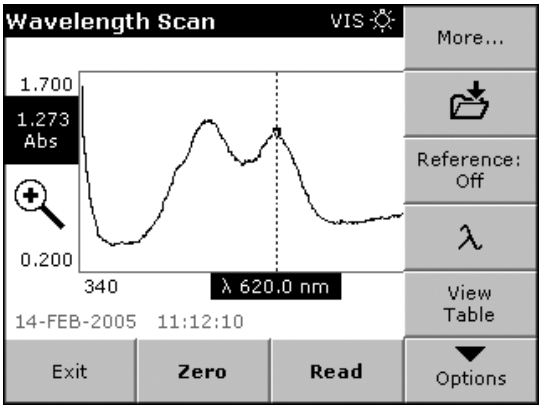


5.3.4 Wavelength Scan Analyses and Time Course Data

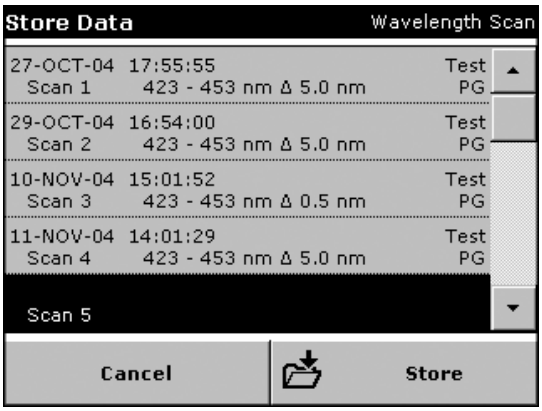
The instrument can store 20 Wavelength Scans and 20 Time Course Data sets. The data can be stored manually per user discretion after viewing the data.

5.3.4.1 Data Storage from Wavelength Scan Analyses or Time Course

1. After a reading is taken in Wavelength Scan Mode or Time Course, press the **STORE** icon in the Option menu.



2. The Store Data list will open. Press **STORE** (folder icon) to save the current scan to the highlighted numbered line. A scan can also be overwritten.



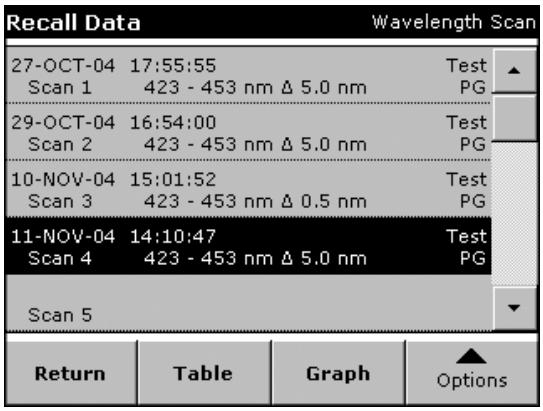
5.3.4.2 Recalling Stored Data from Wavelength Scan Analyses or Time Course

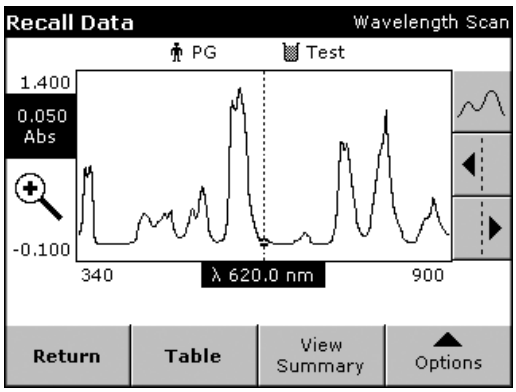
1. Recall the stored data from a wavelength scan or time course.

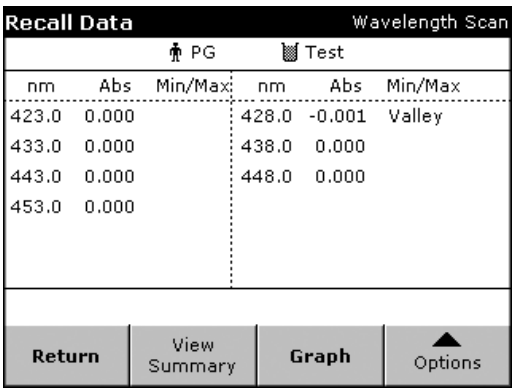
   a. From the Main Menu, press **RECALL DATA** and press **WAVELENGTH SCAN** or **TIME COURSE**, depending which type of data is to be recalled.

   b. Press **OPTIONS**>**MORE> RECALL DATA** in the Measurement screen.

2. Press **GRAPH** and/or **Table** to view the details.





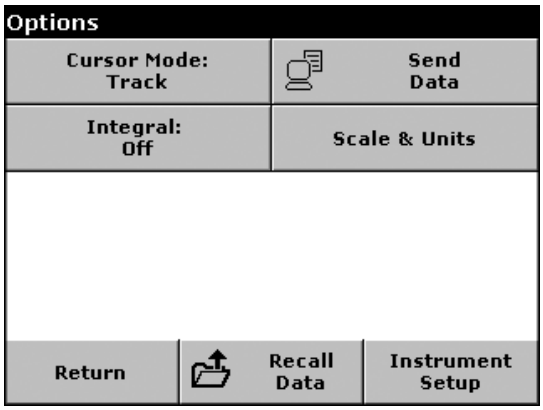


Note: *Press* **VIEW SUMMARY** *to return to the Recall Data list.*

5.3.4.3 Sending Data from Wavelength Scan Analyses or Time Course

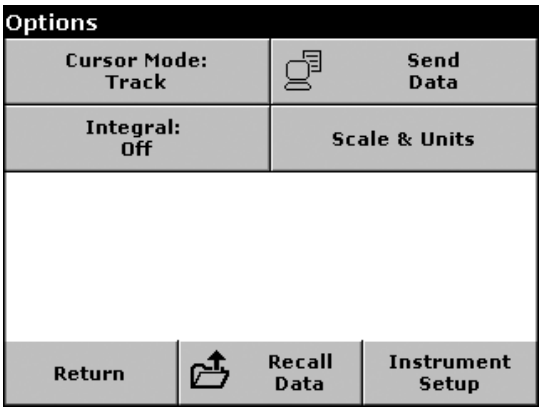
Option 1
The files will be automatically sent as CSV files (Comma Separated Value) to a file ”WLData“ (Wavelength Scan Data) or ”TCData“ (Time Course Data), which can be processed using a spreadsheet program. The file name will be formatted as: ”ScanData_X.csv“ (Wavelength Scan Data) or ”TCData_X.csv” (Time Course Data) X = number of scans (1–20)

1. From the Main Menu, press **RECALL DATA** and then **WAVELENGTH SCAN** or **TIME COURSE** and then **OPTIONS**>**SEND DATA** icon to send the data to a USB memory stick or to a printer.



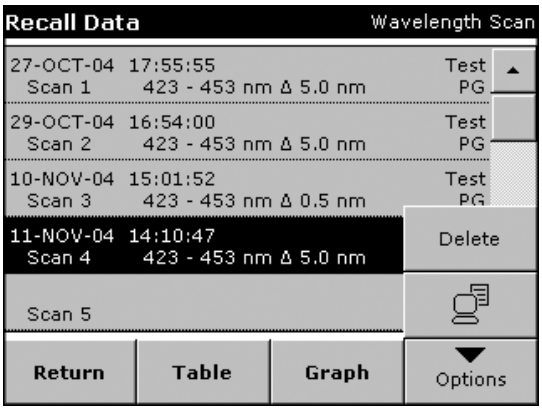
Option 2
The files will be automatically sent as CSV files (Comma Separated Value) to a file ”WLData“ (Wavelength Scan Data) or ”TCData“ (Time Course Data) which can be processed using a spreadsheet program. The file name will be formatted as: ”ScanData_Year_Month_Day_Hour_Minute_Second.CSV“ (Wavelength Scan Data) or ”TCYear_Month_Day_Hour_Minute_Second.CSV“ (Time Course Data).

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.



5.3.4.4 Deleting Stored Data from Wavelength Scan Analyses or Time Course

1. From the Main Menu, press **RECALL DATA** and then **WAVELENGTH SCAN** or **TIME COURSE** from the Options menu, select **MORE>RECALL DATA**.



2. A list of the stored data is displayed. Highlight any data to be deleted.

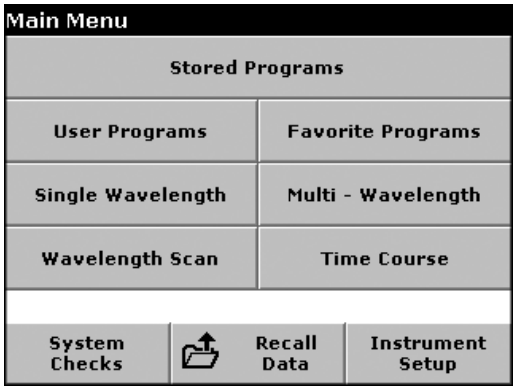
3. From the Options menu, press **DELETE** and press **OK** to confirm.

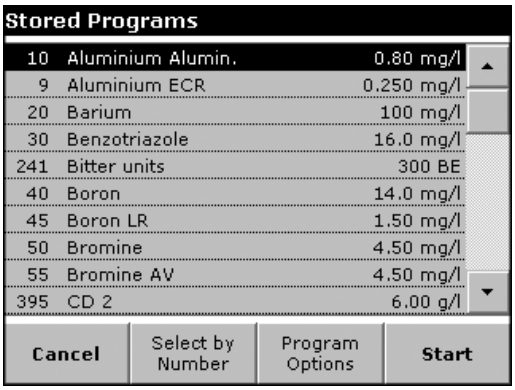
5.4 Stored Programs

The DR 5000 Spectrophotometer contains programmed procedures that can be accessed through the Stored Programs menu.

5.4.1 Selecting a Stored Program

1. From the Main Menu, press **STORED PROGRAMS** to view an alphabetical list of stored programs.





2. Select the program number by name or use the arrow keys to scroll through the list quickly and highlight the program or press **SELECT BY NUMBER** to search for a number. Use the alphanumeric keypad to enter the test number and press **OK** to confirm.

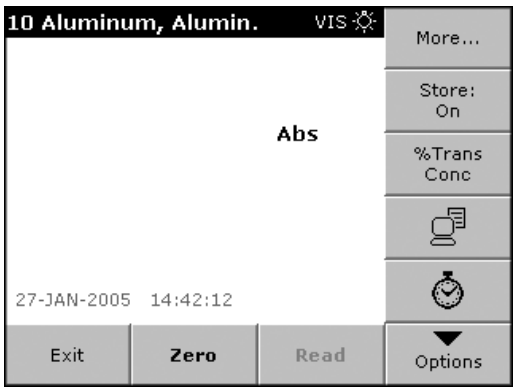
3. Press **START** to run the program. After a program is selected, the screen for that parameter will appear. The wavelength does not need to be selected. Only the Options appropriate to the method will be displayed in black. Unused options will be grayed out or will not appear.

4. Follow the chemical procedure described in the Procedure Manual.

5.4.2 Stored Program Options

1. From the Main Menu, select **STORED PROGRAMS.** Choose the desired method and press **START**.

2. Press **OPTIONS** to access data storage, readings, concentration, or wavelength setup options. Press **MORE** to view additional setup options. Refer to Table 4 on page 36 for descriptions.



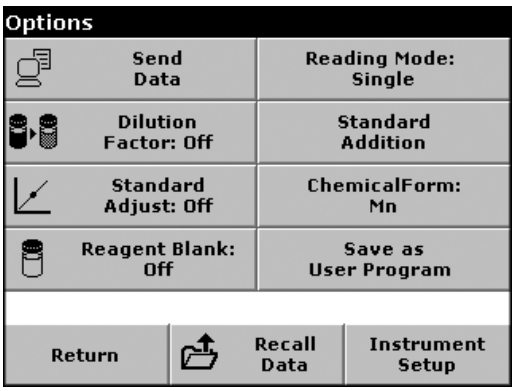


Table 4 Stored Program Options

Option	Description
Store Off/On	With **STORE ON** selected, all measurement data are stored automatically. With **STORE OFF** selected, no measurement data are stored.
% Trans/Abs/Conc	Toggle between % transmittance, absorbance readings, or concentration
	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.
	Concentration: Displays the results in concentration.
Send Data Icon	Sends data to a printer, computer, or USB memory stick.
Timer icon	Functions as a stopwatch. Displays pre-set periods for reactions, heating, etc., along with a description of the activity, when appropriate. When the specified time has elapsed, an audible signal is emitted. The timer has no influence on the measurement program.
Reading Mode	Single: A reading is only displayed after a measurement has been performed. The **ZERO** or **READ** key must be pressed to initiate a measurement.
	Continuous: After zero measurement, all readings are displayed automatically and continuously (default setting). The **READ** key does not appear.
Dilution Factor On/Off	A corrective dilution factor can be entered in order to take into account certain properties. The number entered at the dilution factor prompt will be multiplied by the result to compensate for the adjustment. For example, if the sample has been diluted by a factor of 2, enter 2. The default setting of the dilution factor is 1, corresponding to no dilution. When a dilution is in effect, the **DILUTION** icon will appear on the display. Refer to section 5.4.4 on page 38.
Standard Addition	Enables the accuracy of the measurements to be checked. The procedure for a test parameter contains a detailed explanation of how to use this function.
Chemical Form	For some stored programs, the chemical form and measuring range can be selected.
Reagent Blank	Enables the reagent blank value to be added to, or subtracted from, the subsequent readings. The reagent blank value shifts the calibration curve along the y-axis (concentration), without changing the shape or gradient of the curve. The effect corresponds to a y-axis intercept of the calibration straight line. This is represented by the equation: Concentration = [(Conc. factor) * Abs] – (reagent blank value).
Save as User Program	Stores the selected parameters as a User Program.
Recall Data	Recalls saved measurement data, wavelength scans, or time courses (section 5.3.4.2 on page 32).
Instrument Setup	Basic operation settings of the instrument (section 5.2 on page 19).

5.4.3 Using Program Timers

Some procedures do not require the use of timers. Other procedures require several timers. These timers are pre-programmed into each Stored Program, along with a description of the activity to be performed during the timed period.

1. Press the **TIMER** (clock) icon on the display. Press **OK** to start the timer. The timer will count down on the screen.

Note: *To view the Program screen while the timer is running, press* ***CLOSE****. The time will be shown on the bottom left side instead of the date.*

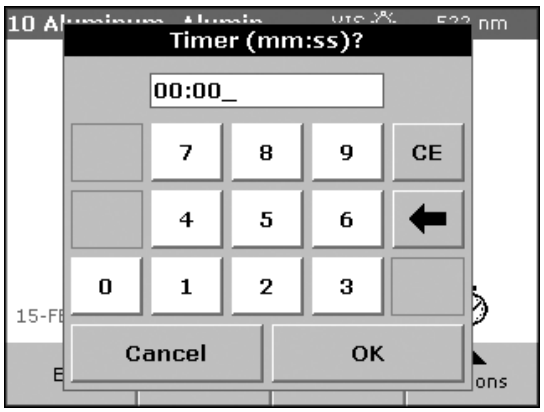
2. To start the next timed activity for the Stored Program, press the **TIMER** icon and **OK**. If necessary, press **CANCEL** to stop the countdown. The Timer will beep when the timed interval ends.

5.4.3.1 Setting the General Purpose Timer

A general purpose timer is also available in many programs.

1. Press the **TIMER** icon, and select General Timer.

2. Enter the length of the timed interval and press **OK**.

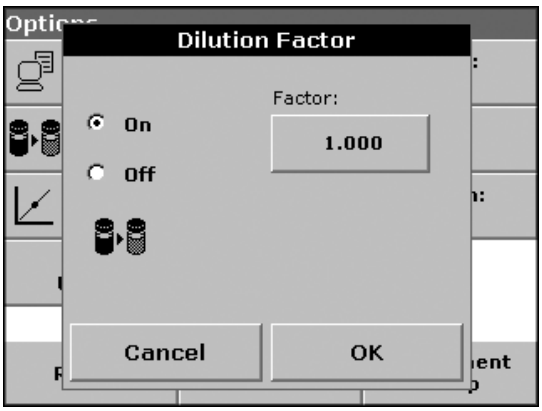


3. Press **OK** to start the timer. The timer will beep when the timed interval ends.

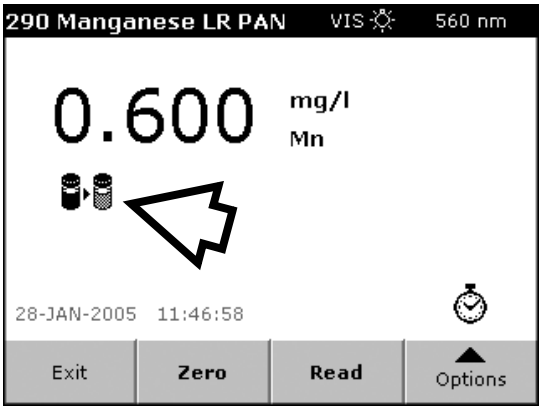
5.4.4 Setting the Dilution Factor

1. Press **DILUTION FACTOR** from the Options menu**.**

2. Select On to activate the dilution factor. Press the **FACTOR** button to enter the dilution factor. This number will be multiplied by the result to compensate for the adjustment. For example, if the sample has been diluted by a factor of 2, enter 2. The default setting of the dilution factor is 1, corresponding to no dilution.



3. Press **OK** to confirm. Press **OK** again. When a dilution is in effect, the Dilution icon will appear on the display.

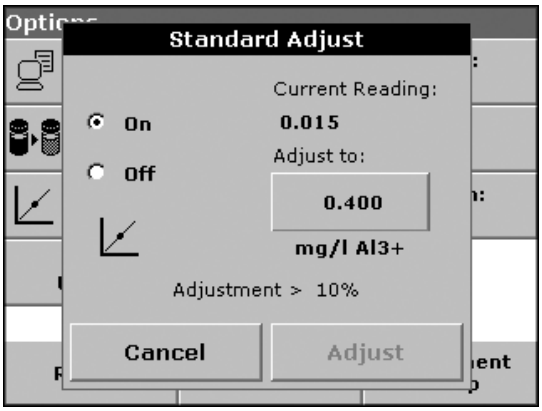


5.4.5 Running a Standard Adjust

Read a standard before setting Standard Adjust to On.

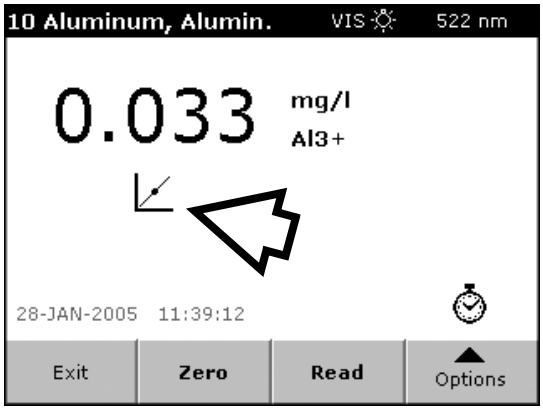
1. Follow the entire procedure, using a known standard for the sample.

2. After reading the concentration, press **OPTIONS>MORE>STANDARD ADJUST**.



3. If Standard Adjust is set to Off, select On. The current reading will show the concentration. The box on the right will show the default standard value for the test, as specified in the procedure. If the measurement used a standard concentration that is different from the one displayed, press the **ADJUST TO** key to enter a different standard value.

4. Press **ADJUST** to enable the Standard Adjust. The Standard Adjust icon will appear when the standard adjust is in effect.

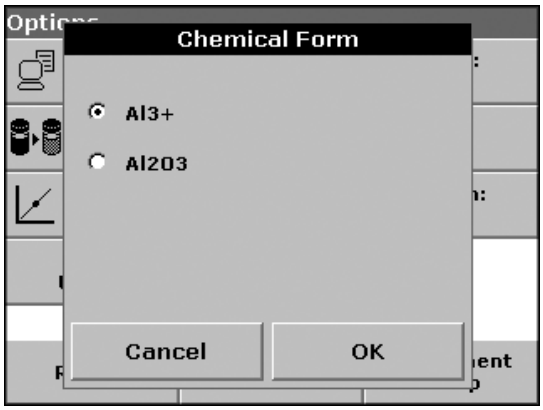


Note: *The adjustment must be within certain limits, which vary with each program. The allowable percentage is shown after "Adjustment >"*

5.4.6 Setting the Chemical Form

1. Press **CHEMICAL FORM** from the Options menu.

2. Select the Chemical Form and press **OK**. The selected Chemical Form will appear on the display. Test results will be calculated and displayed in this chemical form.



Note: *The conversion of the measurement result is completed automatically.*

Alternatively, press the unit (e.g. mg/L) or the chemical representation of the evaluation form (e.g. Al^{3+}). A list of available evaluation forms is displayed. Select the form required by pressing the corresponding entry in the list.

Note: *When the program is exited, the evaluation form reverts to the standard setting.*

5.4.6.1 Changing the Chemical Form Default Setting

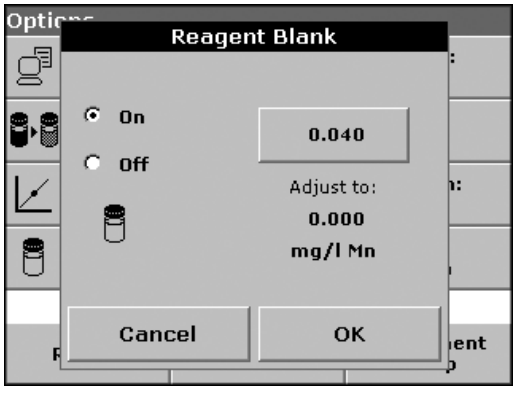
1. Insert a sample cell or blank (depending on the procedure) into the cell compartment and close the cover.
2. In the result display, press **OPTIONS>MORE>CHEMICAL FORM**.
3. A list of available evaluation forms appear. Select the form for the new default setting and press **OK** to confirm.
4. Press **EDIT** and then **SAVE**.

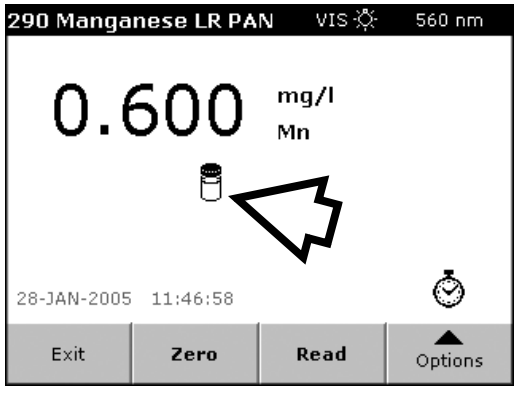
The current result and all further measurements will be displayed in the new chemical form.

5.4.7 Running a Reagent Blank

1. Prepare the Test/Method as specified in the procedure. Instead of a sample, distilled water is used to determine the reagent blank value.
2. Select the test. If required by the procedure, place the zero solution in the cell compartment. Close the compartment and press **ZERO**.
3. Place the prepared cell in the cell compartment and close the cell compartment. Press **READ**. The result is displayed.
4. Press **OPTIONS>MORE> REAGENT BLANK**.
5. Select On to activate the Reagent Blank function. The concentration shown on the key is the measured value and will be subtracted from subsequent measurements. To use this value for more analyses, press **OK**. If the measurement does not need to be saved, press the key to the right, and use the alphanumeric keypad to enter a theoretical reagent blank value and press **OK** to confirm.
6. Record the values for use on subsequent measurements using this lot of reagents.

Note: *The Reagent Blank icon is shown in the result display.*





Note: *The Reagent Blank function is deactivated when the measurement program is exited.*

Note: *The results calculated using the reagent blank value must lie within the limits of the measuring range of the test/method.*

5.4.8 Analysis of Samples

1. Press **STORED PROGRAMS** and select a program.
2. Insert the blank vial into the cell holder. Close the cell compartment and press **ZERO**.

3. Insert the sample vial into the cell holder and close the cell compartment.
4. The result will be displayed.

Note: *If the Reading Mode is set to Single, press* ***READ*** *to obtain the result.*

Note: *During the warm-up phase of the UV lamp, the message "Warming up..." is displayed and the UV lamp symbol flashes. As soon as the UV lamp is ready, the blank reading is performed.*

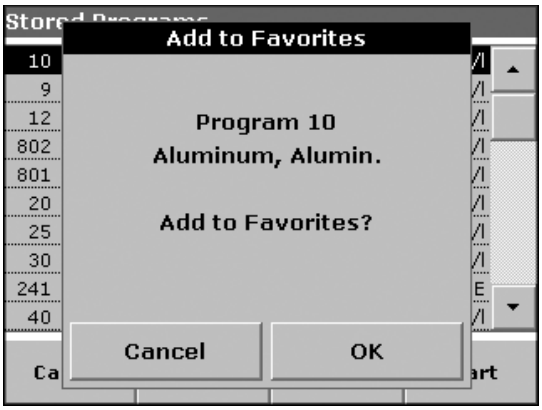
Note: ***ZERO*** *and* ***READ*** *are disabled until the cell compartment is closed.*

5. For data storage, refer to section 5.3.1 on page 29.

5.4.9 Adding Stored Programs to the Favorite Programs List

Frequently used programs can be added to the favorite list.

1. From the Main Menu, press **STORED PROGRAMS**. The Stored Programs list will appear.
2. Highlight the selection or press **SELECT BY NUMBER** to search for the program by number.
3. Press **PROGRAM OPTIONS**>**ADD TO FAVORITES** and press **OK** to confirm.



4. The program can now be selected from **FAVORITE PROGRAMS** on the Main Menu.

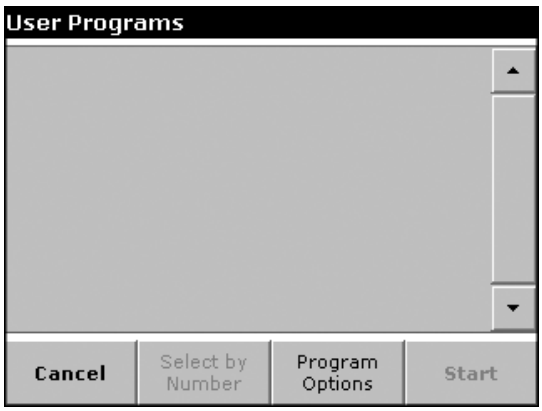
6.1 User Programs

User programs provide the opportunity of carrying out "made to measure" analyses.

The User Programs database is empty when the instrument leaves the factory and is used to accommodate programs created by users for their own specific requirements. Here are a few examples of entries:

- Programming of user-created procedures. The user must define or determine the program sequences, calculation formulas, measurement wavelengths, factors, measuring range limits, etc.
- Specifically modified tests.
- Creation of a specific selection of methods and tests.

1. From the Main Menu, press **USER PROGRAMS** and then **PROGRAM OPTIONS**. The Program Options menu will be displayed. Refer to Table 5 for option descriptions.



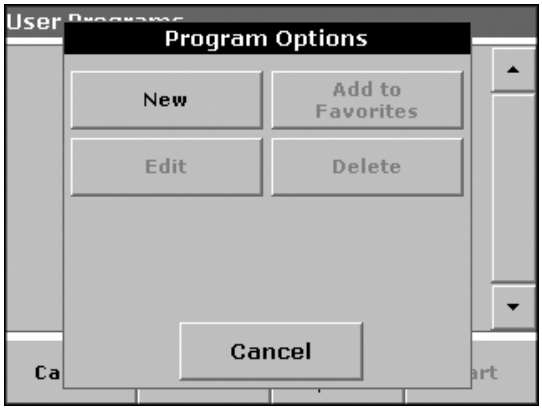


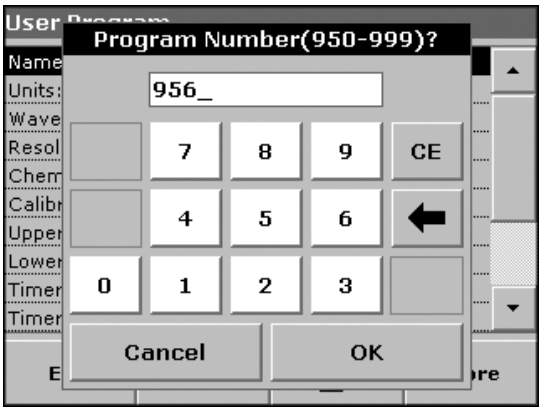
Table 5 Program Options

Option	Description
New	Select **NEW** to program a new user program. The first time **PROGRAM OPTIONS** is selected, only the **NEW** option is available. The other options remain inactive (gray) until the first program has been created.
Add to Favorites	Select **ADD TO FAVORITES** to add a user program to the list of **FAVORITE PROGRAMS**.
Edit	Select **EDIT** to modify an existing user program.
Delete	Select **DELETE** to remove a program from the list of user programs. Program will also be deleted from the favorites list.

6.1.1 Programming a New User Method

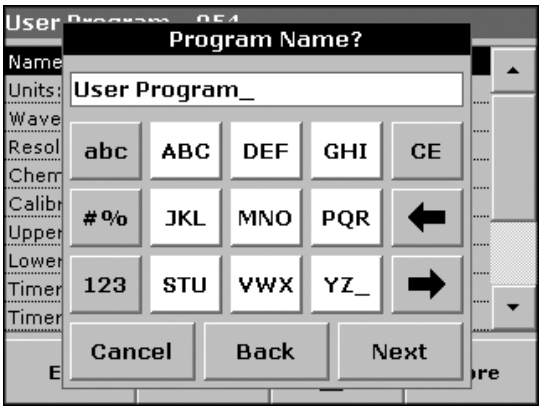
1. Select **NEW** in the Program Options menu.

2. Enter a program number between 949 and 999. The lowest available number appears automatically. The program number will be displayed in the User Program and Favorite Program menu lists (if the method is stored as a favorite). Press **OK** to confirm.



Note: *If the program number is already assigned to another user program, a message appears asking whether the existing program should be replaced. Press* ***OK*** *to overwrite an existing program.*

3. Use the alphanumeric keypad to enter a program name. The name can be a maximum of 28 characters long. Press **BACK** to return to the previous screen or press **NEXT** to continue with the input of the program data.



4. Select the type of program (Single Wavelength, Multi-Wavelength, or Free Programming, refer to Table 6) and press **NEXT** to continue. If Single or Multi-Wavelength was selected, continue to step 5. If Free Programming was selected, refer to section 6.1.4 on page 53.

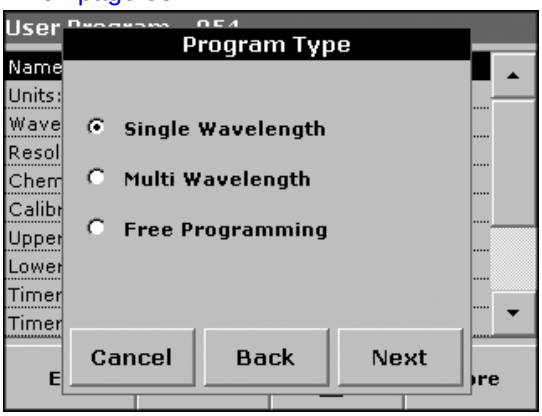
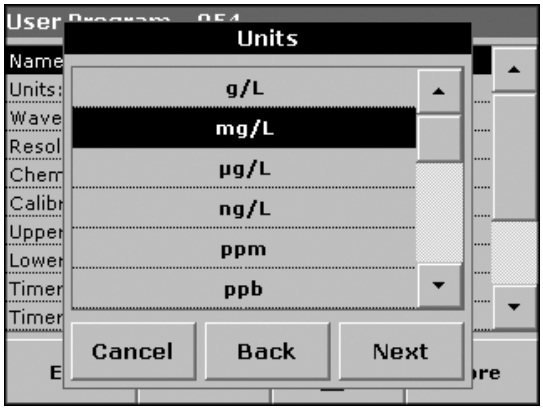


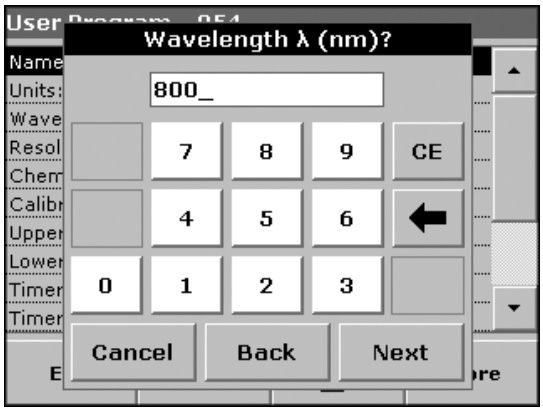
Table 6 Programs Descriptions

Program Type	Description
Single Wavelength	Measurements at a defined wavelength.
Multi-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.
Free Programming	This is an extended form of test or method programming. A high level of flexibility offers individual options for creating a user program.

5. Select the required unit from the list and press **NEXT**. A user-specific unit that is not included in this list can be added in the edit program under **PROGRAM OPTIONS>EDIT**.

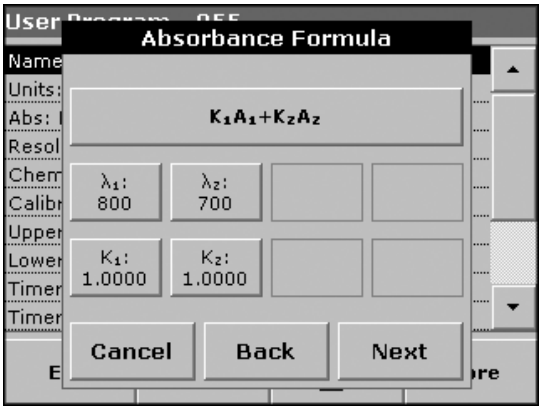


6. If Single wavelength was selected, use the alphanumeric keypad to enter the measurement wavelength. The entered wavelength must be in the range from 190–1100 nm. Press **NEXT** to enter the Chemical Form (see step 8 on page 47).

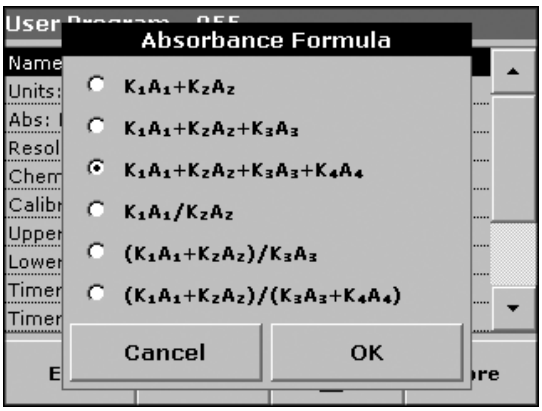


7. If Multi-Wavelength was selected, enter the absorbance formula information (wavelengths and coefficients). The absorbance formula defines the calculation for the multi-wavelength measurement.

a. Press the **FORMULA** key.



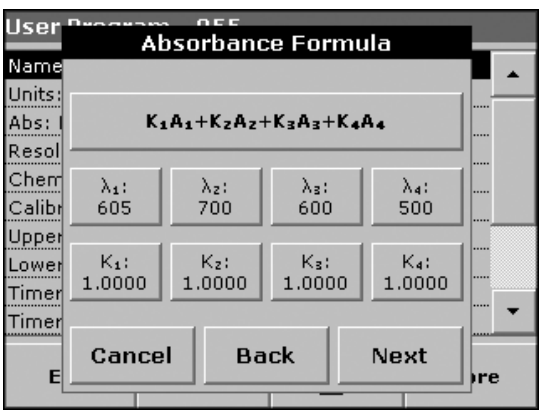
b. Select the formula for the program and press **OK** to confirm. A_1 is the absorbance at wavelength 1, A_2 is the absorbance at wavelength 2 and so on. K_1 is the concentration factor at wavelength 1, K_2 is the factor at wavelength 2, and so on.



If a subtraction has to be performed, the factors must be entered with a minus sign.

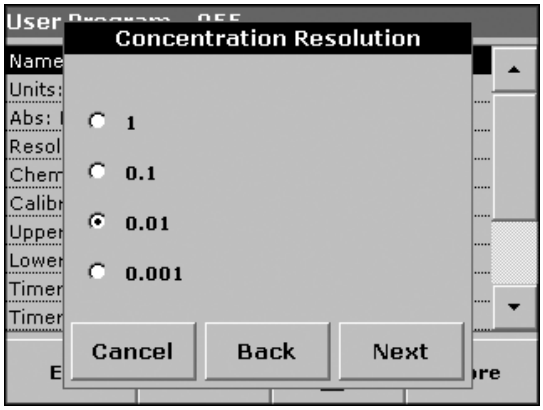
c. Select the wavelength. Press a λ_1 key and use the alphanumeric keypad to enter a wavelength. If necessary, repeat until all the wavelengths for the formula have been entered. The wavelengths must be in the range from 190–1100 nm. Press **OK**.

d. Enter the concentration factor (multiplication factor for converting absorbance values into concentration values). Press a factor key (K_1 to K_4) key and use the alphanumeric keypad to enter a factor (up to five digits, including a maximum of 4 decimal places). If the formula includes more than one factor, press another factor key and enter another factor, and repeat until all the factors have been entered.

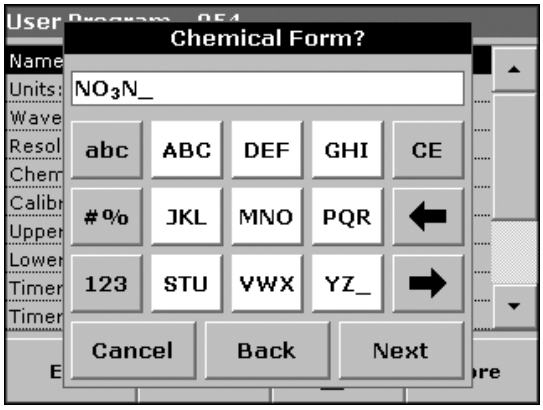


e. Press **OK** when all relevant data have been entered, then press **NEXT**.

f. Select the concentration resolution (number of decimal places) and press **NEXT**.

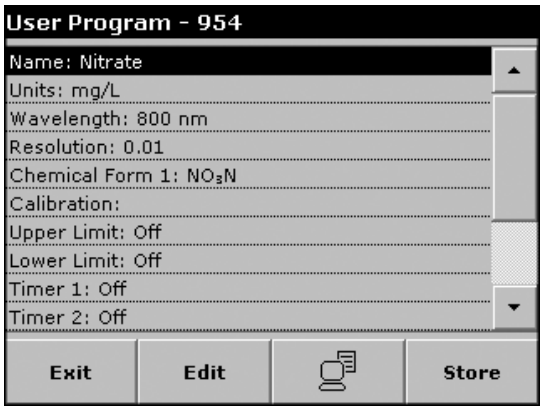


8. Enter the chemical form (the chemical representation of the analysis parameter in the result display) using the alphanumeric keypad. Press **NEXT** to continue.



9. Edit the Calibration settings. Refer to section 6.1.2 on page 48.

10. The basic data are complete. An overview of the variable program is displayed. The overview contains additional parameters/functions for the user program, refer to section 6.1.3 on page 51 for more information. Press **STORE** to save the data.



If more specifications or changes need to be made, highlight the appropriate line and press **EDIT**.

6.1.2 Calibration Settings

A method is calibrated by determining the absorbance values of several standard solutions of known concentration. There are several ways to obtain a calibration curve, refer to Table 7 for more information.

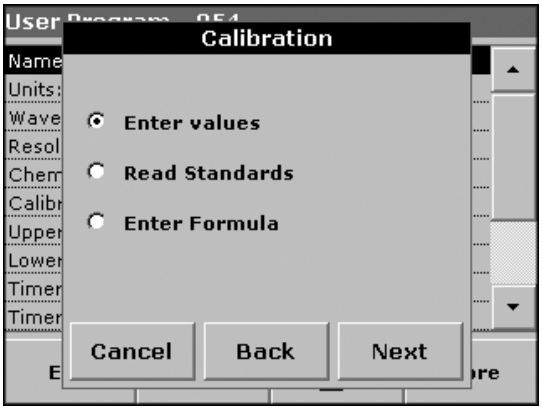
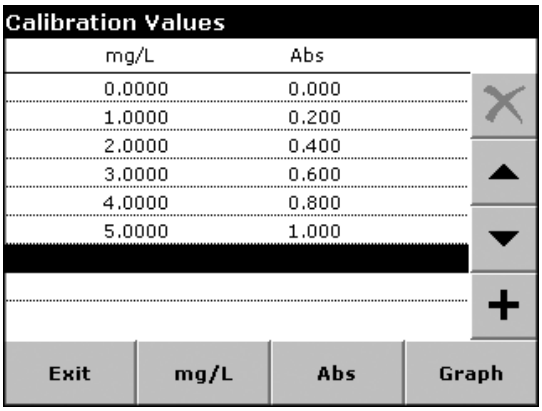


Table 7 Calibration Curve Definitions

Options	Description
Enter Values	A calibration table is created by entering the concentration values and the absorbance values of the corresponding standard solution. The absorbance values are plotted against the concentrations of the standard solutions and the calibration curve is displayed as a graph.
Read Standards	A calibration table is created by entering the concentration values of the standard solutions and then measuring the solutions to determine the corresponding absorbance values. The absorbance values are plotted against the concentrations of the standard solutions and the calibration curve is displayed as a graph.
Enter Formula	If the calibration curve can be determined from the mathematical relationship between concentration and absorbance by linear regression, or some other curve fitting is possible, the corresponding formula can be selected (linear, 2nd or 3rd order polynomial) from a list and the appropriate factors can be entered.

6.1.2.1 Entering Calibration Values

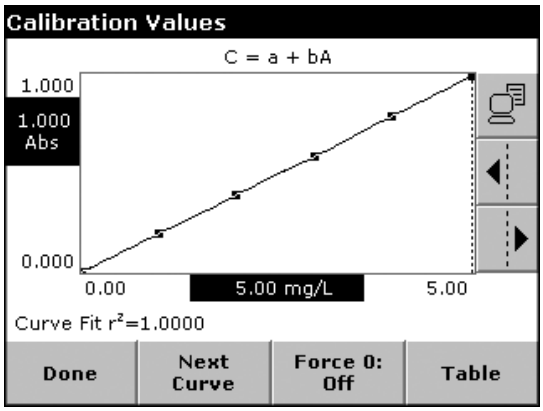
1. From the Calibration screen, select Enter Values and press **NEXT**.
2. Press the **+** symbol and then use the alphanumeric keypad to enter the first standard concentration.



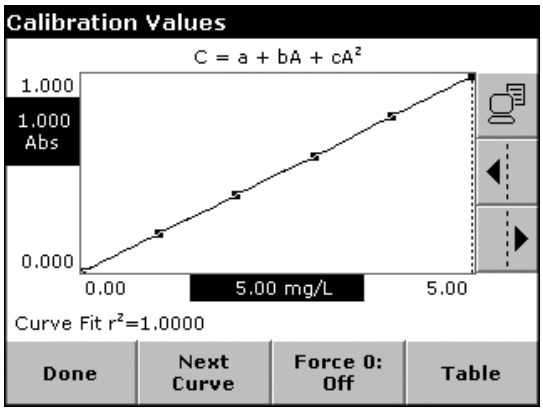
3. Press **OK** and enter the corresponding absorbance value. Press **OK**. The entered data are displayed in the table. Repeat the sequence for each data point.
4. To change the value in the table, activate the appropriate line, press the **UNIT** key (e.g. mg/L) or **ABS** and enter the new value using the alphanumeric keypad.

5. When the data are entered, press **GRAPH** to display the curve. The square of the correlation coefficient is shown on the left, below the axes.

6. The linear curve corresponds to the standard setting. Press **NEXT CURVE** to display the polynomial 2nd order curve. Press **NEXT CURVE** again to view the polynomial 3rd order curve.



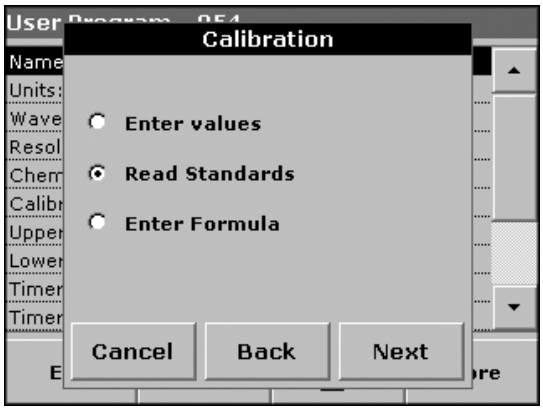
7. Press **FORCE 0** to change the setting from Off to On. The curve now passes through the origin of the coordinate system. This may have an adverse effect on the square of the correlation coefficient but it will force the instrument to read zero concentration when the **ZERO** key is pressed (setting absorbance to 0.000).



8. Press **TABLE** to display the table. When the table is completed and the curve type has been selected, press **DONE**.

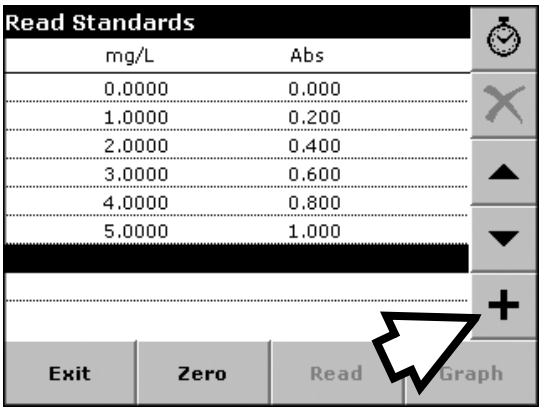
6.1.2.2 Measuring the Absorbance of the Standard Solution

1. Select Read Standards and press **NEXT**.



2. Press the **+** symbol and use the alphanumeric keypad to enter the standard concentration. Press **OK**.

3. Press the **+** symbol again and enter the next standard concentration. Repeat this sequence until all standard concentrations (maximum of 24 solutions) are entered.



4. Activate the line with the appropriate concentration and insert the cell with the corresponding standard solution.

5. Place the zero solution in the cell compartment. Close the compartment. Press **ZERO**.

6. Place the first standard solution in the cell compartment and close the cell compartment. Press **READ**.

7. Place the second standard solution in the cell compartment and close the cell compartment. Press **READ**. Repeat this sequence until all the standard solutions are measured (maximum of 24 solutions).

8. The entered and measured data are displayed in the Table. To delete a standard concentration, highlight the appropriate line and press **DELETE**.

9. The **TIMER** icon shown in the display helps to ensure, when necessary, that the steps of an analysis are correctly timed (e.g. reaction times, wait times, etc., can be exactly specified). When the specified time has elapsed, an acoustic signal is emitted. The use of the timer has no influence on the measurement program.

10. When the data are entered and the measurements are complete, press **GRAPH** to display the curve that results from plotting the entered data.

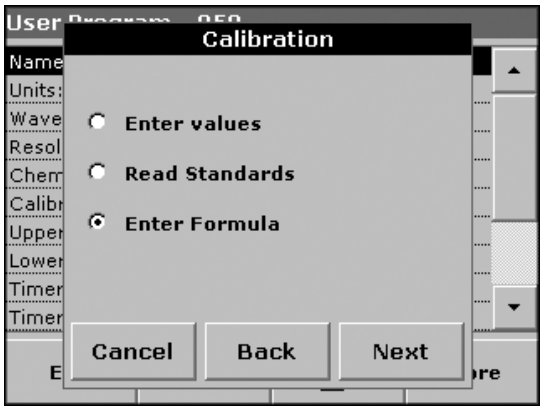
11. The linear curve corresponds to the standard setting. Press **NEXT CURVE** to display the polynomial 2nd order curve. Press **NEXT CURVE** again to display the polynomial 3rd order curve.

12. Press **FORCE 0** to change the setting from Off to On. The curve now passes through the origin of the coordinate system. This will force the instrument to read zero concentration when the **ZERO** key is pressed (setting absorbance to 0.000).

13. Press **TABLE** to display the table again. When the table has been completed and the curve type has been chosen, press **DONE**.

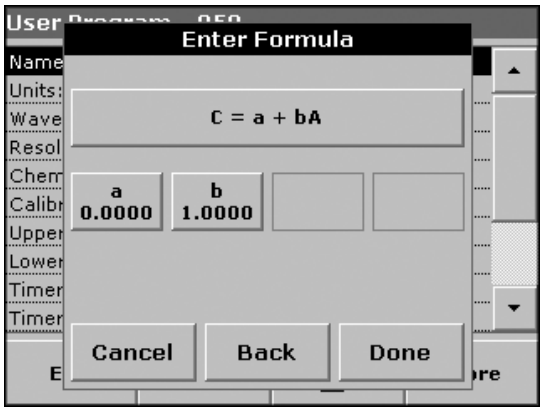
6.1.2.3 Entering the Formula

1. Select Enter Formula and press **NEXT**.



Up to 4 coefficients can be entered, depending on the selected formula.

2. Press the **FORMULA** key. A list of available formulas (linear, 2nd, and 3rd order polynomial) is displayed. Press the required formula.



The coefficients can have 5 digits and can have a positive or a negative sign.

3. Depending on the selected formula, the required coefficients are displayed. Press the **COEFFICIENT** keys and enter the corresponding values using the alphanumeric keypad. After each entry, press **OK** to confirm.

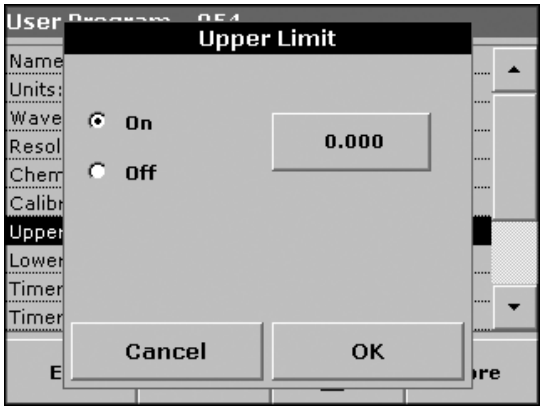
6.1.3 Additional User Program Parameters/Functions

6.1.3.1 Upper and Lower Measuring Range Limits

Enter the Upper and Lower Limits of the measuring range. An error message is displayed if a reading is above the upper limit or below the lower limit.

1. Activate the appropriate line in the overview of the program data and press **EDIT**.

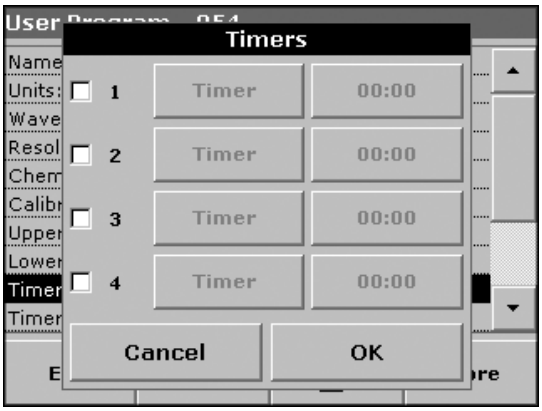
2. Select On. Press **0.000** to enter the measuring range limit. Press **OK** to confirm.



6.1.3.2 Timer Intervals

1. Enter the time intervals for the timers. This function can be used to enter abbreviations for work steps and defined intervals for up to four timers.

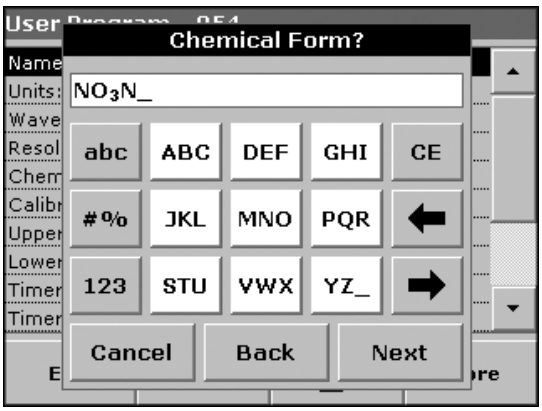
2. Select the appropriate program in the program data overview screen and press **EDIT**.



3. Check the appropriate timer(s). Press the **TIMER** key to select from a list of names that describe the corresponding step. Press **00:00** to enter the times for each timer.

6.1.3.3 Chemical Form

1. If a Chemical Form is defined, up to three additional alternatives can be entered.



2. Select the appropriate program in the program data overview screen and press **EDIT**.

3. Check the appropriate chemical form(s) to activate or deactivate the form.

4. Press the left key to enter another chemical form using the alphanumeric keypad. Press **OK** to confirm.

5. Press the right key to enter the conversion factor for the additional chemical form and press **OK** to confirm.

6.1.4 Free Programming

An overview of the specifications of the programmed test is displayed. Refer to Table 8 for more information. To modify an input option, select the appropriate line and press **EDIT**.

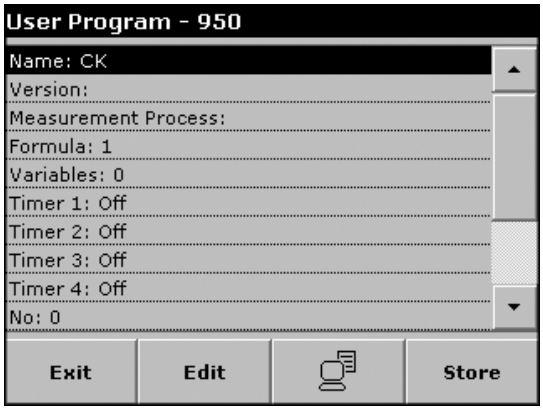


Table 8 Free Programming Options

Input Option	Description
Name	Name of the analysis parameter.
Version	An abbreviation assigned by the user, or the version number, etc. is entered here.
Measurement Process	Exact definition of the test: the number of wavelengths at which measurements are made, the number of absorbance measurements needed, the keys to be used, any waiting periods between measurements, etc.
Formula	Definition of the evaluation formulas with which the test result is calculated.
Variables	The number of variables shown in the display depends on the definition of the measurement process and the formulas. Input of the numerical values of the wavelengths, factors, constants, etc.
Timer 1, Timer 2, Timer 3, Timer 4	Used to enter abbreviations and defined times for up to four timers. Activate the appropriate line and touch **EDIT.** The timers are activated or deactivated with the control boxes on the left of the display. In the next column, a selection can be made from a list of names that describe the corresponding work step. In the third column, the times for each active timer are entered.

6.1.4.1 Measurement Process

The measurement process defines exactly the handling and the measurements of the test:

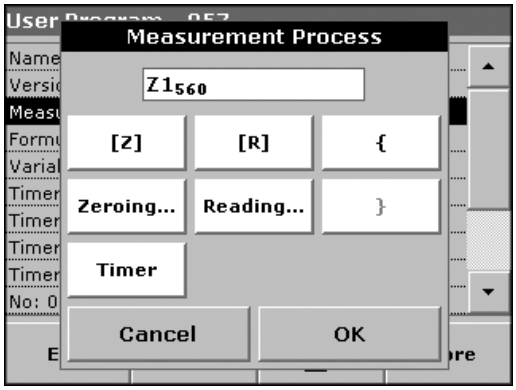
- At which and how many wavelengths should measurements be performed?
- How many absorbance measurements must be performed?
- When should the zero measurement and the sample measurement be performed?
- Are waiting times necessary between measurements?
- Should individual program sequences be repeated?

The elements of a measuring sequence, such as zero and sample measurements, and the timer(s) (reaction times, waiting times, etc.) are individually defined.

1. Press **USER PROGRAMS>PROGRAM OPTIONS>NEW.** Choose a program number, create a program name and select **FREE PROGRAMMING**.

2. Select the Measurement Process line and press **EDIT**.

3. Press **EDIT** again and then **NEW**.



[Z] Key

   a. Press the **[Z]** key to program a zero measurement.

   b. Press the **ZEROING** key and use the alphanumeric keypad to enter the wavelength at which the zero measurement is to be used.

   c. Press **OK** and confirm by pressing **OK** again. Repeat for each wavelength. The entered measurement sequence is displayed.

[R] Key

   a. Press the **[R]** key to program a measurement sample.

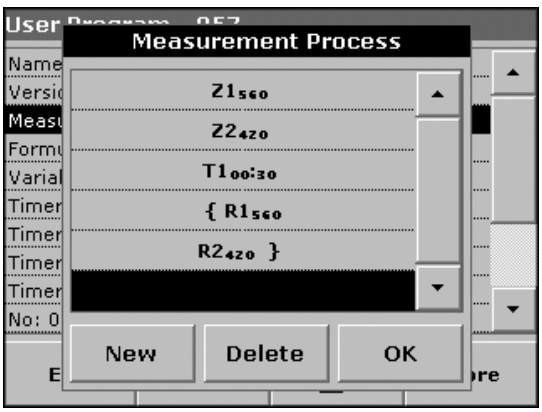
   b. Press the **READING** key and use the alphanumeric keypad to enter the wavelength at which the measurement is to be performed.

   c. Press **OK** and confirm by pressing **OK** again. Repeat for each wavelength. The entered measurement sequence is displayed.

{ and } Keys

Use the bracket keys to enter elements of the measurement sequence to be repeated. The left bracket "**{**"marks the start of the sequence that is to be repeated and the right bracket "**}**" marks the end. A right bracket has no significance unless it is preceded by a left bracket.

   a. Press **{**. Press the key that defines the sequence that is to be repeated: **[Z]** or **[R]**.



b. Press **ZEROING** or **READING** and use the alphanumeric keypad to enter the wavelength at which the measurement should be performed. Press **OK** to confirm.

c. Press **}** to end the sequence.

Note: *If an action such as a zero measurement occurs at different stages of a measurement sequence, the series of actions is numbered sequentially (e.g. Z1, Z2, etc.).*

TIMER Key

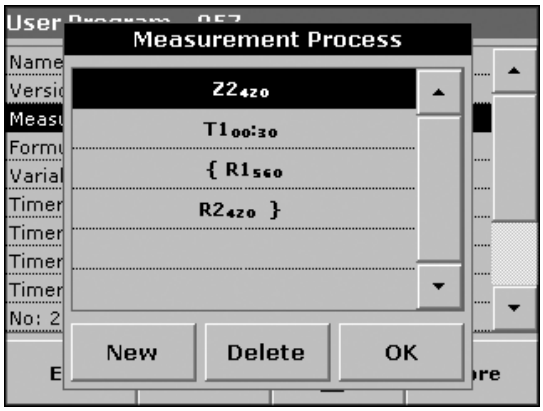
a. Press the **TIMER** key to enter any waiting, reaction, or handling times that have to be taken into account. Use the alphanumeric keypad to enter the time. Press **OK** twice to confirm.

b. This time is integrated into the measurement process. The entered measurement sequence is displayed.

6.1.4.2 Deleting and Inserting a Measuring Sequence Element

To delete an item, select the appropriate line and press **DELETE**.

To insert an item, select the appropriate line at the insertion point and press **NEW**. A new element can be entered at the selected position. When the input is complete, press OK in the Measurement Process display. The data overview is then displayed.



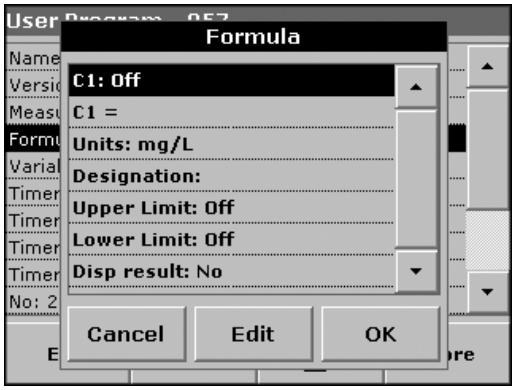
6.1.4.3 Entering the Calibration Formula

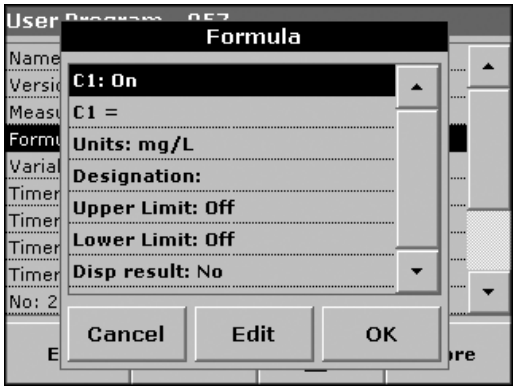
The calibration formula (evaluation formula) defines the calculation and display of intermediate and final results. The previously defined elements of the measuring sequence are the basis for calculating the concentrations.

C1 Calibration Formula

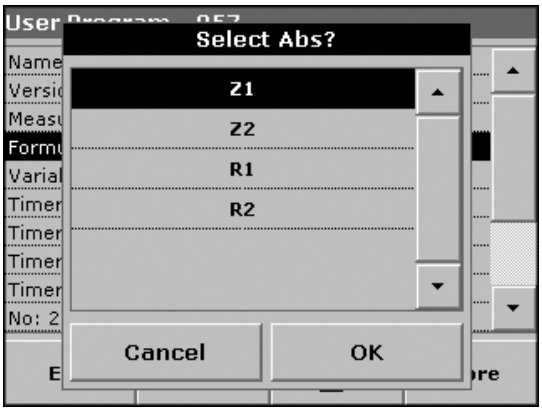
1. Select the Formula line in the data overview and press **EDIT**.

2. Select C1: Off and press **EDIT**. Select C1: Off again and press **EDIT**. The display changes to C1: On.

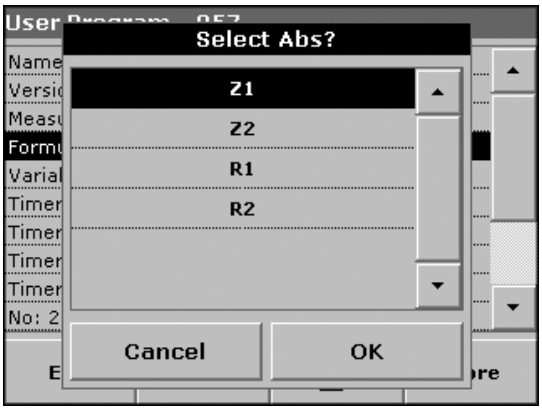




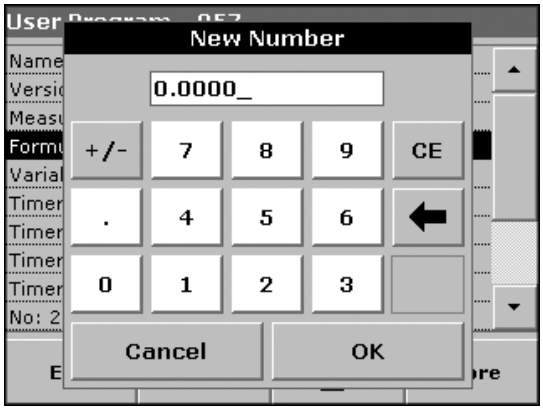
3. Activate the next line (C1 =) to define the formula and press **EDIT**. The evaluation formula is built successively in the display according to the input. The arrow key deletes the most recently entered element of the formula.



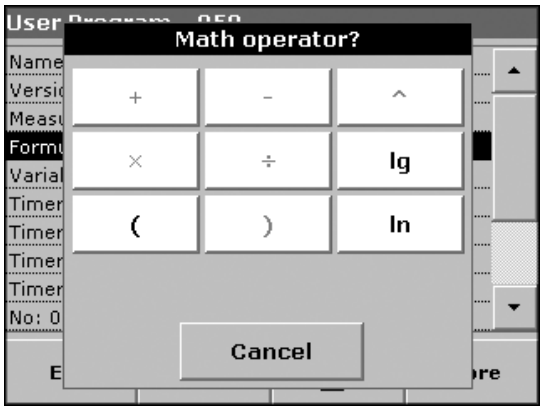
4. Press **SELECT ABS** to select the required element of the defined measuring sequence and the corresponding measurement wavelength.



5. Press the **NEW NUMBER** key to enter a new factor or constant.



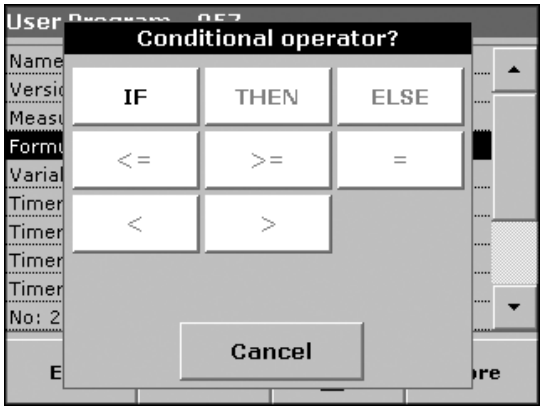
6. Press the **+/–** key to enter a mathematical operation. Select the operation and press **OK** to confirm.



The available choice of mathematical operations depends on the defined formula. This means that functions such as “( )” or “ln”/”log”, etc. are only active if a term in parentheses or the calculation of a logarithm is mathematically permissible in the defined formula

The following mathematical operations are available: addition (+), subtraction (–), division (/), multiplication (X), exponentiation (^), natural logarithm (l_n), and common logarithm (lg).

7. Press the **>=<** key to include logical statement/links/conditions in the formula.



The following functions are available: Equal to (=), Less than (<), Greater than (>), Less than or equal to (<=), Greater than or equal to (>=), IF, THEN, and ELSE.

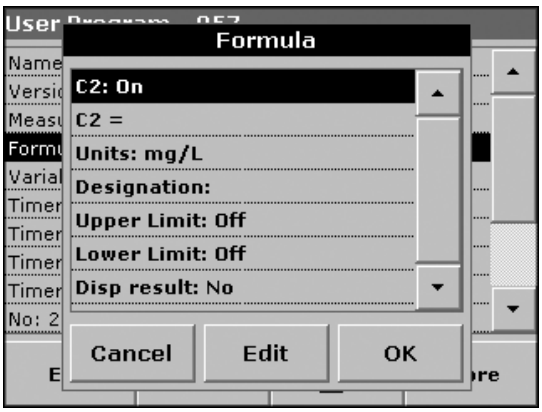
8. When the evaluation formula C1 has been entered, press **OK** to confirm. Press **OK** again to return to the Formula display.

9. When the formula C1 has been entered and confirmed, further specifications can be entered in the display overview of the formula.

C2 or Cn Calibration Formula

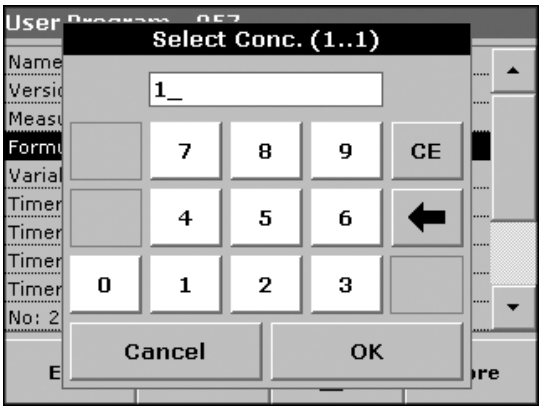
1. Select C2: Off and press **EDIT**.

2. Select C2: Off again and press **EDIT**. The display changes to C2: On.



3. Select C2 = to define the formula. Press **EDIT**.

4. Edit the formula as described in the C1 Calibration Formula. Also press the **CONC**. key to take into account another formula for C2. Enter the number of the formula (e.g. 1 for C1) and press **OK** to confirm. Cn can now be linked with a mathematical operation.



Note: *The Cn concentrations to be calculated are numbered in sequence: C1, C2, C3, etc.*

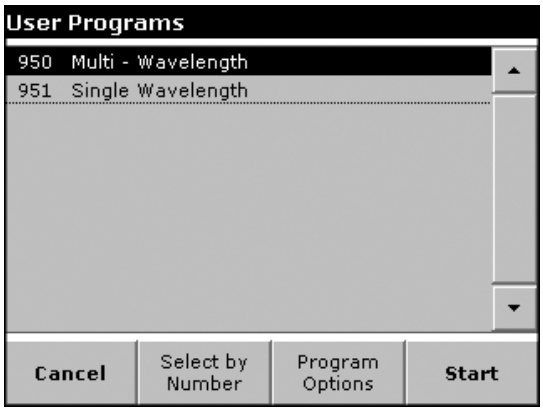
Note: *When the first Cn formula has been defined, the Formula list is automatically extended by Cn+1.*

6.1.4.4 Saving a Free Programming User Program

Press **STORE** to save the entered data. The data can be stored under any data point (Measurement sequence, Formula, Timer, etc.).

6.1.5 Selecting a User Program

1. From the Main Menu, press **USER PROGRAMS** to display an alphabetical list of user programs with program numbers.



2. Highlight the selection or press **SELECT BY NUMBER** to search for the program by number.

3. Press **START** to run the program.

6.1.6 Adding User Programs to the Favorite List, Editing, and Deleting User Programs

The most frequently used tests/methods in the user program menu can also be added to the list of favorites to simplify their selection.

1. From the Main Menu, press **USER PROGRAMS**. The User Programs list will appear.

2. Highlight the selection or press **SELECT BY NUMBER** to search for the program by number. Use the scroll bar to scroll through the list quickly.

3. Press **PROGRAM OPTIONS**.

4. Press **ADD TO FAVORITES**, **EDIT,** or **DELETE.** Press **OK** to confirm.

6.2 Barcode Programs

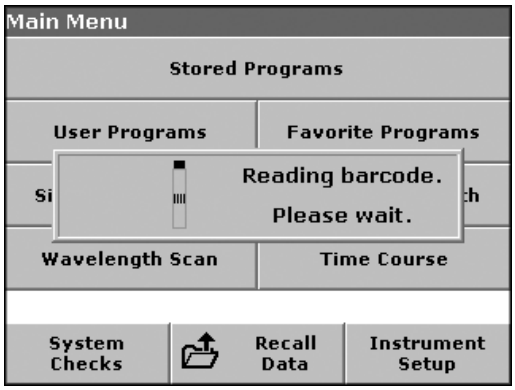
A special barcode reader in the vial compartment automatically reads the coded information on each round vial while the vial completes a single rotation. The instrument uses the barcode identification to set the correct wavelength for the analysis and calculates the result immediately.

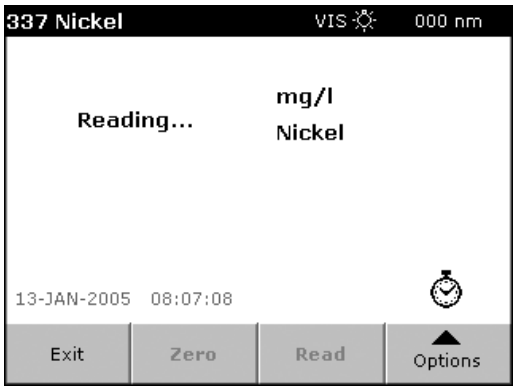
When a TNT plus™ (13 mm round vial with barcode label) is placed in the round vial compartment, the corresponding measurement program is activated in the main menu.

Important Note: *The cover must be closed before a measurement is made.*

1. Prepare the barcode test as specified in the procedure manual.

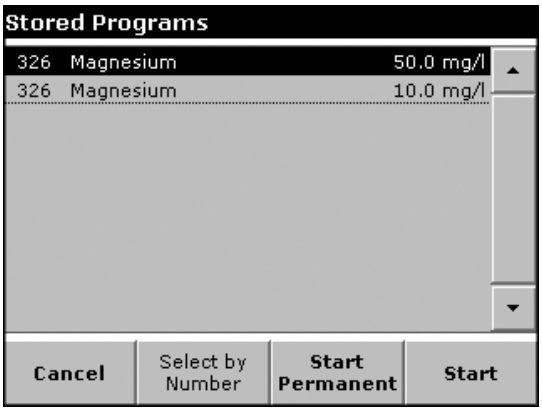
2. From the Main Menu, insert the sample cell or blank into the cell compartment and close the cover. The measurement process and results are displayed automatically.





6.2.1 Selecting the Measuring Range

Some sample cell tests can be used for different measuring ranges. After the sample cell has been inserted, a list of different ranges is displayed. Select the measuring range. Press **START PERMANENT** if the measuring range is to be applied to all subsequent measurements. To change the standard setting, in the results display, press **OPTIONS>MORE>START PERMANENT**. The Permanent: On key will be displayed.



6.2.2 Selecting a Chemical Evaluation Form

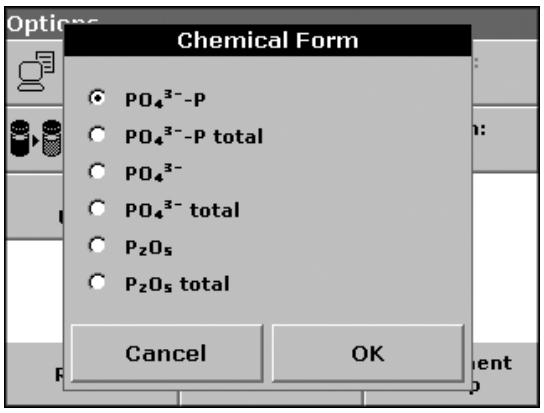
The form of the chemical evaluation of a number of test parameters can be selected individually.

In the Results display, press the unit (e.g. mg/L) or the chemical representation of the evaluation form (e.g. PO_4^{3-}–P). A list of possible evaluation forms is displayed from which the required form can be selected.

Note: *The selected evaluation form is displayed.*

Another way of changing the standard setting is:

1. In the results display, press **OPTIONS>MORE**>**CHEMICAL FORM**. A list of available evaluation forms appears.



2. Press the required chemical form. To evaluate other vial tests and other parameters, place the prepared cell in the cell compartment, close the compartment, and read the result.

6.2.3 Changing a Default Chemical Form Setting

1. Insert the sample cell or blank (depending on the working procedure) into the cell compartment and close the cover.

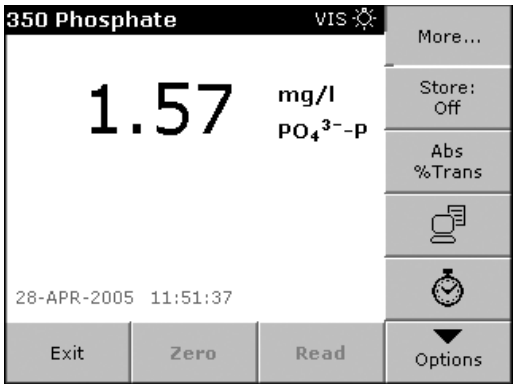
2. In the results display, press **OPTIONS>MORE>CHEMICAL FORM**.

3. A list of available evaluation forms appears. Select the new default setting and press **OK** to confirm.

4. Press **EDIT** and then **STORE**. The current result and all further measurements will be displayed in the new chemical form.

6.2.4 Changing the Parameter Options

1. Press **OPTIONS** to access data storage, readings, concentration, or wavelength setup options. Press **MORE** to view additional setup options. Refer to Table 9 for descriptions.



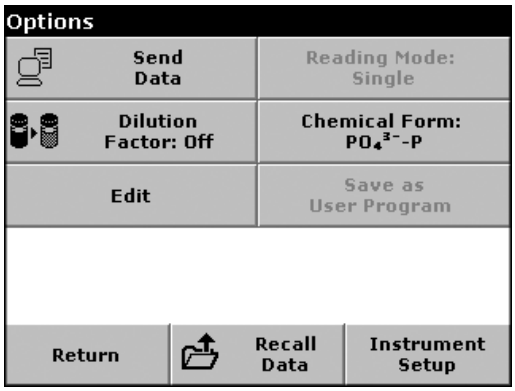


Table 9 Barcode Program Options

Option	Description
Store Off/On	With **STORE ON** selected, all measurement data are stored automatically. With **STORE OFF** selected, no measurement data are stored.
Abs % Trans	Toggles between % transmittance, absorbance readings, or concentration
Send Data Icon	Sends data to a printer, computer, or USB memory stick.
Timer icon	Functions as a stopwatch. Ensures that the steps of an analysis are correctly timed (e.g. reaction times, wait times, etc., can be exactly specified). When the specified time has elapsed, an audible signal is emitted. The timer has no influence on the measurement program.
Reading Mode	Disabled for Barcode readings.
Dilution Factor	A corrective dilution factor can be entered in order to take into account certain properties. The number entered at the dilution factor prompt will be multiplied by the result to compensate for the adjustment. For example, if the sample has been diluted by a factor of 2, enter 2. The default setting of the dilution factor is 1, corresponding to no dilution. When a dilution is in effect, the **DILUTION** icon will appear on the display. Refer to 5.4.4 on page 38.
Standard Addition	Enables the accuracy of the measurements to be checked. The procedure for a test parameter contains a detailed explanation of how to use this function.
Chemical Form	For some stored programs, the chemical form and measuring range can be selected.
Edit	Modify an existing program.
Recall Data	Recalls saved measurement data, wavelength scans, or time courses (section 5.3.1.2 on page 29).
Instrument Setup	Basic operational settings of the instrument (section 5.2 on page 19).

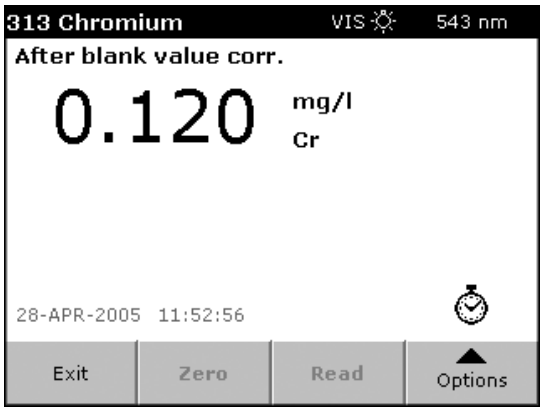
6.2.5 Preparing a Sample Blank

Turbidity and color in the sample matrix can alter the results of a photometric analysis. The interference factors come from the sample or are created by reactions with the reagents.

The influence of turbidity and/or color can be eliminated or reduced by taking a sample blank reading.

In the barcode mode, a special vial (Cat. No. TNT919) containing the sample blank is placed in the round vial compartment after the sample reading has been taken and is automatically measured. The sample reading is then corrected by adding or subtracting the blank value and the final result is displayed, together with the message "After blank value corr.".

Some barcode tests do not require a sample blank value to be determined, as turbidity and color are dealt with during the test procedure.

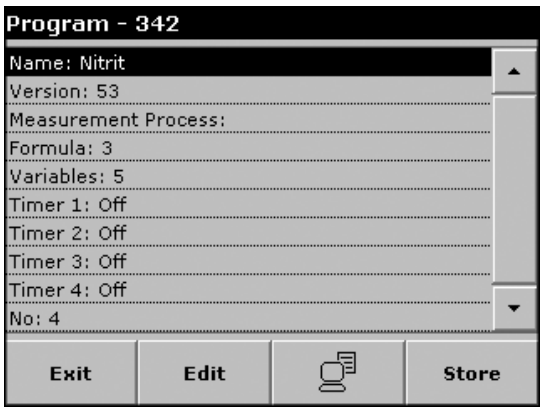


6.2.6 Updating/Editing Barcode Cuvette Tests

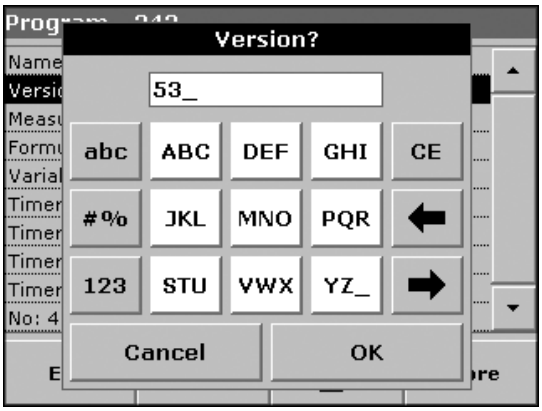
6.2.6.1 Programming Data

From the program list, select the appropriate item to configure. From within the method (after reading a vial), press **OPTIONS>MODE>EDIT**. Check the working procedure in advance to determine if these inputs need to be changed.

1. Enter the name of the analysis parameter. Highlight Name and press **EDIT**. Use the alphanumeric keypad to enter the name indicated in the procedure and press **OK** to confirm.

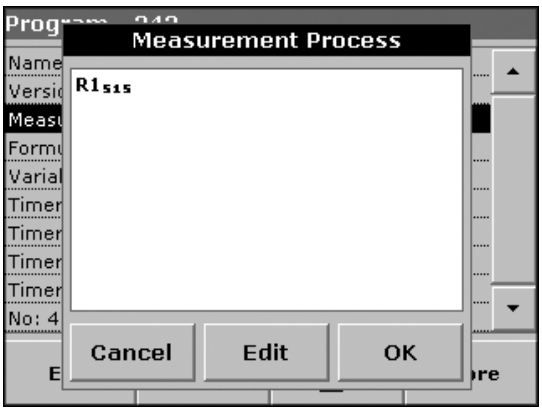


2. Enter the version number. Highlight Version and press **EDIT**. Use the alphanumeric keypad to enter the name indicated in the procedure and press **OK** to confirm.



3. Enter the measurement process (exact definition of the test: the number of wavelengths at which measurements are performed, the number of absorbance measurements needed, the keys to be used, any waiting periods between measurements, etc.). For detailed information, refer to section 6.1.4.1 on page 53.

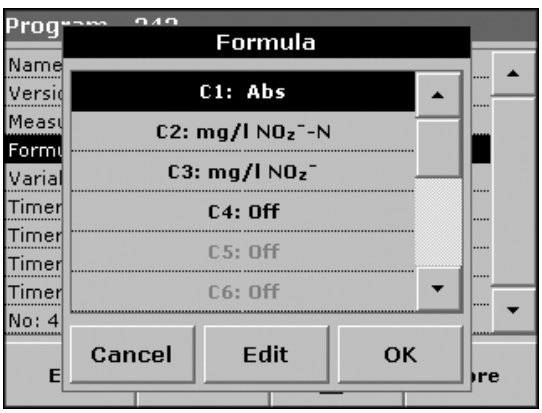
   a. Highlight Measurement Process in the data overview and press **EDIT**.



   b. Press **EDIT**, select the sequence to be edited, and press **DELETE**.

   c. Press **NEW** and use the alphanumeric keypad to enter the process indicated in the procedure.

4. Enter the formula (definition of the evaluation formulas for which the test is calculated), concentration units, designation, and measuring modes. Refer to section 6.1.4 on page 53 for more information.

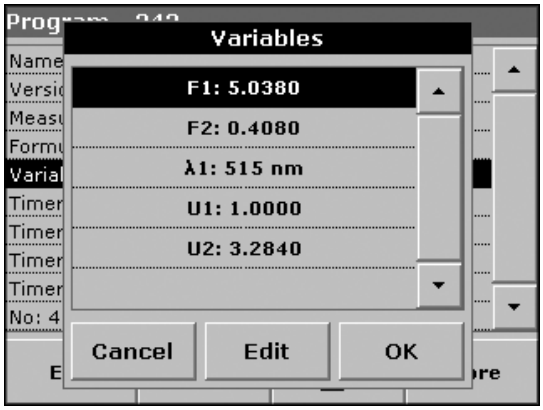


a. Highlight Formula in the data overview and press **EDIT**.

b. Select the formula to be edited, press **EDIT** and use the alphanumerical keypad to enter the data specified in the working procedure (for C1=, C2=, units, name, measuring range limits, etc.).

5. Enter the variables (factors, wavelengths, and conversion factors). The number of variables displayed depends on the definition of the measurement process and the formulas. Refer to section 6.1.4 on page 53 for more information.

a. Highlight Variables in the data overview and press **EDIT**. Use the alphanumeric keypad to enter the data specified in the procedure (for F1, F2, λ1, U1 etc.). Confirm each entry with **OK**.



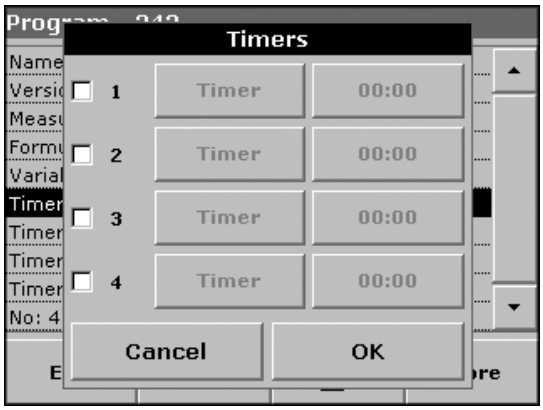
Abbreviation of Variables:

- F1: Factor 1
- F2: Factor 2
- λ1: Wavelength 1
- U1: Conversion Factor 1 for the first chemical form
- U2: Conversion Factor 2 for the second chemical form

6. Enter the timer information. This can be used to enter abbreviations and defined times for up to four timers.

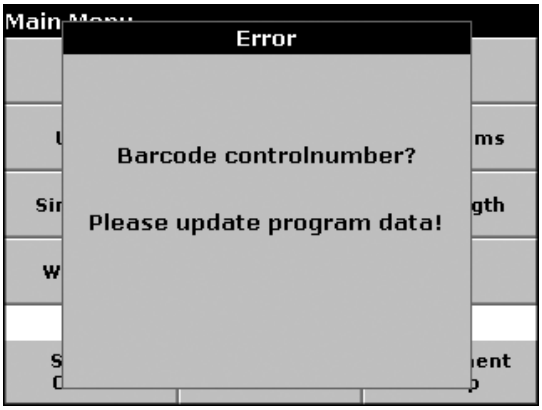
a. Highlight the appropriate Timer and press **EDIT**.

b. Check the appropriate timer(s). Press the **TIMER** key to select from a list of names that describe the corresponding step. Press **00:00** to enter the times for each timer.



6.2.7 Manually Updating a Barcode Program

Using the data provided in the barcode, the instrument automatically sets the measurement wavelength and factors. If a discrepancy is detected between the barcode data and the stored data, or a new test is identified, the instrument requests an update.



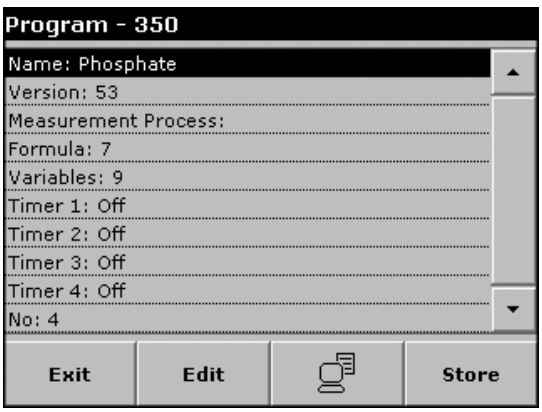
6.2.7.1 Updating an Existing Barcode Vial Test

Note: *Only in very few cases does the revision of a test require all test specifications to be updated.*

Option 1: Manual Update of Test Data

1. From the Main Menu, insert the sample cell or blank (depending on the procedure) into the cell compartment and close the cover.

2. After the comment "Barcode controlnumber?", a data overview is displayed, including the specifications of the test that is to be revised.



Note: *The procedures of the corresponding Vial Test contains the new data (Wavelength, Factors, Measurement Ranges, Conversion Factor for Chemical Form, etc.).*

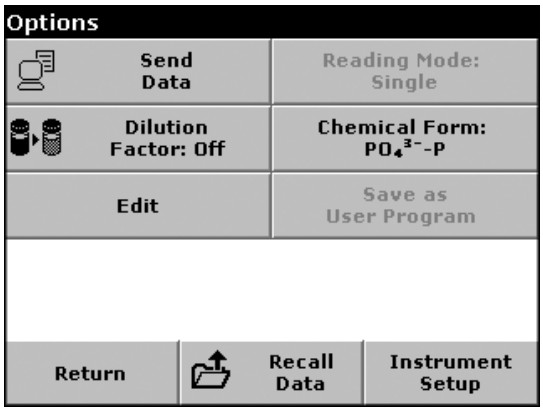
3. Highlight the corresponding line in the data overview and press **EDIT**.

Option 2: Manual Check/Revision of Test Data

If an incorrect entry was made during the data update and is not recognized via the barcode of the vial (e.g. an incorrect measuring range), another option is available for checking, and if necessary, revising the test data.

1. From the Main Menu, insert the sample cell or blank (depending on the working procedure) into the cell compartment and close the cover.

2. Press **OPTIONS>MORE>EDIT**.

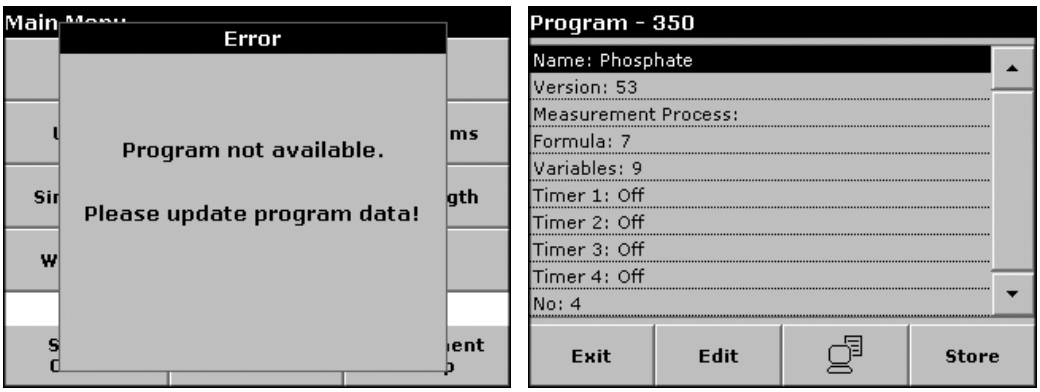


3. A data overview is displayed, including the specifications of the test that is to be revised. Compare the displayed data with the data in the working procedure, and edit the displayed data in accordance with the working procedure data.

6.2.7.2 Updating a New Test

1. From the Main Menu, insert the sample cell or blank (depending on the working procedure) into the cell compartment and close the cover.

2. After the comment "Program not available.", a data overview is displayed, including the specifications of the test that is to be revised.



The working procedures of the corresponding test contains the new data (Wavelength, Factors, Measurement Ranges, Conversion Factor for Chemical Form, etc.).

3. Highlight the corresponding line, including the specifications of the test that is to be programmed, and press **EDIT**.

6.2.8 Updating a Barcode Program from the Internet

Refer to section 6.8.2 on page 90 for more information.

6.3 Standard Addition–Monitoring/Checking Results

Refer to section 6.3.1 on page 69 for instructions on how to perform a standard addition using the DR 5000.

The accuracy of measured values (their correspondence with the actual concentration of the parameter in the sample) and the precision (correspondence of the measurement results obtained from several samples containing the same concentration of the test parameter) can be determined or improved using the standard addition method. This method (also referred to as spiking) serves to identify sample-specific interference factors, e.g. substances in the sample that alter the analysis results (sample matrix effect), a defective measuring instrument or contaminated reagents.

Perform Standard Additions by adding a known amount of a standard solution to a sample. If results are not close to 100% recovery, an identifiable problem exists.

If the use of standard additions is appropriate for a test, a Standard Additions method will be in the procedure under Accuracy Check. Follow the detailed instructions provided.

If the results are about 100% recovery for each addition, they are likely correct. Results can be verified by running a standard solution through the test. Poor recovery indicates that a problem exists. For example, to test for interference in the sample, repeat the standard additions using deionized water as the sample to check the reagents, instrument, and technique. If recovery is now about 100% for each addition, interference is present in the sample.

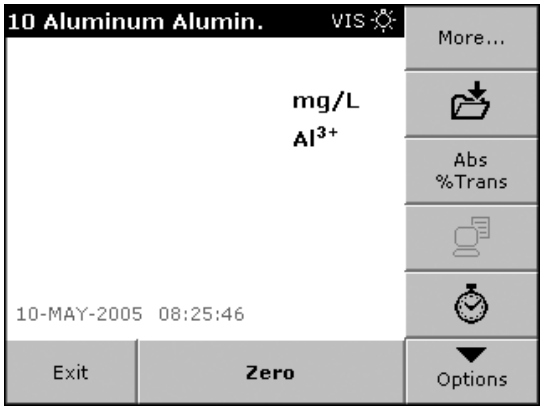
For poor recoveries with the deionized water, use the following list to find the problem:

1. Follow the procedure exactly:
   - Are the reagents added in the correct order?
   - Is enough time allowed for color development?
   - Is the correct glassware in use?
   - Is the glassware clean?
   - Does the test need a specific sample temperature?
   - Is the sample pH in the correct range?

   Consult the procedure in the DR 5000 Procedure Manual to answer these questions.
2. Follow the instructions in Troubleshooting on page 105 to check the performance of the instrument.
3. Check the reagents. Repeat the standard additions using fresh reagents. If the results are now good, the original reagents were bad.
4. If nothing else is wrong, the standard is almost certainly bad. Repeat the standard additions with a new standard.
5. If the problem persists, contact Technical Support.

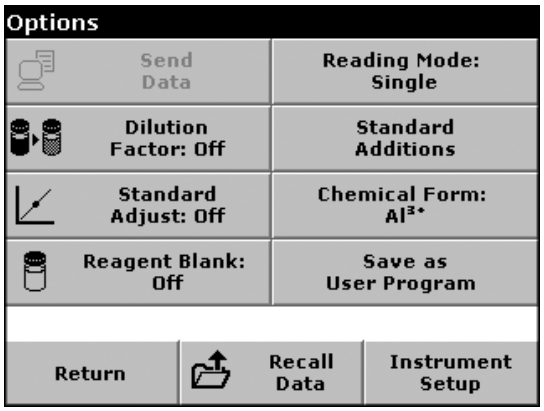
6.3.1 Using the Standard Additions Option

1. From the Main Menu, select **STORED PROGRAMS**. Select the required program and press **START**.

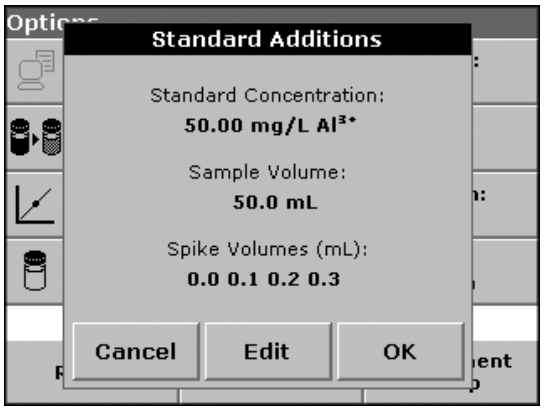


2. Analyze a sample without added standard solution in accordance with the instructions in the Procedure Manual. When the measurement is complete, leave the sample cell in the cell holder.

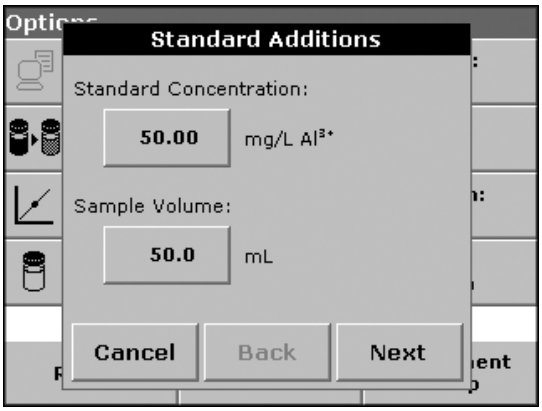
3. Press **OPTIONS>MORE>STANDARD ADDITIONS**.



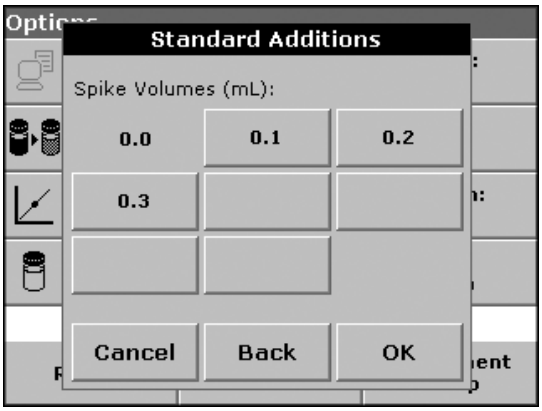
4. An overview of the standard addition procedure data is displayed. Press **OK** to accept the standard values for standard concentration, sample volume, and standard addition (spike) volume. Press **EDIT** to change any of these values.



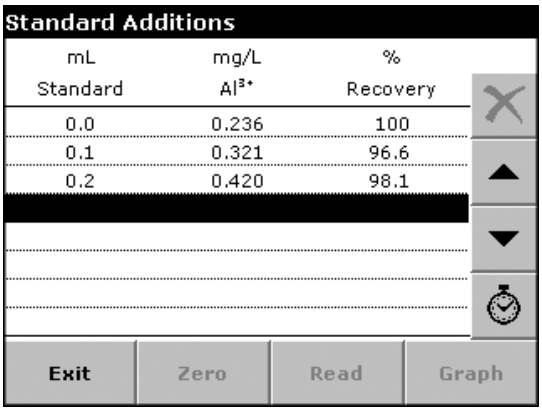
5. Press the key of the value to change. Use the alphanumeric keypad to change the value. Press **OK** to confirm.



6. Press the keys to enter the standard addition volumes. Use the alphanumeric keypad to enter the new data. Press **OK** to confirm.



7. A table of the reading will be displayed.



- The first column shows the standard addition volume. A sample containing no standard shows 0 mL.
- The second column shows the reading of the samples with and without added standard.
- The third column shows the detection rate of the added standard.
- The black highlighted line is active.

8. The reading of the sample in the instrument, without added standard, is automatically shown under 0 mL.

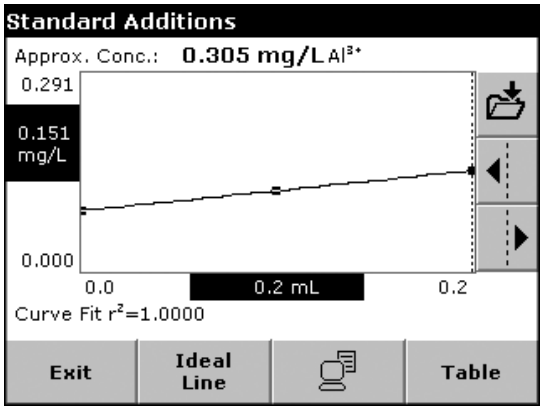
9. Prepare the standard addition solution as described in the procedure.

10. Use the arrow keys to select the first standard addition volume in the table and place the vial with the corresponding volume of added standard in the cell compartment. Close the compartment. Press **READ**.

11. Repeat the procedure from step 8 with all the other standard addition solutions.

12. After all the standard addition solutions have been measured, press **GRAPH**.

13. The regression line through the standard addition data points is displayed. The square of the correlation coefficient indicates how close the data points are to the line. If the square of the correlation coefficient = 1, the curve is linear.



The concentration shown above the curve is the estimated concentration of the sample without the added standard. Press **TABLE** to display all the data in the table.

14. Press **IDEAL LINE** to display the relationship between the added standard solutions and the ideal line (100% recovery).

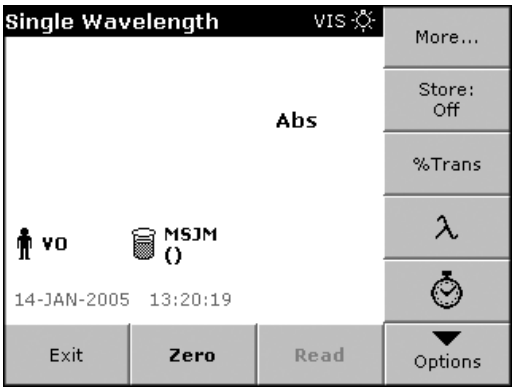
6.4 Single Wavelength Mode

The Single Wavelength Mode can be used in three ways. If the wavelength of a parameter is known, the instrument can be set to measure the absorbance, % transmittance, or concentration of the analyte.

6.4.1 Setting Up Single Wavelength Mode

1. From the Main Menu, select **SINGLE WAVELENGTH.**

2. Press **OPTIONS** to access data storage, readings, concentration, or wavelength setup options. Press **MORE** to view additional setup options. Refer to Table 10 for descriptions.



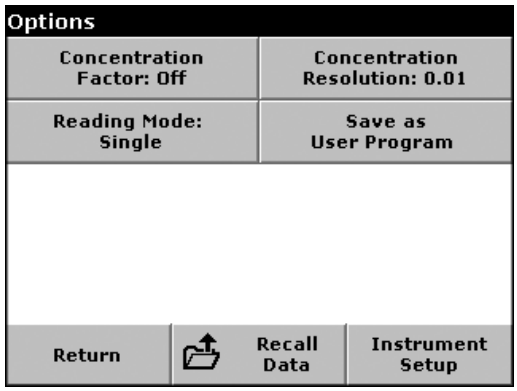
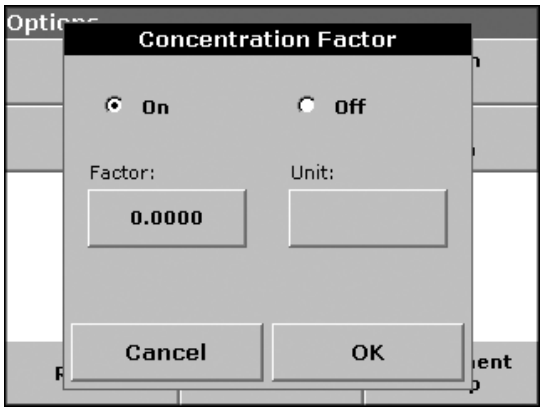


Table 10 Single Wavelength Setup Options

Option	Description
Store Off/On	With **STORE ON** selected, all measurement data are stored automatically. With **STORE OFF** selected, no measurement data are stored.
% Trans/Abs/Conc	Toggles between % transmittance, absorbance readings, or concentration
	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.
	Concentration: Allows the selection of a specific multiplier for converting absorbance readings to concentration.
λ	Enters the measurement wavelength. Use the alphanumeric keypad to enter the measurement wavelength. The entered wavelength must be in the range from 190–1100 nm.
Timer icon	Functions as a stopwatch. Ensures that the steps of an analysis are correctly timed (e.g. reaction times, wait times, etc., can be exactly specified). When the specified time has elapsed, an audible signal is emitted. The timer has no influence on the measurement program.
Concentration Factor: On/Off	Multiplication factor for converting absorbance values into concentration values. In a graph of concentration versus the absorbance, the concentration factor is the slope of the line.
Concentration Resolution	Select the position of the decimal point in the calculated concentration readings.
Reading Mode:	**Single:** A reading is only displayed after a measurement has been completed. The **READ** key must be pressed to initiate a measurement.
	Continuous: After zero measurement, all readings are displayed automatically and continuously (default setting). The **READ** key does not appear.
Save as User Program	Stores the selected parameters as a User Program.
Recall Data	Recalls saved measurement data, wavelength scans, or time courses (section 5.3.4.2 on page 32).
Instrument Setup	Basic operational settings of the instrument (section 5.2 on page 19).

6.4.1.1 Setting the Concentration Factor

1. Press **CONCENTRATION FACTOR: OFF** in the Options menu. Select On to activate.



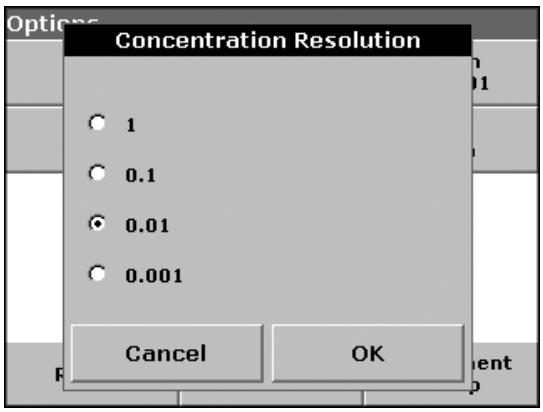
2. Press the **FACTOR** key to enter the factor by which absorbance readings are to be multiplied. Press the **UNIT** key to select the units for concentration measurements or to create a new unit.

3. Press **OK** to confirm.

6.4.1.2 Setting the Concentration Resolution

1. Press **CONCENTRATION RESOLUTION** in the Options Menu.

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



6.4.1.3 Setting the Reading Mode

1. Press **READING MODE** to activate the required mode (Single Readings or Continuous Reading).

2. Select the required mode and press **OK** to return to the result display.

Note: *In continuous reading mode only the **ZERO** key is shown to start the reading. The reading sequence is started automatically when the cell compartment is closed. In Single Reading Mode, both the **ZERO** and **READ** key are shown.*

6.4.2 Performing a Single Wavelength Measurement

1. Set the wavelength. Refer to section 6.4.1 on page 71 for more information.

1. Insert the blank vial into the cell holder and close the cell compartment. Press **ZERO**.

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

2. Insert the sample vial into the cell holder and close the cell compartment. Press **READ**.

Note: *The UV lamp is not switched on until a wavelength in the UV spectrum has been entered and the blank reading has been started. During the warm-up phase of the UV lamp, the message "Warming up..." is displayed and the UV lamp symbol flashes. As soon as the UV lamp is ready, the blank reading is performed.*

Note: ***ZERO*** *and* ***READ*** *are disabled until the cell compartment is closed.*

3. For data storage, refer to section 5.3.1 on page 29.

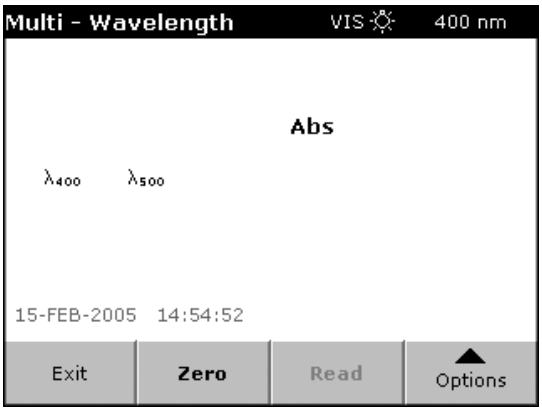
6.5 Multi-Wavelength Mode

If measurements are to be performed at more than one wavelength, two to four different wavelengths can be selected. The number of wavelengths depends on the selected absorbance formula.

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. Concentration is calculated using a single factor for each wavelength, which is input by the user.

6.5.1 Setting the Reading Mode at Different Wavelengths

1. From the Main Menu, press **MULTI-WAVELENGTH**.
2. Press **OPTIONS** to access data storage, readings, concentration, or wavelength setup options. Press **MORE** to view additional setup options. Refer to Table 11 for descriptions.



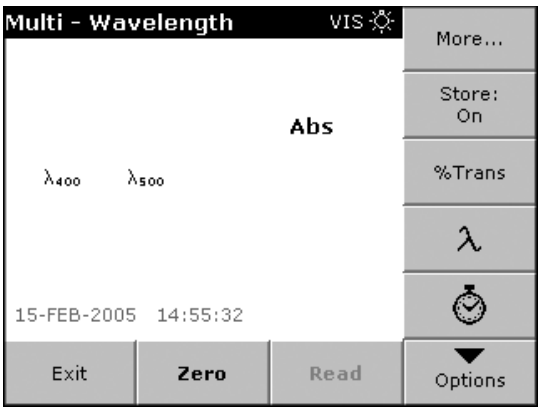
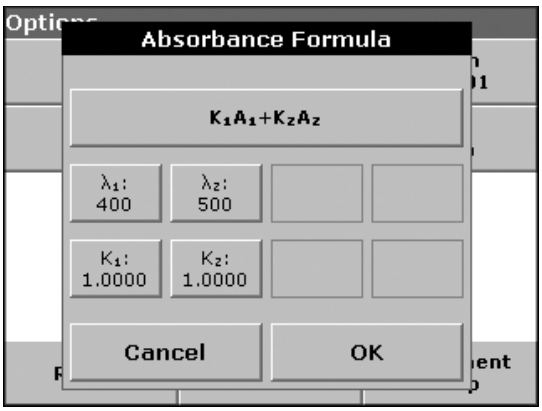


Table 11 Multi-Wavelength Setup Options

Option	Description
Store Off/On	With **STORE ON** selected, all measurement data are stored automatically. With **STORE OFF** selected, no measurement data are stored.
% Trans/Abs/Conc	Toggles between % transmittance, absorbance, or concentration readings .
λ	Enter the measurement wavelengths. Use the alphanumeric keypad to enter the measurement wavelengths. The entered wavelengths must be in the range from 190–1100 nm.
Timer icon	Functions as a stopwatch. It helps to ensure that the steps of an analysis are correctly timed (e.g. reaction times, wait times, etc., can be exactly specified). When the specified time has elapsed, an audible signal is emitted. The use of the timer has no influence on the measurement program.
Concentration Factor: On/Off	Multiplication factor for converting absorbance values into concentration values.
Concentration Resolution	Select the position of the decimal point in the calculated concentration readings.
Absorbance Formula	Calculation basis for evaluating samples.
Save as User Program	Stores the selected parameters as a user program.
Recall Data	Recalls saved measurement data, wavelength scans or time courses (section 5.3.4.2 on page 32).
Instrument Setup	Basic operational settings of the instrument (section 5.2 on page 19).

6.5.1.1 Setting the Absorbance Formula

1. Press **ABSORBANCE FORMULA**.



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

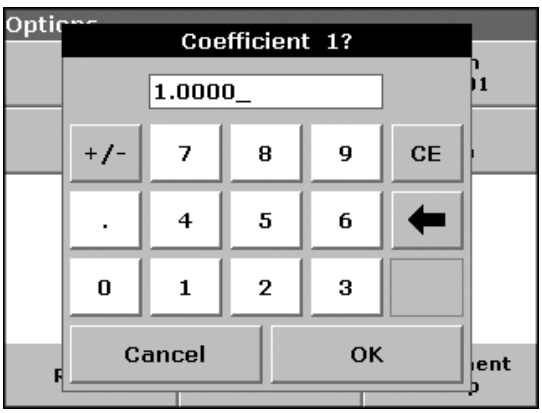
   The following formulas are available:
   $K_1 A_1 + K_2 A_2$
   $K_1 A_1 + K_2 A_2 + K_3 A_3$
   $K_1 A_1 + K_2 A_2 + K_3 A_3 + K_4 A_4$
   $K_1 A_1 / K_2 A_2$
   $(K_1 A_1 + K_2 A_2) / K_3 A_3$
   $(K_1 A_1 + K_2 A_2) / (K_3 A_3 + K_4 A_4)$

   Where:
   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 to negative where subtraction is required.

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

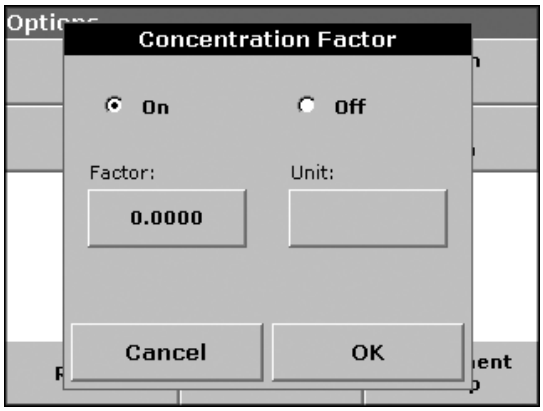
4. To change a coefficient, press one of the K_X**:** keys. Enter the desired coefficient into the numeric keypad and press **OK** to confirm.

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



6.5.1.2 Setting the Concentration Factor

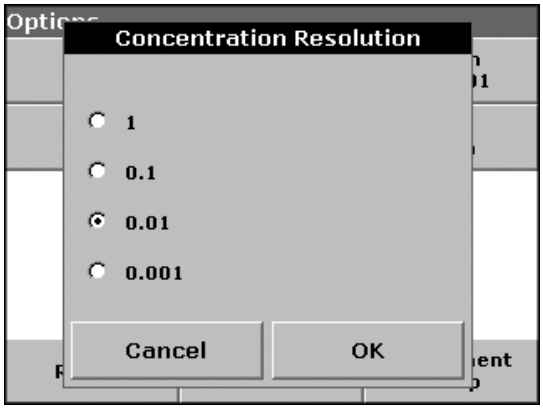
1. Press **CONCENTRATION FACTOR** in the Options menu. Select On to activate.



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. Press **OK** to confirm.

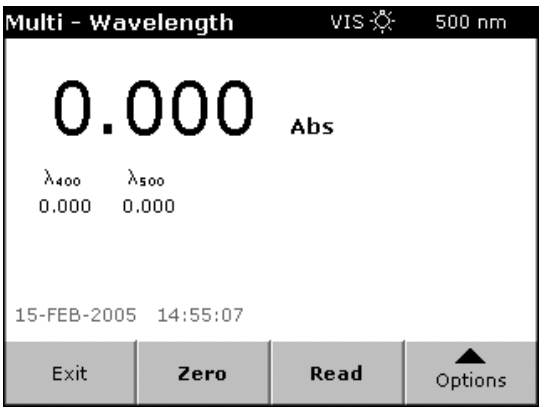
6.5.1.3 Setting the Concentration Resolution

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



6.5.2 Performing a Measurement in Multi-Wavelength Mode

1. Insert the blank vial into the cell holder and close the cell compartment. Press **ZERO**.



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

2. Insert the sample vial into the cell holder and close the cell compartment. Press **READ**.

Note: *The UV lamp is not switched on until a wavelength in the UV spectrum has been entered and the blank reading has been started. During the warm-up phase of the UV lamp, the message "Warming up..." is displayed and the UV lamp symbol flashes. As soon as the UV lamp is ready, the blank reading is performed.*

Note: **ZERO** *and* **READ** *are disabled until the cell compartment is closed.*

3. For data storage, refer to section 5.3.1 on page 29.

6.6 Wavelength Scan Mode

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

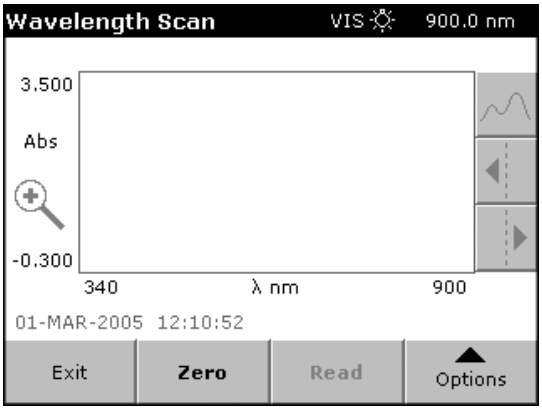
The measurement results can be displayed as a curve, as percent transmittance (%T) or as Absorbance (Abs). The collected data can be printed as a table or a curve.

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 the absorbance or transmittance value and the wavelength. The data associated with each data point can also be shown as a table.

6.6.1 Setting Up the Wavelength Scan

1. From the Main Menu, press **WAVELENGTH SCAN**.
2. Press **OPTIONS** to access data storage, readings, concentration, or wavelength setup options. Press **MORE** to view additional setup options. Refer to Table 12 for descriptions.



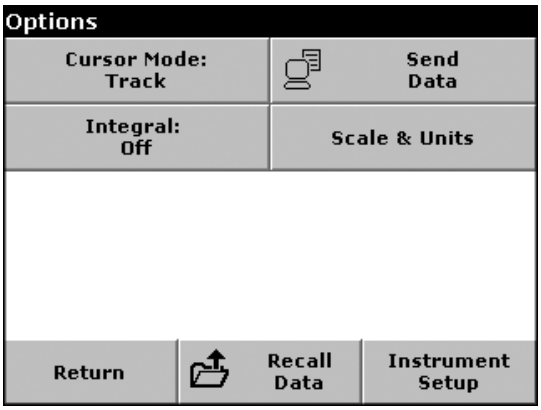


Table 12 Wavelength Scan Setup Options

Option	Description
Cursor Mode: Track	Select **Track** or **Peak/Valley**. Allows identification of specific points or maximum/minimum absorbance or %T readings.
Send Data	Sends data to a printer, computer, or USB memory stick.
Integral: On/Off	Integral provides 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	Recalls saved measurement data, wavelength scans, or time courses (section 5.3.1.2 on page 29).
Instrument Setup	Basic operational settings of the instrument (section 5.2 on page 19).
Store icon	Stores the scanned 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. This option is only available when there are stored scans with the same wavelength range and step.
λ	Enter the wavelength spectrum and the scan interval (step).
Select View	Enables the user to toggle the display back and forth between the scan data tables (wavelength/absorbance) and the graph of the curve. Select View will be activated after the first reading.

6.6.1.1 Store Scan Data

Refer to section 5.3.4 on page 32 for more information.

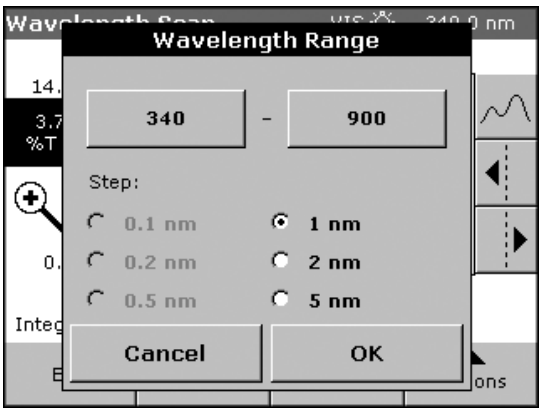
6.6.1.2 Setting Wavelength

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. Do not select the same wavelength for minimum and maximum.

4. Activate the required wavelength step. Selecting a larger step allows the instrument to scan faster, but decreases the resolution of the collected data. Intervals between 0.1 and 5 nm can be chosen. Allowable step sizes depend on the wavelength range chosen.



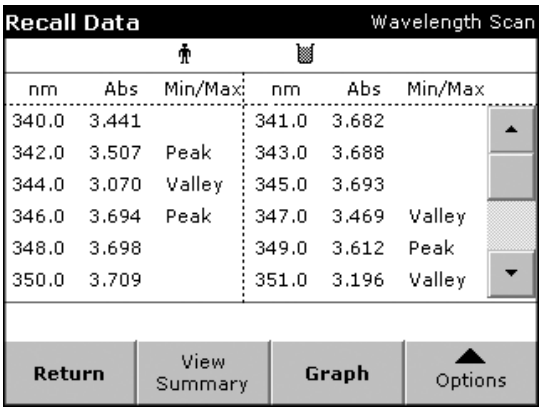
Note: *The maximum wavelength adjusts automatically if the difference between the maximum and minimum wavelength is not a multiple of the interval. In total, 910 measuring steps are possible.*

5. Press **OK** to return to the scan mode. Selected parameters are displayed along the x-axis on the graph.

6.6.1.3 Selecting the View (Displayed Table)

1. Press **VIEW TABLE** in the Option menu after a reading is taken.

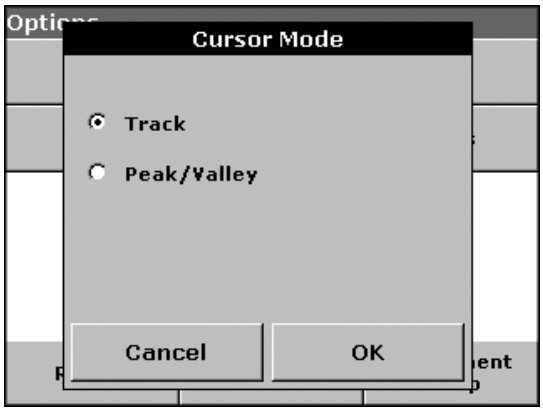
2. A table with the results is displayed.



3. To return to the graph, press **OPTIONS** and then **VIEW GRAPH**.

6.6.1.4 Selecting the 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. Select Track or Peak/Valley, refer to Table 13 on page 83.



3. Press **OK** to confirm.
4. Press **RETURN** to return to the scan mode.

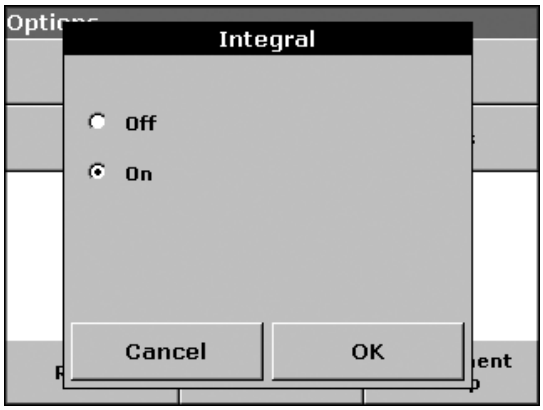
6.6.1.5 Sending Data

Refer to section 5.3.4.3 on page 33 for more information.

6.6.1.6 Integral Data

The integral applies to the entire wavelength range of the scan.

1. Press **INTEGRAL: OFF** in the Options menu.
2. Select On to show the Integral. To find the integral of other wavelength ranges, change the wavelength range and scan again.



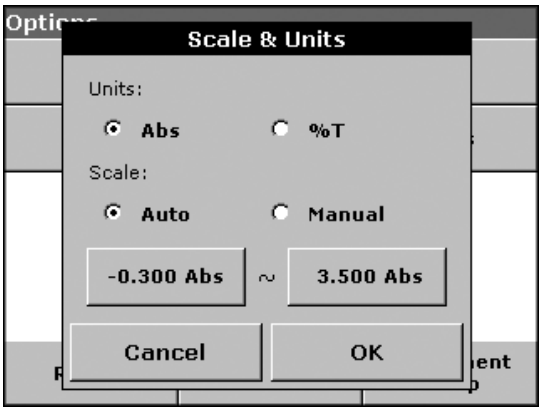
3. Press **OK** to confirm.
4. Press **RETURN** to return to the scan mode.

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.*

6.6.1.7 Scale and Units

1. Press **SCALE & UNITS**.
2. Select the required units (Abs or %T).



3. Select Auto or Manual scaling on the graph 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 scan values in the selected range. If automatic scaling is selected, the instrument sets the limits automatically so that the total scan range can be displayed.*

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

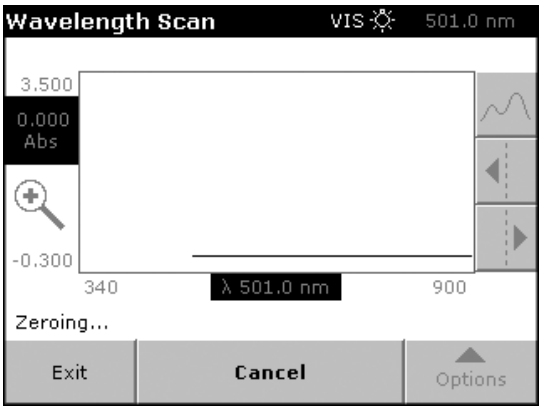
6.6.2 Performing a Wavelength Scan Reading

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. From the Main Menu, press **WAVELENGTH SCAN**.
2. Insert the blank vial into the cell holder and close the cell compartment.

Note: *If the lid of the cell compartment is not closed, the **ZERO/READ** key is disabled.*

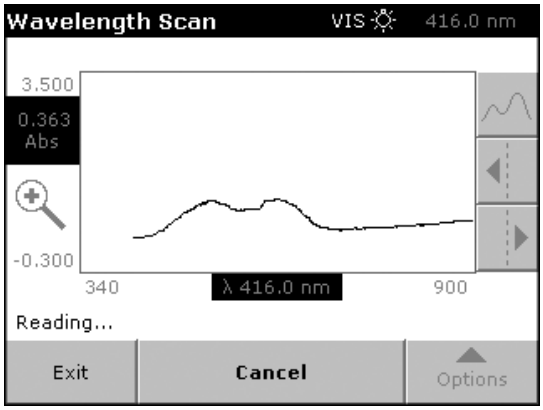
3. Press **ZERO**. "Zeroing...." appears below the graph as the baseline scan begins.



Note: *The UV lamp is not switched on until a wavelength in the UV spectrum has been entered and the blank reading has been started. In the warm-up phase of the UV lamp, the message "Warming up..." is displayed and the icon UV lamp flashes. As soon as the UV lamp is ready, the blank reading is performed.*

4. After the baseline scan has been completed, insert the prepared sample vial into the cell holder and close the cell compartment.

5. Press **READ**. Below the graph "Reading..." appears and a graph of the absorbance or % transmittance values at the scanned wavelengths is displayed continuously.



6. The Wavelength Scan is complete. The graph is shown in full size, the scaling of the x-axis fits automatically, and the cursor functions in the vertical navigation bar are activated. Refer to Table 13 for information on how to navigate the scan graph.

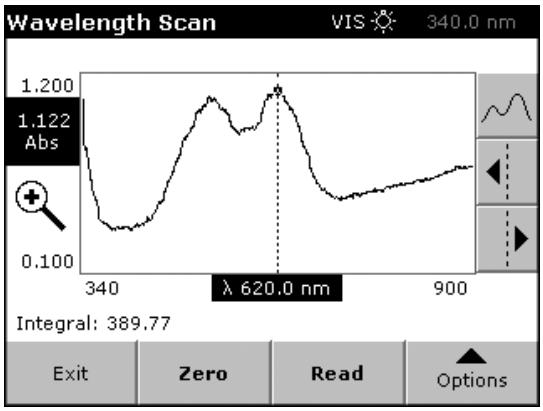


Table 13 Navigating the Wavelength Scan Graph

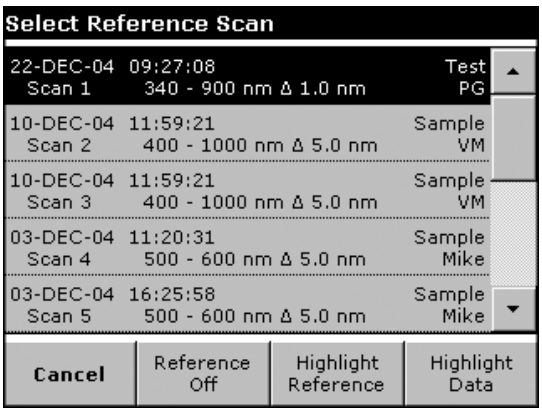
Cursor/Zoom Function	Description
Curve Icon	In Peak/Valley mode the cursor moves between minimum/maximum absorbance values. In Tracking mode the cursor moves over each data point of the scan.
Arrow Keys	The right and left arrow keys move the cursor (depending on the selected mode) to the next data point. The data of the data point (wavelength/absorbance or % transmittance value) are highlighted on the x and y axes. Select any point on the curve to display the associated data.
Zoom Icon	Magnifies a section of the curve. The original curve size can be restored by pressing the **ZOOM** icon again.

6.6.3 Working with Reference Scans

There are two options when using the Reference Scan:

Option 1

1. Press **REFERENCE: OFF** in the Option menu to select another scan to display on the same screen as the current scan. Activate the required scan number and press **HIGHLIGHT REFERENCE**.

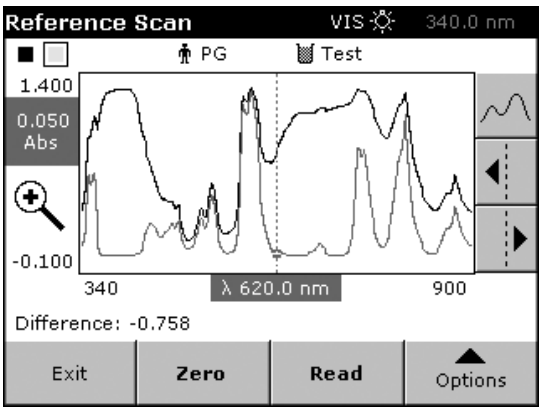


Note: *After selecting a reference scan the* ***REFERENCE: OFF*** *key in the Options menu turns into* ***REFERENCE: ON****.*

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 gray. The absorbance or % transmittance value and the associated wavelength are highlighted in gray. A black and a gray box are shown in the left corner of the display. The gray box relates to the reference scan and the black one relates to the current wavelength scan.

3. Carry out the wavelength scan reading, refer to section 6.6.2 on page 82.



- The newly plotted wavelength scan curves are shown in black.
- The absorbance or % transmittance value and the associated wavelength are highlighted in black.
- In addition, the difference between the wavelength scan curve and the reference curve is displayed against the wavelength.

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

Option 2

1. Insert the blank vial into the cell holder and close the cell compartment. Press **ZERO**.

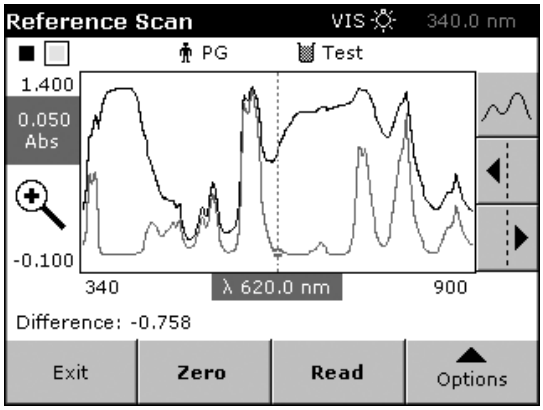
Note: *The UV lamp is not switched on until a wavelength in the UV spectrum has been entered and the blank reading has been started. During the warm-up phase of the UV lamp, the message "Warming up..." is displayed and the UV lamp symbol flashes. As soon as the UV lamp is ready, the blank reading is performed.*

Note: ***ZERO*** *and* ***READ*** *are disabled until the cell compartment is closed.*

2. Insert the sample vial into the cell holder and close the cell compartment. 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.
   - In addition, the difference between the wavelength scan curve and the reference curve is displayed against the wavelength.

3. Press **OPTIONS** and then **REFERENCE: OFF** in the Option menu to select another scan to display on the same screen with the current scan. Activate 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 gray. The absorbance or % transmittance value and the associated wavelength are highlighted in gray.

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

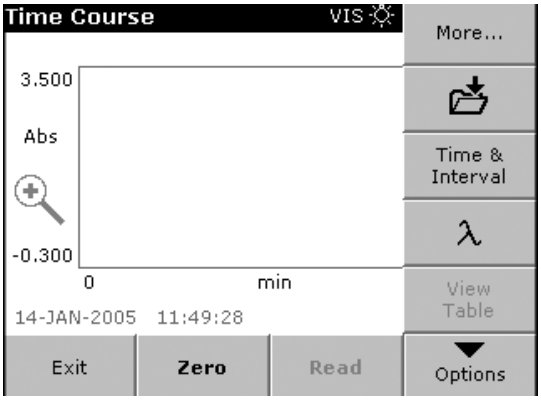
5. Press the black or gray small box in the upper-left corner on the screen to toggle between the actual wavelength scan and reference scan.

6.7 Time Course Measurements

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

6.7.1 Time Course Setup Parameters

1. From the Main Menu, press **TIME COURSE MODE**.
2. Press **OPTIONS** to access data storage, readings, concentration, or wavelength setup options. Press **MORE** to view additional setup options. Refer to Table 14 for descriptions.



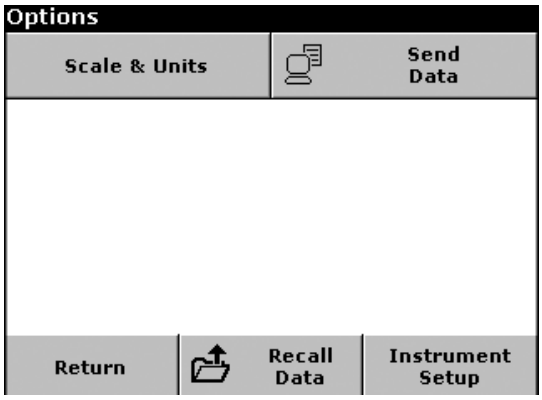
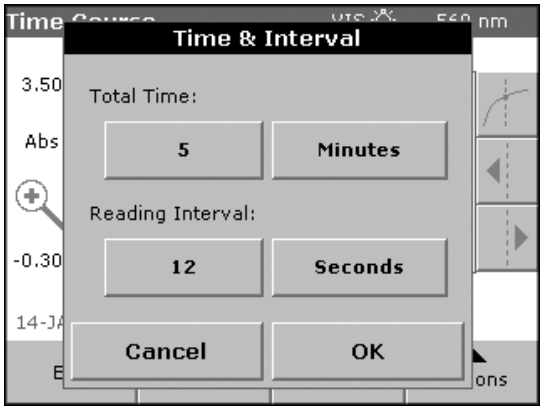


Table 14 Time Course Setup Options

Option	Description
Store (folder) icon	Stores the scanned data.
Time & Interval	Enters the total time for data collection and the time interval between the collection of data points.
λ	Enters the wavelength setting.
View Table	Displays 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	Sends data to a printer, computer, or USB memory stick.
Recall Data	Recalls saved measurement data, wavelength scans ,or time courses (section 5.3.1.2 on page 29).
Instrument Setup	Basic operational settings of the instrument (section 5.2 on page 19).

6.7.1.1 Setting the Time Interval

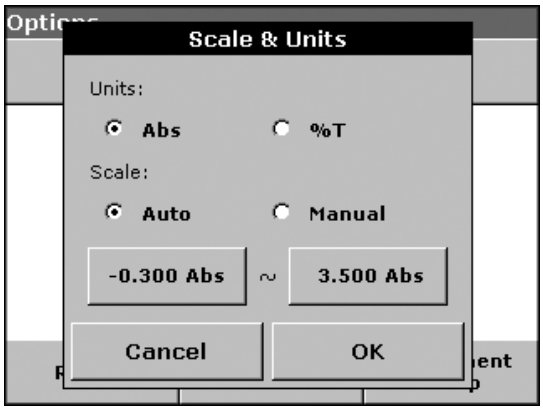
1. Press **TIME & INTERVAL** in the **OPTIONS>MORE** menu.
2. Input the total time and the reading time and press **OK** to confirm.



Note: *In total, 500 measuring steps are possible. If a total time and reading interval are selected that would cause this number of measurements to be exceeded, the time interval is defined automatically.*

6.7.1.2 Setting the Scale and Units

1. Press **SCALE & UNITS** in the Option menu.



2. Select Abs or %T as the required units.
3. Select Auto or Manual scaling on the graph 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.

6.7.2 Time Course Scan Reading

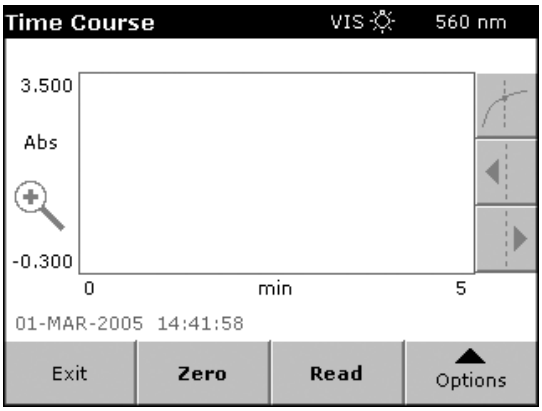
After the parameters have been selected, the instrument must be blanked, so that the sample can be analyzed.

1. From the Main Menu, press **TIME COURSE**.

2. Insert the blank vial into the cell holder and close the cell compartment.

Note: *The **ZERO/READ** function is inactive as long as the vial compartment is open.*

3. Press **ZERO**. The blank reading is shown on the display.

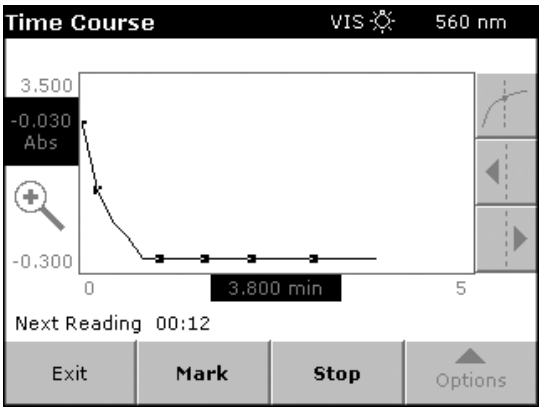


Note: *The UV lamp is not switched on until a wavelength in the UV spectrum has been entered and the blank reading has been started. In the warm-up phase of the UV lamp, the message "Warming up..." is displayed and the icon UV lamp flashes. As soon as the UV lamp is ready, the blank reading is performed.*

4. Insert the sample vial into the cell holder and close the cell compartment. Press **READ**. Start collecting time course (kinetic) data.

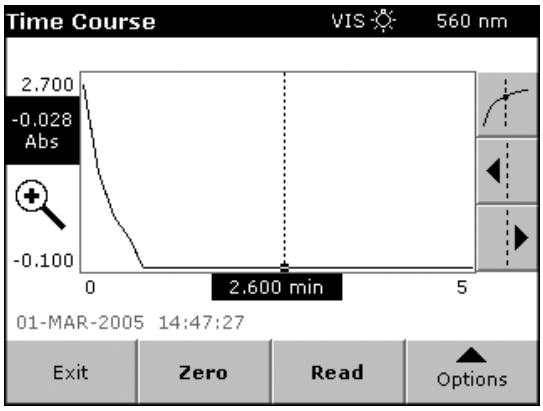
Note: *During the measurement the **ZERO** and **READ** keys change to **MARK** and **STOP**.*

5. Select **MARK** or **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 stop taking the sample readings.



6. For data storage, see section 5.3.4.1 on page 32.

6.7.3 Analysis of Time Course Data



The Time Course Program is complete if:

- the sound is activated and the instrument beeps when the readings are done,
- the graph is shown in full size,
- the scaling of the x-axis occurs automatically, and
- the cursor functions in the vertical navigation bar are activated.

After the data are collected, the graph data can be changed.

Navigating in the graph 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. Table 15 provides more navigation information.

Table 15 Navigating the Wavelength Scan Graph

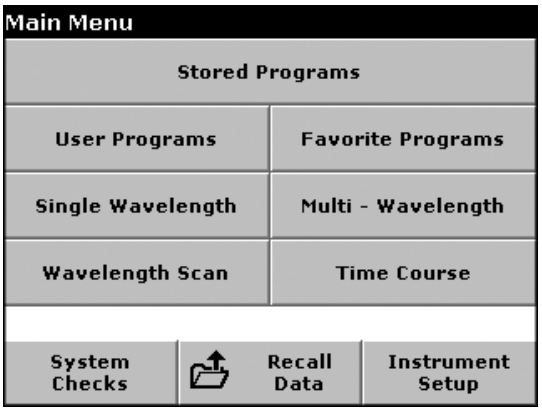
Cursor/Zoom Function	Description
Curve Icon	Choice of Cursor Mode.
	Cursor Mode Single: The cursor moves to each selected measurement point of the scan.
	Delta mode: A second cursor is activated. The position of the fixed cursor was previously defined in Cursor Mode Single. You can use the active cursor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

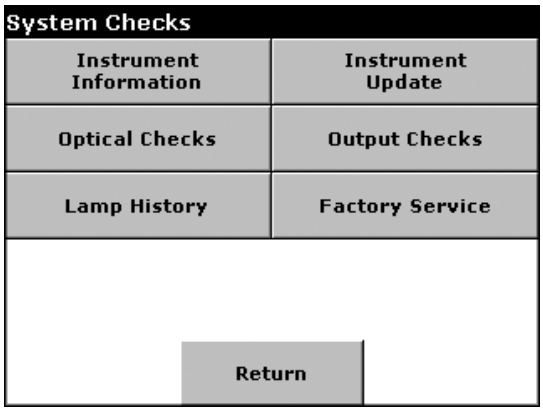
6.8 System Checks

The DR 5000 Spectrophotometer lets the user verify the performance of the instrument. The instrument contains the programs for checking wavelength accuracy, bandwidth, photometric noise, stray light, photometric accuracy, photometric repeatability, and photometric stability.

The user must provide the samples necessary to perform the stray light, photometric accuracy, and photometric repeatability tests.

1. From the Main Menu, press **SYSTEM CHECKS**. The System Check menu contains the instrument information and various performance tests.





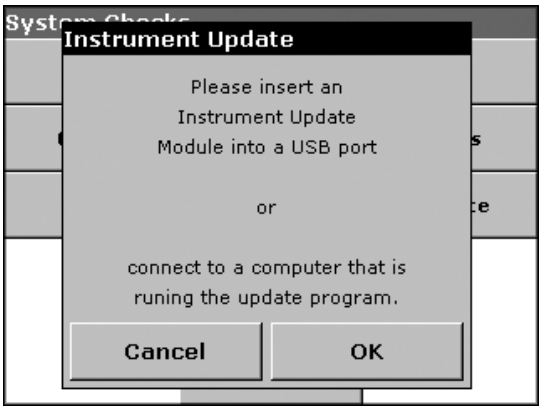
6.8.1 Instrument Information

Press **INSTRUMENT INFORMATION** to display the model, serial number, and software version.

6.8.2 Upgrading the Instrument Software

Software updates can be downloaded from www.hach.com. Contact Technical Support for more information on downloading software updates, or go to www.hach.com.

1. Save the update to a USB memory stick.
2. Press **INSTRUMENT UPDATE** from the System Checks menu.

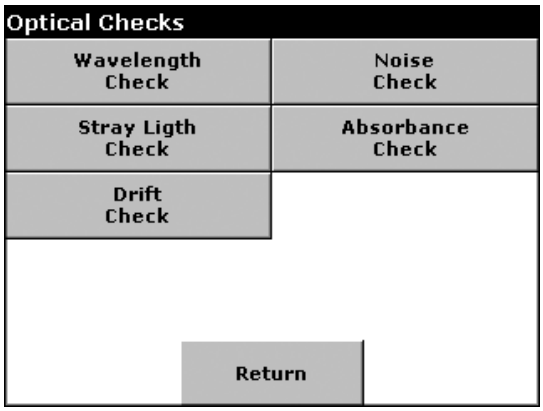


3. Connect the USB memory stick to the USB interface of the DR 5000 (Figure 1 on page 13).

4. Press **OK**.
5. The link is established automatically and the software is updated.
6. Press **OK** to return to the System Checks menu.

6.8.3 Optical Checks

1. Press **OPTICAL CHECKS** from the System Checks menu.

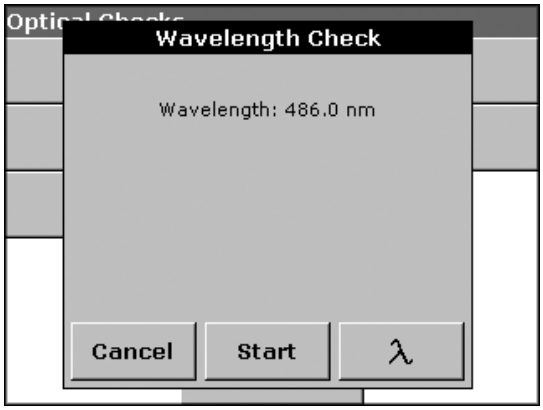


2. Select the type of optical check to perform (wavelength, noise, stray light, absorbance, or drift).

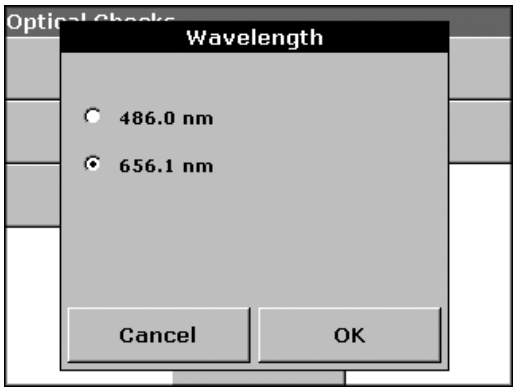
6.8.4 Wavelength Check

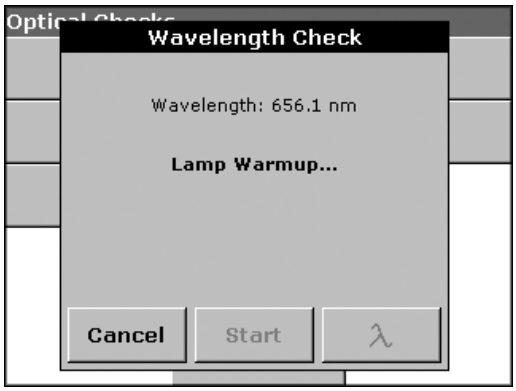
The Wavelength Check test is used to check wavelength accuracy at 656.1 and 486.0 nm and to check bandpass at 656.1 nm, only.

1. Press **WAVELENGTH CHECK** in the Optical Checks menu.
2. Press λ to select the wavelength.

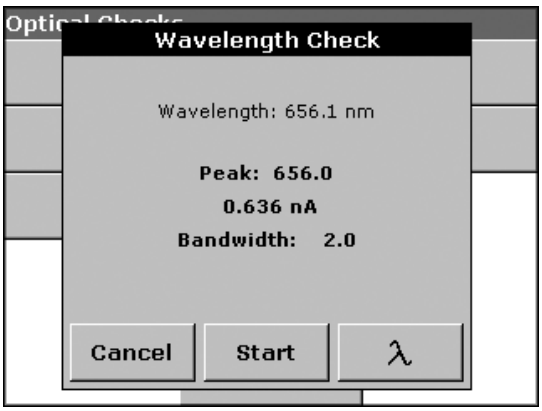


3. Select the wavelength and press **OK** to confirm. During the warm-up phase of the **UV lamp**, the message "Lamp Warmup..." is displayed.





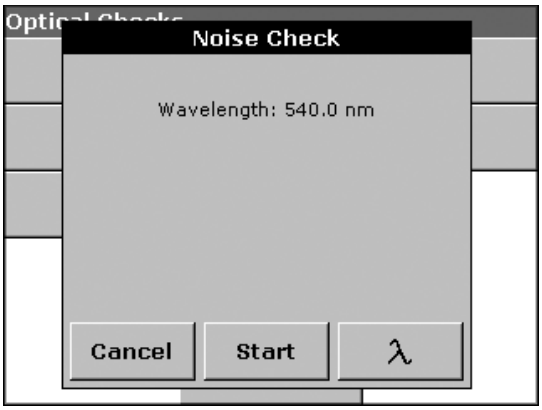
4. The result will be displayed. Press **START** or **CANCEL** to return to the Optical Checks menu.



6.8.4.1 Noise Check

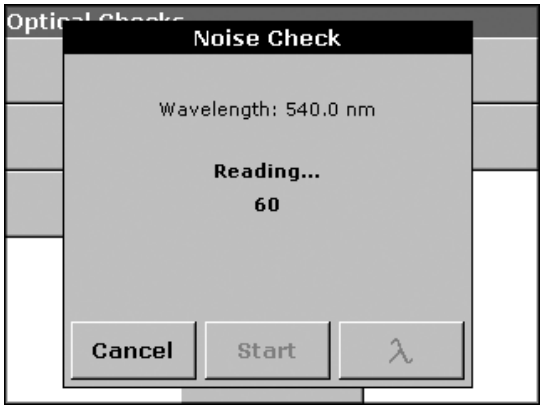
The Noise Check test is used to test the photometric noise in the instrument. This test can be used to test noise at any wavelength and at an absorbance level determined by using a sample.

1. Press **NOISE CHECK** from the Optical Checks menu.

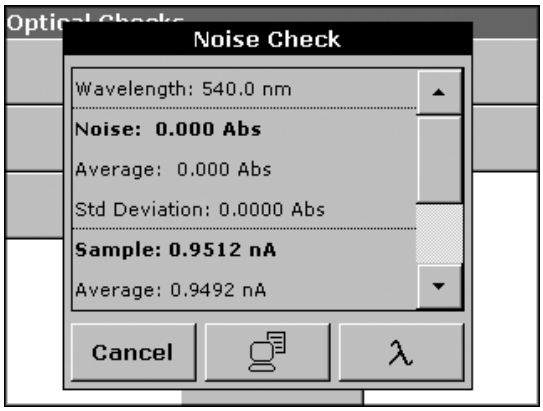


2. Press λ to input the wavelength. Input the wavelength and confirm with **OK**.
3. Press **ZERO**.

4. Press **START**.



5. The result will be displayed. Thirty readings are averaged for the blank. The Average and Std Deviation are calculated from 100 consecutive absorbance readings (Noise**,** Sample, Reference).



6. Press the **PC & PRINTER** icon to send data to a PC or Printer.

7. Press **CANCEL** to return to Optical Checks menu.

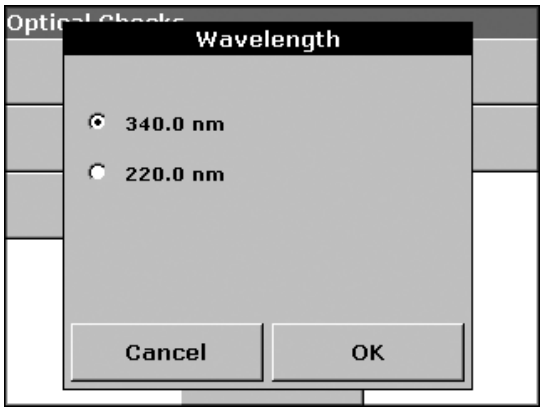
6.8.4.2 Stray Light Check

The Stray Light test is used to measure the stray light in the instrument at 220.0 nm and 340.0 nm.

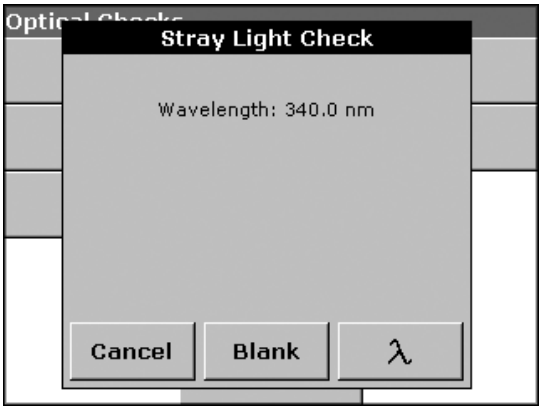
1. Press **STRAY LIGHT CHECK** in the Optical Checks menu.

2. Press λ to select the wavelength.

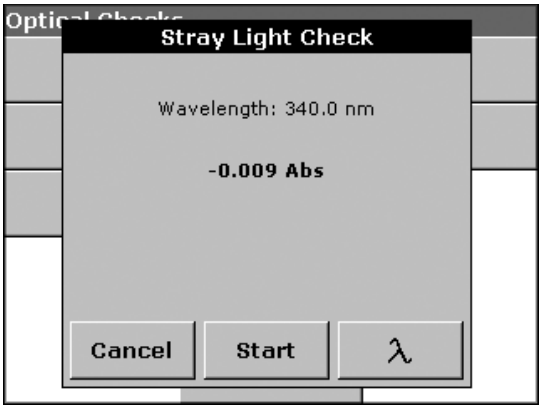
3. Select the wavelength and press **OK** to confirm.



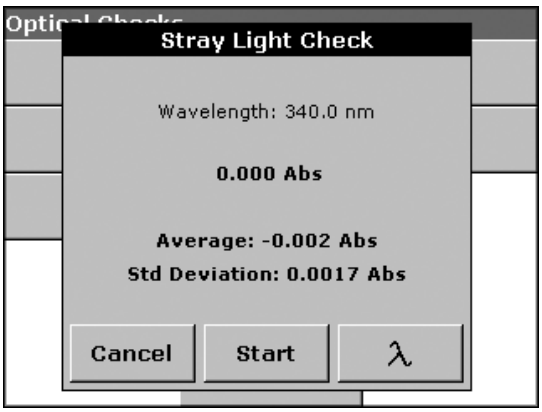
4. Press **ZERO**.



5. Insert the sample vial into the cell holder and close the cell compartment. Press **START**.



6. The result will be displayed. Thirty readings are averaged for the blank. The Average and Standard Deviation are calculated from 100 consecutive absorbance readings. The Average of the readings is the stray light value in absorbance.



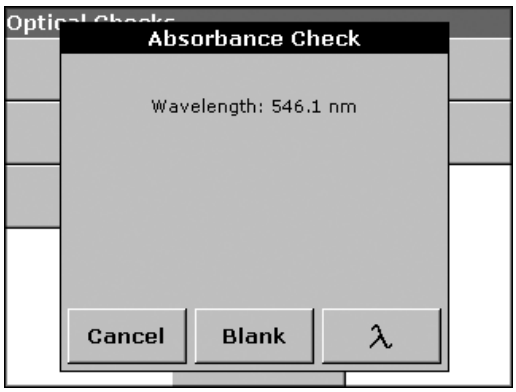
7. Press **CANCEL** to return to the Optical Checks menu.

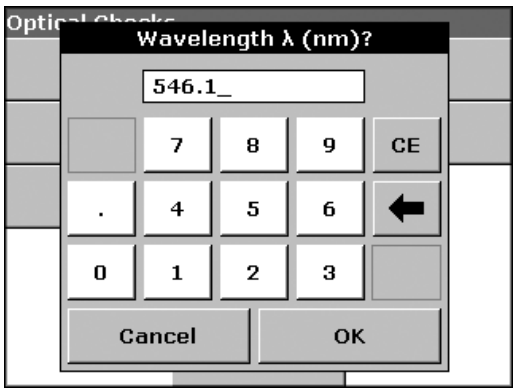
6.8.4.3 Absorbance Check

The Absorbance Check test is used to test the photometric accuracy and repeatability of the instrument.

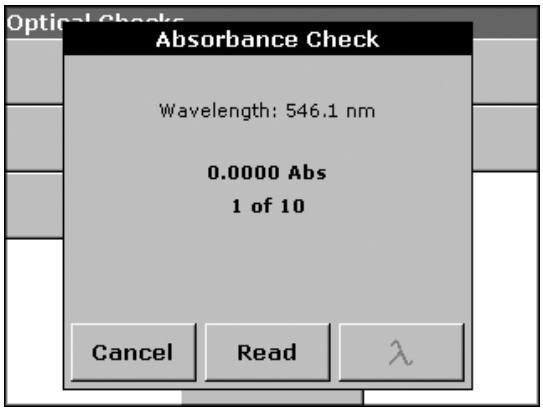
1. Press **ABSORBANCE CHECK** in the Optical Checks menu.

2. Press λ to input the wavelength. Input the wavelength and press **OK** to confirm.

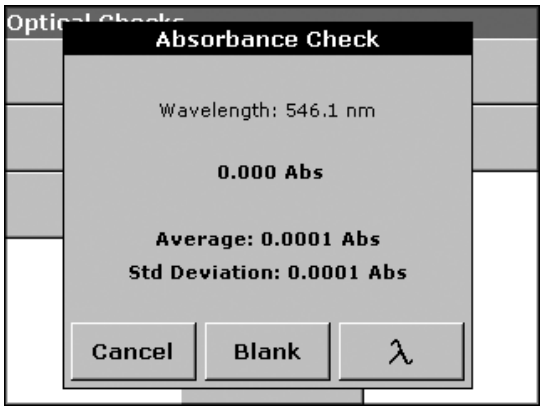




3. Ten replicates of blanking and reading are performed.



4. The results are displayed. Press **CANCEL** to return to Optical Checks menu.

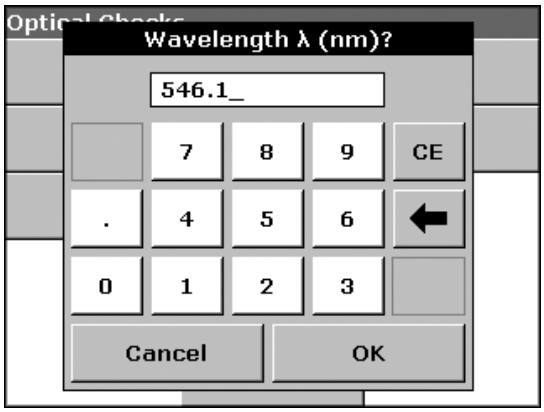


6.8.4.4 Drift Check

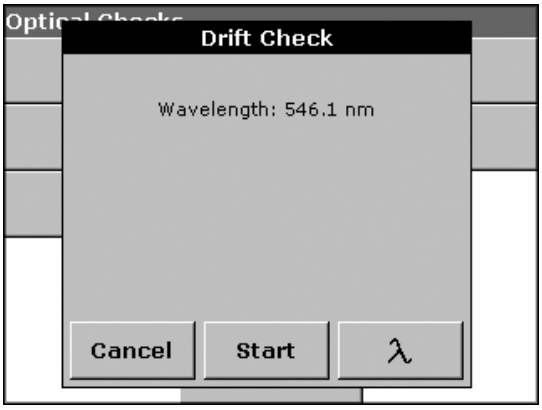
The Drift Check test is used to test the stability of the instrument. The Drift Check runs for an hour.

1. Press **DRIFT CHECK** in the Optical Checks menu.

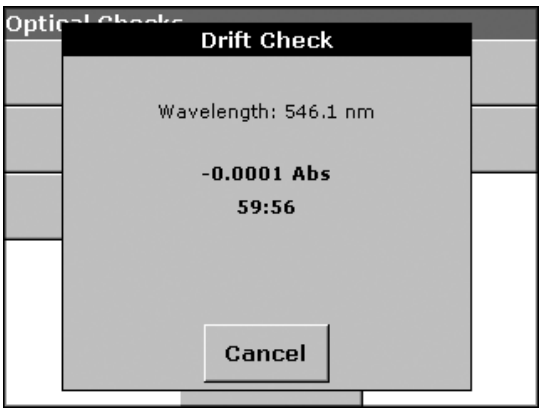
2. Press λ to input the wavelength. Input the wavelength and press **OK** to confirm.



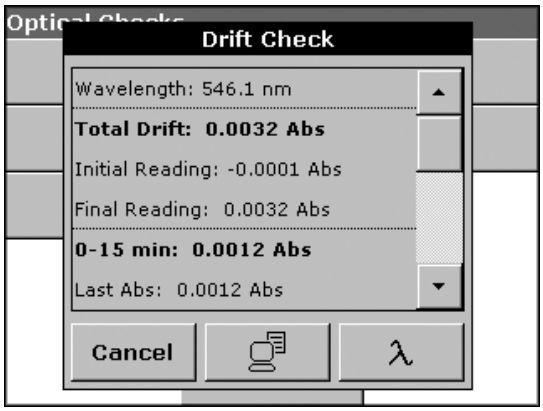
3. Press **START**.



4. The Drift Check runs for one hour, taking a reading every minute. Every fifteen minutes, linear regression is used to calculate the slope (rate of change) for the previous fifteen minute interval.



5. The last reading and slope for each 15-minute interval are displayed. At the end of the hour, the overall values are calculated and displayed.



6. Press **CANCEL** to return to Optical Checks menu.

6.8.5 Output Checks

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

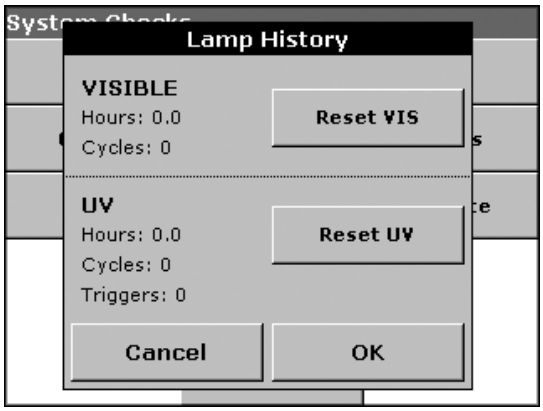
6.8.6 Lamp History

The menu Lamp History provides the following information:

- The amount of time that the lamp has been on (Hours).
- The number of times that the lamp has been turned on (Cycles).
- The number of times that the instrument tried to turn the UV lamp on (triggers).

After a lamp change, the display of the total operating time is reset to zero.

1. Press **LAMP HISTORY** from the System Checks menu.
2. Press **RESET VIS** to reset the Visible Lamp. Press **RESET UV** to reset the UV Lamp.



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

6.8.7 Factory Service

The Factory Service requires a service code. This menu is not intended for customer use.

6.9 Favorite Programs

Frequently used tests/methods in the Stored Programs and User Programs menu can also be added to the list of favorites to simplify selection. To add stored programs and/or user programs to the favorite programs, see section 5.4.9 on page 42 or section 6.1.6 on page 59.

6.9.1 Recalling a Favorite Program

1. From the Main Menu, select **FAVORITE PROGRAMS**.
2. Select the program. Use the scroll bar to scroll through the list quickly. If the analysis program number is already known, press **SELECT BY NUMBER.** Use the alphanumeric keypad to enter the test number (program number), and press **OK** to confirm.
3. Press **START**.

6.9.2 Deleting a Favorite Program

1. Press **Favorite Programs** in the Main Menu. The Favorite Programs list will appear.
2. Select the program. Use the scroll bar to scroll through the list quickly. If the analysis program number is already known, press **SELECT BY NUMBER.** Use the alphanumeric keypad to enter the test number (program number), and press **OK** to confirm.
3. Press **REMOVE PROGRAM** and press **OK** to confirm.

Note: *When removing a Favorite Program, it will not be deleted in the User Programs or Stored Programs. When deleting the stored program in User Programs**,** it will also be deleted in Favorite Programs.*

DANGER
Only qualified personnel should conduct the tasks described in this section of the manual.

7.1 Cleaning Requirements

DANGER
Always disconnect the power from the DR 5000 before attempting any cleaning operations.

7.1.1 Spectrophotometer

- Do not expose the instrument to temperature extremes (heating, direct sunlight, etc.).
- Keep all obstructions away from the instrument to ensure proper ventilation.
- 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.
- Clean the enclosure, the cell compartment, and all accessories with a soft damp cloth. A mild soap solution can also be used.
- Dry the cleaned parts carefully with a soft cotton cloth.

7.1.2 Display

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

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

7.1.3 Cells

CAUTION
Use proper laboratory practices whenever there is a risk of chemical exposure.

CAUTION
Avoid scratching the cells with brushes or other cleaning devices.

7.1.3.1 Glass Cells

Important Note: *Glass 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 cells are dried.*

- Clean glass cells with cleaning agents and water.
- Afterwards, rinse the cells several times with tap water and then thoroughly with deionized water.

7.1.3.2 Polystyrene Cells

Important Note: *Never use organic solvents to clean polystyrene cells.*

- Clean disposable polystyrene cells with cleaning agents and water.
- Afterwards, rinse the cells several times with deionized water.

7.2  Lamp Replacement

CAUTION
The UV lamp generates UV light. Do not look directly at an operating lamp without wearing UV protective eye glasses.

The Lamp compartment is on the left side behind the display and is provided with ventilation on the back side. The tungsten and deuterium (UV) lamp are installed in the lamp compartment. On the back side a fan is installed for cooling of electric components. The ventilation system operates automatically.

Refer to section 7.2.2 on page 101, section 7.2.3 on page 102 and Figure 5 on page 101 for instructions on replacing the tungsten lamp and deuterium lamp (UV).

7.2.1  Electrostatic Discharge (ESD) Considerations

Important Note: *To minimize hazards and ESD risks, maintenance procedures not requiring power to the analyzer should be performed with power removed.*

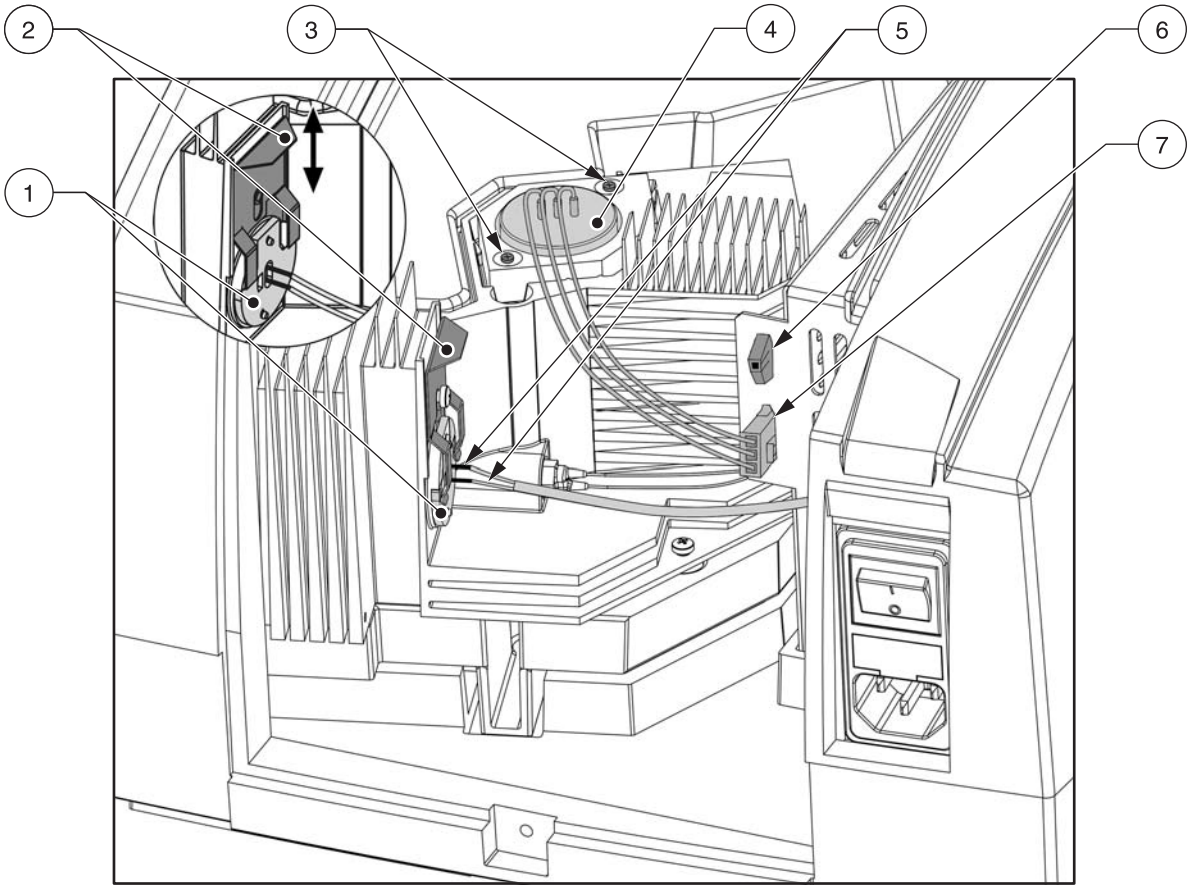
Delicate internal electronic components can be damaged by static electricity, resulting in degraded instrument performance or eventual failure.

The manufacturer recommends taking the following steps to prevent ESD damage to the instrument:

- Before touching any instrument electronic components (such as printed circuit cards and the components on them) discharge static electricity from your body. This can be accomplished by touching an earth-grounded metal surface such as the chassis of an instrument, or a metal conduit or pipe.
- To reduce static build-up, avoid excessive movement. Transport static-sensitive components in anti-static containers or packaging.
- To discharge static electricity from your body and keep it discharged, wear a wrist strap connected by a wire to earth ground.

Handle all static-sensitive components in a static-safe area. If possible, use anti-static floor pads and work bench pads.

Figure 5 Lamp Compartment



1.	Tungsten Lamp	**5.**	Contacts of Tungsten Lamp with Cable
2.	Spring	**6.**	Plug Contacts for Fan
3.	Screws	**7.**	Plug Contact for Deuterium Lamp
4.	Deuterium Lamp (lamp socket)		

7.2.2 Changing the Tungsten Lamp

DANGER
Remove power from the instrument prior to changing the lamp. Wait until the lamp has cooled prior to replacement.

1. Switch the instrument off.
2. Unplug the power cord.
3. Use a screwdriver to remove the cover from the back of the instrument (the screws may be slotted or cross-headed).
4. Place the cover and the attached fan carefully beside the instrument (take special care with the fan cable).
5. Push the spring (item 2, Figure 5) up and remove the tungsten lamp (item 1, Figure 5) (Cat. No. A23778) from the lamp compartment.
6. Unplug both plug contacts (item 6, Figure 5) from the Tungsten lamp.

Note: *The lamp should only be held by the lamp socket. Avoid touching the glass.*

7. Push the plug contacts firmly onto the new Tungsten lamp.
8. Insert the tungsten lamp into the lamp compartment. Push the spring down.
9. Check that the spring and the lamp socket are positioned correctly.
10. Use a screwdriver to reinstall the back cover.
11. Plug in the power supply. The instrument is now ready for use.
12. Switch the instrument on.
13. Reset the Lamp History, refer to section 6.8.6 on page 97.

7.2.3  Changing the Deuterium Lamp (UV)

DANGER
Remove power from the instrument prior to changing the lamp. Wait until the lamp has cooled prior to replacement.

Important Note: *Do not touch the glass envelope on the new lamp. If it is touched, clean with alcohol.*

1. Switch the instrument off. Unplug the power cord.
2. Use a screwdriver to remove the cover from the back of the instrument (the screws may be slotted or cross-headed).
3. Place the cover and the attached fan carefully beside the instrument (take special care with the fan cable).
4. Unplug the deuterium lamp (item 7, Figure 5) (Cat. No. A23792) from the socket by pushing down on the safety contact.
5. Use a screwdriver to unscrew the two fastening screws (item 3, Figure 5) (the screws may be slotted or cross-headed) out of the socket.
6. Holding the lamp socket, lift the deuterium lamp up and out of the lamp compartment (remove the complete unit, including the cable).
7. Carefully insert the new deuterium lamp into the lamp compartment.
8. Screw in both fastening screws until they are finger-tight.
9. Insert the deuterium lamp cable connector in the socket so that the safety contact clicks into place.
10. Use a screwdriver to reinstall the back cover.
11. Plug in the power supply. The instrument is now ready for use.
12. Switch the instrument on.
13. Reset the Lamp History, see section 6.8.6 on page 97.

7.3 Fuse Replacement

DANGER
Certain electrical circuits within this equipment are protected by fuses against over-current conditions. For continued protection against a risk of fire, replace fuses only with the same type and rating specified.

DANGER
Failed fuses are generally an indication of a problem with the equipment. If fuse failure continues, contact a service representative for instructions on how to return the equipment for repair. Do not attempt to repair the equipment yourself.

1. Switch the instrument off.
2. Unplug the power cord to remove all power from the instrument.
3. Pull out the plastic base over the power cable socket.
4. Remove the defective fuses.
5. Insert a new fuse (T 2 A H; 250 V).
6. Replace the plastic base.
7. Plug in the power cord. Switch the instrument on.

7.4  Air Filter Pad Replacement

7.4.1 Visual Check

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

Lift the instrument carefully and check the color of the air filter pad. If the filter is dark-gray or black, replace the air filter. If the filter is white or gray, air filter replacement is not necessary.

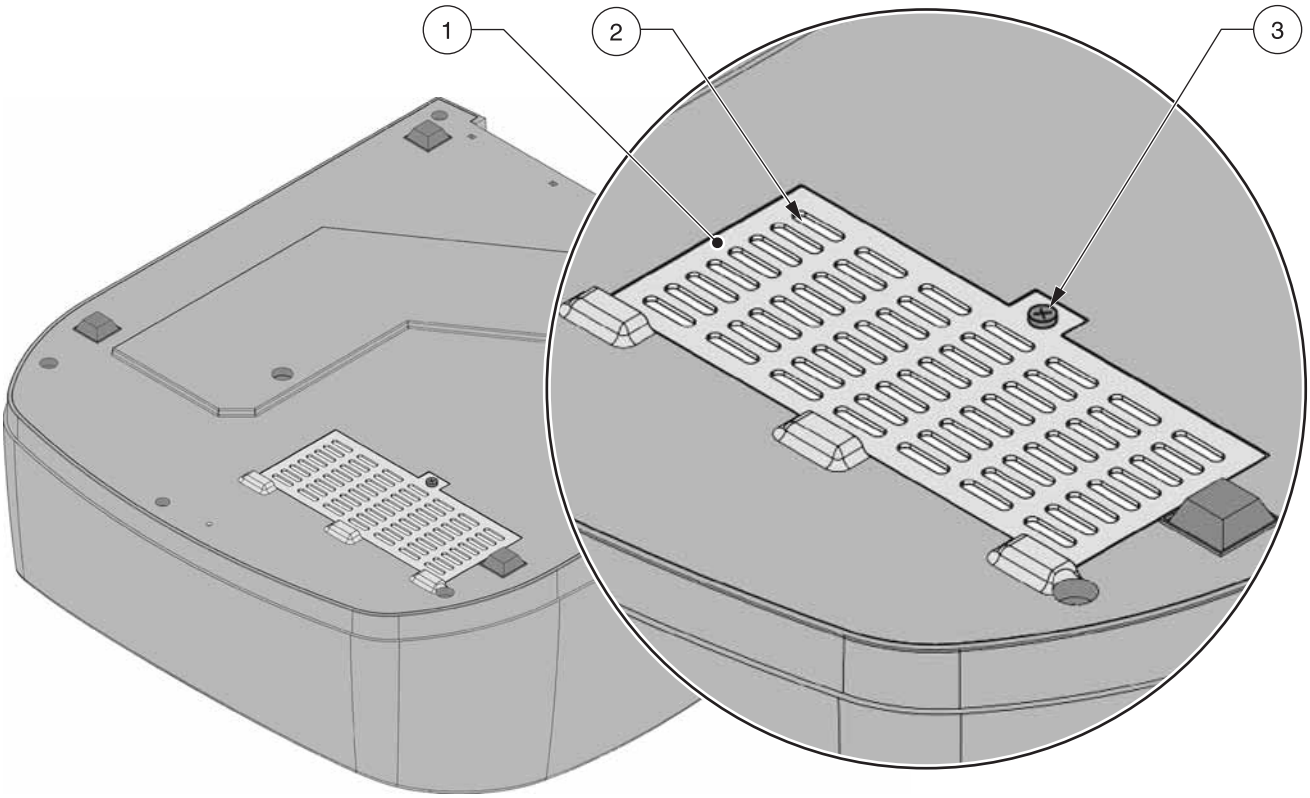
7.4.2 Changing the Filter Pad

DANGER
Remove power from the instrument prior to replacing the air filter pad.

Important Note: *Empty the cell compartment prior to air filter pad replacement.*

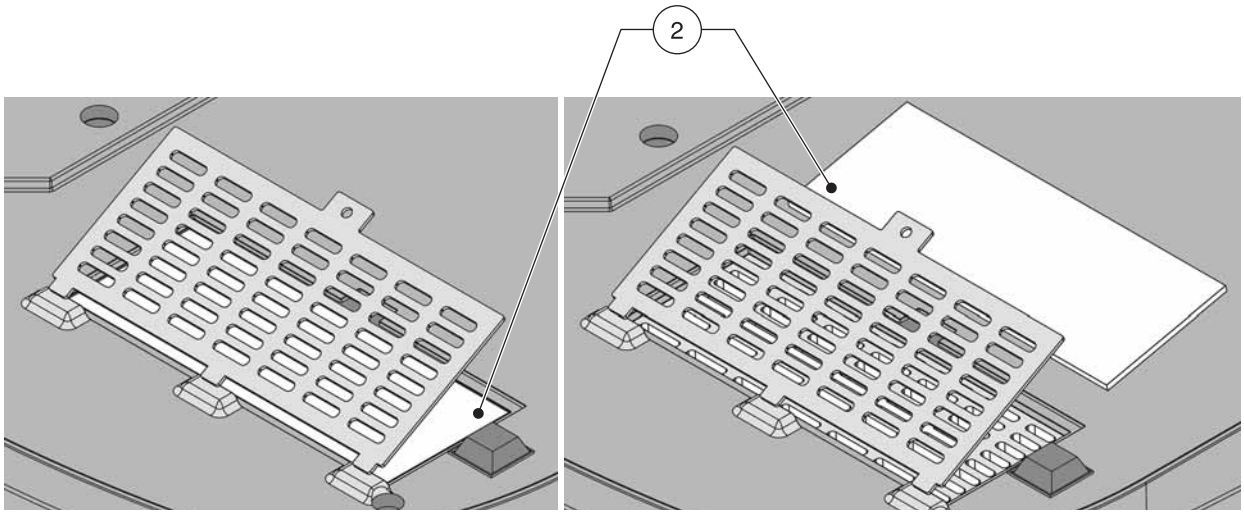
1. Carefully turn the instrument over and place it on a soft surface.
2. Use a screwdriver (standard or Phillips to open the air filter grid (item 3, Figure 6 on page 104).
3. Lift the air filter grid (item 1, Figure 6 on page 104).
4. Remove the old air filter pad and replace it with a new air filter pad (Cat. No. A23766) (Figure 7 on page 104).
5. Screw the grid back in place.
6. Carefully place the instrument upright.
7. Plug in the power supply. The instrument is now ready for use.

Figure 6 Base of DR 5000 with Filter Grid



1. Filter Grid	**2.** Filter Pad	**3.** Phillips Screw

Figure 7 Replacing the Filter Pad



Section 8 Troubleshooting

Problem	Likely Cause	Solution
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 **Clean Cuvette**	The cuvette is soiled or there are undissolved particles in the cuvette.	Clean the cuvette; allow the particles to settle.
Error **Please check the UV Lamp**	The lamp output is too low.	Check the lamp and replace it if necessary.
Error **Selfcheck stopped.** **Please remove the cuvette**	Self Check Test stops while starting the instrument.	Remove the vial. Press **OK**.
Hardware error	Electronic defect	Contact Technical Support.
Negative result!	The calculated result is negative.	Check the concentration of the sample.
No evaluation!	Error in the Test database.	Contact Technical Support.
Over calibration range	During a polygonal interpolation, the measured absorbance exceeds the calibration range of the test.	Dilute the sample and repeat the measurement.
Over measuring range	The measured absorbance is above the calibration range of the test.	Dilute the sample and repeat the measurement.
Please check the lamp	The lamp output is too low.	Check the lamp and replace it if necessary.
Please close the lid	Self Check Test stops while starting the instrument.	Close the lid. Press **START AGAIN**.
Temperature too high! **Lamps are off!**	The measured temperature is above the maximum limit.	Turn the instrument off **immediately** to cool down. Change the filter pad.
Under calibration range	During a polygonal interpolation, the measured absorbance is below the calibration range of the test.	Change the calibration range.
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 vial with a longer path length.

Section 9 Replacement Parts and Accessories

Description	Catalog Number
Filter Pad	A23766
Flow-Through Cell 80 µl OS/10 mm/8.5 mm	LZP334
Flow-Through Cell 80 µl QS/10 mm/8.5 mm	LZP168
Flow-Through Cell 370 µl OS/50 mm/8.5 mm	LZP335
Flow-Through Cell 370 µl QS/50 mm/8.5 mm	LZP336
Fuse	A23772
Lamp, Deuterium	A23792
Lamp, Tungsten	A23778
Macro Cell OG / 20 mm	LZP331
Multi-Cell Holder DR 5000	A23618
Plastic cell, 1" square, 12/pkg	2410200
Pour-Thru , 1" square (1" path length)	5913700
Pour Thru Cell, 1x1 cm (QS/160 µl/ZH10 mm)	LZV509
Pour Thru Cell, 1x1 cm (QS/450 µl/ZH10 mm)	LZV510
Pour Thru Cell, 5x1 cm (QS/2250 µl/ZH10 mm)	LZV511
Pour-Thru Module DR 5000	LZV479
Pour Thru Tube Kit	LZV569
Sample Cell, 1 cm, matched pair	2095100
Sample Cell, 10 mm, quartz	2624410
Sample Cell, 50 mm, optical glass	2629250
Sample Cell, 50 mm, quartz	2624450
Sample Cell, 1" round, 60 high (10 mL)	2427606
Sample Cell, 1" round, 95 high (10-20-25 mL)	2401906
Sample Cell, 1" square, 10-mL	2495402
Sample Cell with cap, 1 cm/10 mL 2/pkg	4864302
Sample Changer	A23620
Semi-Micro Cell OS/50 mm	LZP269
Sipper Module DR 5000	LZV485
Test Filter Set	LZV537
Tubing Inlet Sipper DR 5000 (Silicone)	A23800
USB-Barcode Scanner	LZV566
USB-Interface Cable	LZV567
USB-Keyboard	LZV582

Section 10 How to Order

U.S.A. Customers

By Telephone:
6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH (800-227-4224)

By Fax:
(970) 669-2932

By Mail:
Hach Company
P.O. Box 389
Loveland, Colorado 80539-0389 U.S.A.
Ordering information by e-mail: orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send an e-mail to: intl@hach.com or contact:

Hach Company World Headquarters: Loveland, Colorado, U.S.A.
Telephone: (970) 669-3050; Fax: (970) 669-2932

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you.

Call 1-800-227-4224 or e-mail techhelp@hach.com

Section 11 Repair Service

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the Hach Service Center serving your location.

In the United States:
Hach Company
Ames Service
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
FAX: (515) 232-3835

In Canada:
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

**In Latin America, the Caribbean, the Far East,
Indian Subcontinent, Africa, Europe, or the Middle East:**
Hach Company World Headquarters,
P.O. Box 389
Loveland, Colorado, 80539-0389 U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932
E-mail: intl@hach.com

Section 12 Limited Warranty

Hach Company warrants its products to the original purchaser against any defects that are due to faulty material or workmanship for a period of one year from date of shipment unless otherwise noted in the product manual.

In the event that a defect is discovered during the warranty period, Hach Company agrees that, at its option, it will repair or replace the defective product or refund the purchase price excluding original shipping and handling charges. Any product repaired or replaced under this warranty will be warranted only for the remainder of the original product warranty period.

This warranty does not apply to consumable products such as chemical reagents; or consumable components of a product, such as, but not limited to, lamps and tubing.

Contact Hach Company or your distributor to initiate warranty support. Products may not be returned without authorization from Hach Company.

Limitations

This warranty does not cover:

- Damage caused by acts of God, natural disaster, labor unrest, acts of war (declared or undeclared), terrorism, civil strife or acts of any governmental jurisdiction
- Damage caused by misuse, neglect, accident or improper application or installation
- Damage caused by any repair or attempted repair not authorized by Hach Company
- Any product not used in accordance with the instructions furnished by Hach Company
- Freight charges to return merchandise to Hach Company
- Freight charges on expedited or express shipment of warranted parts or product
- Travel fees associated with on-site warranty repair

This warranty contains the sole express warranty made by Hach Company in connection with its products. All implied warranties, including without limitation, the warranties of merchantability and fitness for a particular purpose, are expressly disclaimed.

Some states within the United States do not allow the disclaimer of implied warranties and if this is true in your state the above limitation may not apply to you. This warranty gives you specific rights, and you may also have other rights that vary from state to state.

This warranty constitutes the final, complete, and exclusive statement of warranty terms and no person is authorized to make any other warranties or representations on behalf of Hach Company.

Limitation of Remedies

The remedies of repair, replacement or refund of purchase price as stated above are the exclusive remedies for the breach of this warranty. On the basis of strict liability or under any other legal theory, in no event shall Hach Company be liable for any incidental or consequential damages of any kind for breach of warranty or negligence.

Section 13 Compliance Information

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory. The DR 5000 has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

Standards include:

Listed by TUV Rheinland of North America to UL61010-1 (Certification #CU 72050790 01)
Certified by TUV Rheinland of North America to CSA C22.2 No. 61010-1 (Certification # CU 72050790 01)
Certified by TUV Rheinland Product Safety GmbH to EN 61010-1 (Certification # S1 60010986) per 73/23/EEC and 93/68/EEC

EMC Immunity

EN 61326:1997 / A1:1998 (Electrical Equipment for measurement, control and laboratory use- EMC requirements) per 89/336/EEC, 92/31/EEC and 93/68/EEC. Supporting test records by Test laboratory Reichl (test report # 040097), certified compliance by Hach Company.

Standards include:

IEC 1000-4-2:2001 (EN 61000-4-2:2001) Electrostatic Discharge Immunity (Criteria B)
IEC 1000-4-3:2001 (EN 61000-4-3:2001) Radiated RF Electromagnetic Field Immunity (Criteria A)
IEC 1000-4-4:2001 (EN 61000-4-4:2001) Electrical Fast Transients/Burst (Criteria B)
IEC 1000-4-5:2001 (EN 61000-4-5:2001) Surge (Criteria B)
IEC 1000-4-6:2001 (EN 61000-4-6:2001) Conducted Disturbances Induced by RF Fields (Criteria A)
IEC 1000-4-11:2001 (EN 61000-4-11:2001) Voltage Dip/Short Interruptions (Criteria B/C)

EMC Emissions

EMC: EN 61326:1997 / A1:1998 (Electrical Equipment for measurement, control and laboratory use-EMC requirements) per 89/336/EEC, 92/31/EEC and 93/68/EEC. Supporting test records by Test laboratory Reichl (test report # 040097), certified compliance by Hach Company.

Standards include:

EN 61000-3-2 Harmonic Disturbances Caused by Electrical Equipment (Class A)
EN 61000-3-3 Voltage Fluctuation (Flicker) Disturbances Caused by Electrical Equipment

Canadian Interference-causing Equipment Regulation, IECS-003, Class A

Based on test records by Test laboratory Reichl (test report # 040097), certified compliance by Hach Company.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.
Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

FCC PART 15, Class "A" Limits: Based on test records by Test laboratory Reichl (test report # 040097), certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. The following techniques of reducing the interference problems are applied easily.

1. Disconnect the DR 5000 from it's power source to verify that it is or is not the source of the interference.

2. If the DR 5000 is connected into the same outlet as the device with which it is interfering, try another outlet.

3. Move the DR 5000 away from the device receiving the interference.

4. Reposition the receiving antenna for the device receiving the interference.

5. Try combinations of the above.

Appendix A Carousel Holder (Sample Changer)

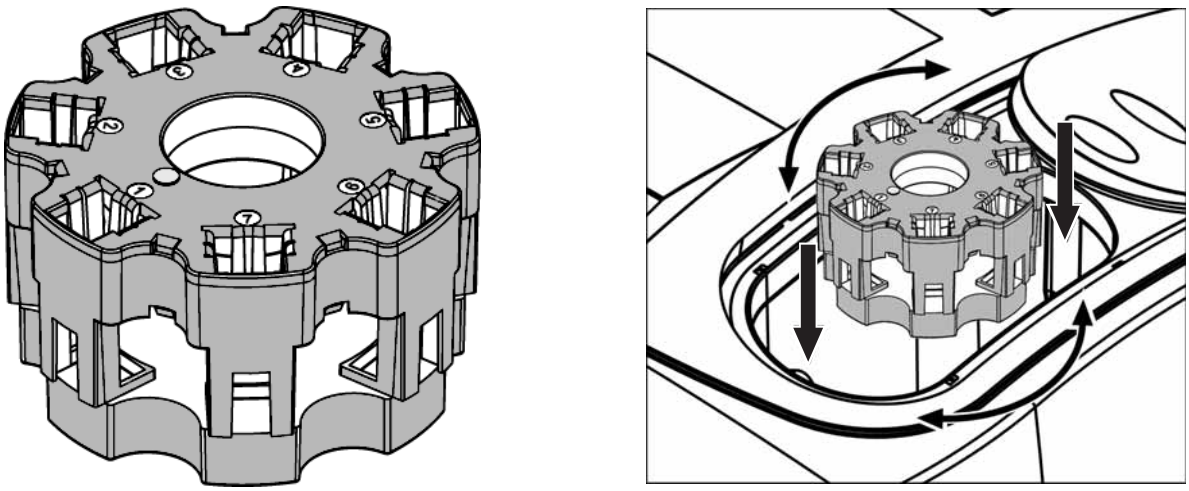
The Carousel Holder allows the user to load up to seven 10 mm cells of solution into the instrument for analysis at one time.

The cells can be various combinations of blanks and samples. The number of cell positions and the orientation of blanks and samples is user-defined in Instrument Setup.

A.1 Carousel Holder Installation

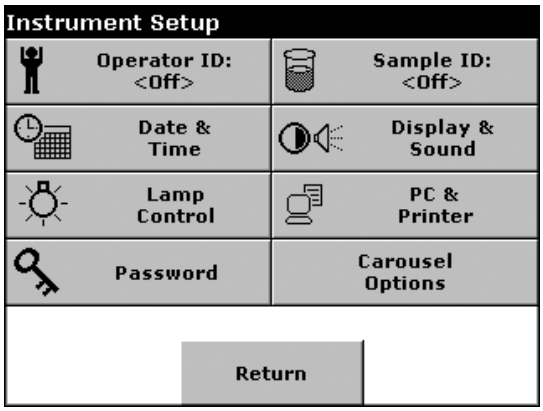
1. Open the cell compartment. Remove the Multi-Cell Adapter, if installed.
2. Place the carousel holder on the rotating attachment on the floor of the cell compartment (Figure 8). The gold dot on the carousel module should be positioned above the gold dot on the attachment. The numbers 1–7 on the cell holder are visible from above.
3. Turn the module slightly to the right and left until the locking pin in the middle clicks into place.

Figure 8 Carousel Holder Installation



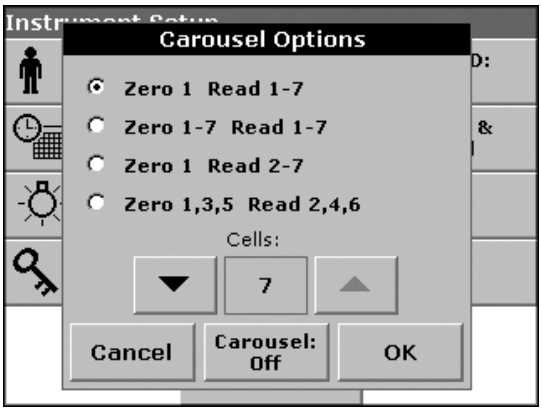
A.1.1 Running a Measurement with a Carousel Holder

1. From Instrument Setup, press **CAROUSEL OPTIONS**.



2. Select **CAROUSEL: OFF** to change the display to **CAROUSEL: ON** and press **OK** to confirm the input.

3. Use the Carousel Options menu to change the carousel holder configuration.

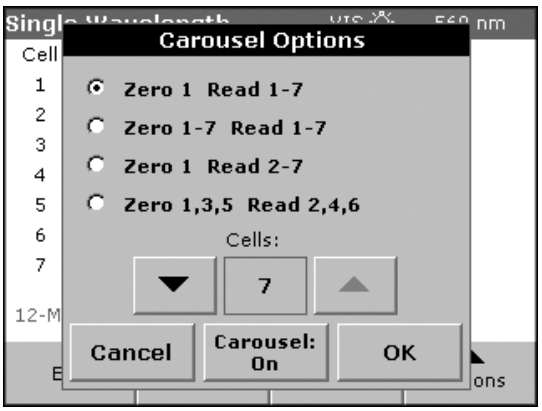


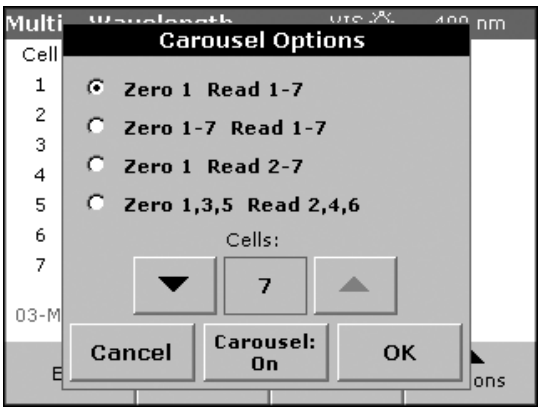
A.1.2 Performing a Single or Multi-Wavelength Measurement with the Carousel Holder

1. Load and insert the Carousel Holder and close the cell compartment.

2. From Instrument Setup, activate the carousel holder by selecting **CAROUSEL OPTIONS** and **CAROUSEL: OFF** (the display changes to **CAROUSEL: ON**). Press **OK** to confirm the input.

Note: *Use the arrow keys to select the number of active cells.*





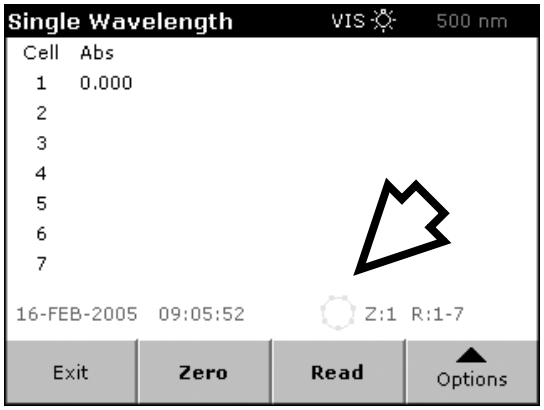
A.1.3 Shifting Activated/Disabled Conditions of Keys Under Carousel Settings

Table 16 lists the activated/disabled conditions of **ZERO**, **READ**, and **ZERO & READ** under various Carousel settings:

Table 16 Activated/Disabled Conditions

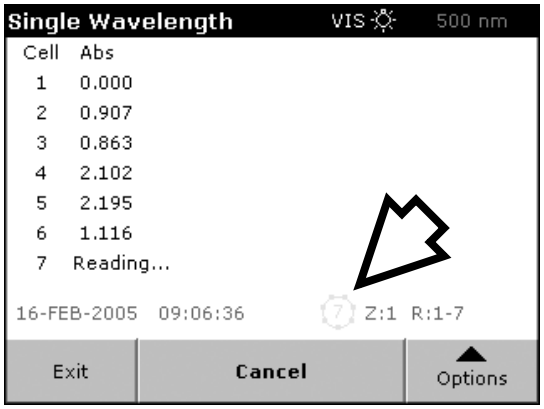
Carousel Mode	Initial State (Display)	After Zero (Display)
B: 1 R: 1 – n	[Zero] [Read]	[Zero] [Read]
B: 1 – n R: 1 – n	[Zero] [Read]	[Zero] [Read]
B: 1 R: 2 – n	[Zero & Read]	[Zero & Read]
B: 1, (3), (5) R: 2, (4), (6)	[Zero & Read]	[Zero & Read]
n = number of samples in the Carousel		

1. Press the **CAROUSEL** Icon to change the carousel settings.



2. Press **OPTIONS** in the Single or Multi-Wavelength menu to configure settings.

3. Press **ZERO** (or **ZERO & READ**) to start the first set of measurements. The status bar displays the instrument operation: "Reading..." ("Zeroing"), while the Carousel turns and the instrument takes readings as programmed through the Instrument Setup menu. The instrument lists each reading on the display as it is taken. When Zeroing or Reading, the position number appears in the Carousel icon (see below).

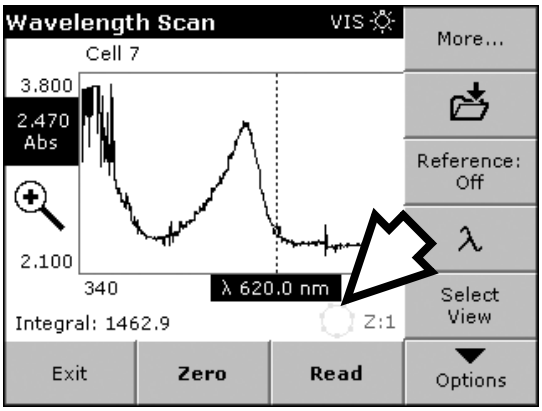


Note: *After starting the Reading sequence the* ***ZERO/READ*** *keys turn into a* ***CANCEL*** *key. Press* ***CANCEL*** *at any time to start over and to erase all readings from the current set of measurements.*

4. After finishing the reading sequence the Carousel turns back to the initial position. The **ZERO/READ** keys are reactivated.

A.1.4 Performing a Wavelength Scan with the Carousel Holder

1. Load and insert the Carousel Holder.
2. From Instrument Setup select **CAROUSEL OPTIONS** and **CAROUSEL: OFF** (the display changes to **CAROUSEL: ON**). Press **OK** to confirm the input.



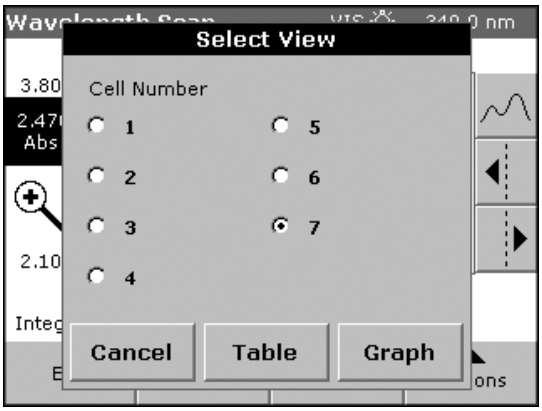
3. Press **OPTIONS** in the Wavelength Scan menu to configure scanning parameters. Press the **CAROUSEL** icon to change the Carousel Settings without returning to Instrument Setup.
4. After the scanning parameters have been selected, the baseline must be scanned. Changing any of the scanning parameters requires a new baseline scan. When the baseline has been scanned, the instrument is ready to scan the samples.

Note: *After starting the Reading sequence the* ***ZERO/READ*** *keys turn into a* ***CANCEL*** *key. Press* ***CANCEL*** *at any time to start over and to erase all readings from the current set of measurements.*

5. After finishing the reading sequence the Carousel turns back to the initial position. The **ZERO/READ** keys are reactivated.

A.1.4.1 Displaying a Graph or Table

1. Press **SELECT VIEW** to select the scan data for one Carousel position.
2. Activate a cell number 1–7 and press **TABLE** or **GRAPH** to display the scan data for one Carousel postition.

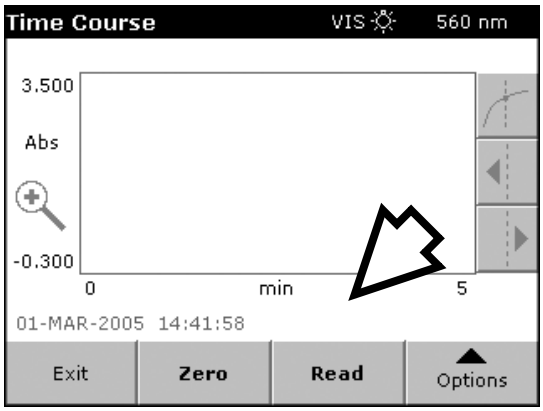


A.1.5 Performing a Time Scan with the Carousel Holder

1. Load and insert the Carousel Holder.
2. From Instrument Setup select **CAROUSEL OPTIONS** and **CAROUSEL:OFF** (the display changes to **CAROUSEL:ON**). Press **OK** to confirm the input.

Note: *Use the arrow keys to select the number of active cells.*

3. Press **OPTIONS** in the Time Course menu to configure parameters, see section 6.7.1 on page 86 and press **OK** to confirm. Press the **CAROUSEL** icon to change the Carousel Settings without returning to Instrument Setup.



4. After the parameters have been selected, the instrument must be blanked.

Note: *After starting the Reading sequence the* ***ZERO/READ*** *keys turn into a* ***MARK/STOP*** *key. Press* ***STOP*** *any time to start over.*

5. After finishing the reading sequence the Carousel turns back to the initial position. The **ZERO/READ** keys are reactivated.

Appendix B Sipper Module

The Sipper Module uses a peristaltic pump to pull samples into a flow cell for readings. After the reading is taken, the sample is either returned to the user or dumped to waste.

The Sipper Module provides improved measurement accuracy, because the same optical characteristics exist for both blanking and reading, and when comparing measurements of different samples. Errors resulting from optical differences between individual cells are eliminated because every reading is taken in the same vial.

B.1 Specifications

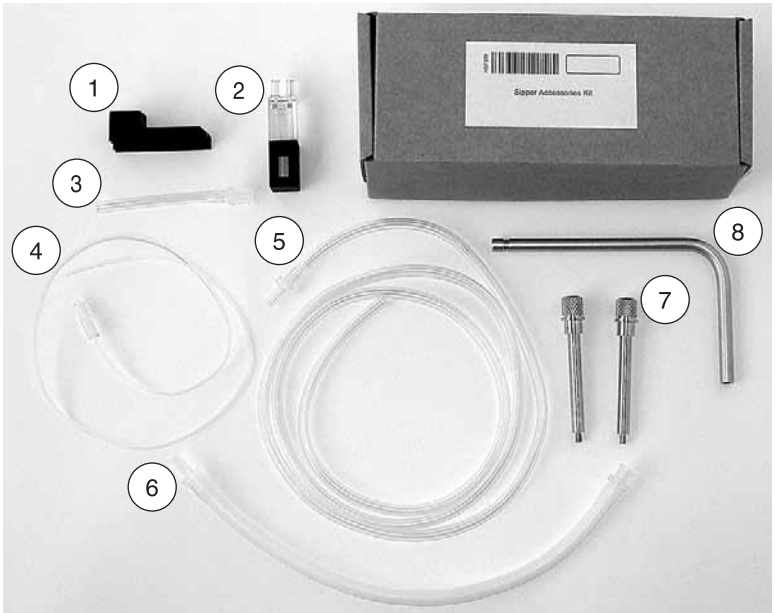
Specifications are subject to change without notice.

Available Path Lengths	2.42 cm (1 in.); 1 cm (0.394 in.)
Wavelength Range	190 to 1100 nm
Rinsing Volume	At least 20 mL for 1-inch path length; at least 10 mL for 1-cm path length
Flow Rate	1 mL/second (nominal)
Storage Temperature	–17 to 60 °C, 85% relative humidity, non-condensing
Operating Temperature	10 to 40 °C; 95% relative humidity, non-condensing at 25 °C; 75% relative humidity, non-condensing at 40°C

B.2 Unpacking the Sipper Module

Remove the Sipper Module from the shipping container and inspect it for any damage that may have occurred during shipment. All models are shipped with a Sipper Module and Sipper Accessories Kit (Figure 9). If any of these items are missing or damaged, contact the manufacturer or a sales representative immediately.

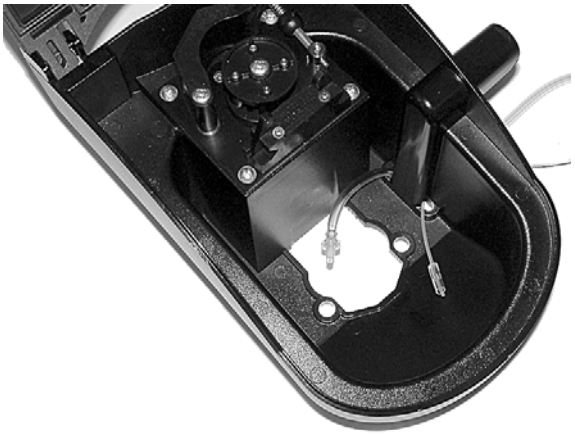
Figure 9 Sipper Accessories Kit



1. Rubber Fitting	**4.** Sample/Inlet Tubing	**7.** Locking Screws (2)
2. Sipper Cell, 1-cm	**5.** Drain/Waste Tubing	**8.** Guide Tube
3. Outlet Connector (from pump to drain)	**6.** Pump Tubing (white)	

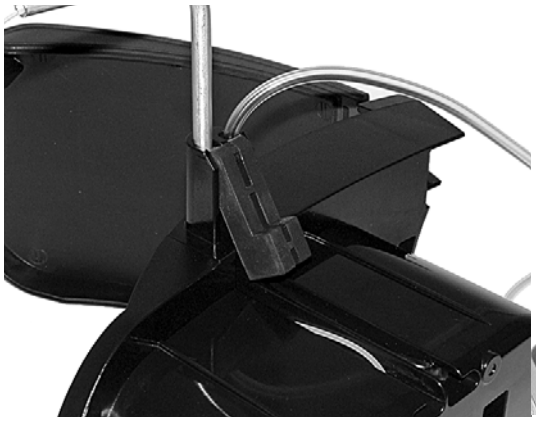
B.3 Sipper Module Installation

1. Pull the drain tube through the exit channel of the sipper from the inside outwards. Pull the inlet tube through the entry channel of the sipper module from the outside inwards. The push-in connectors must be inside the module. Avoid kinks in the tubes.



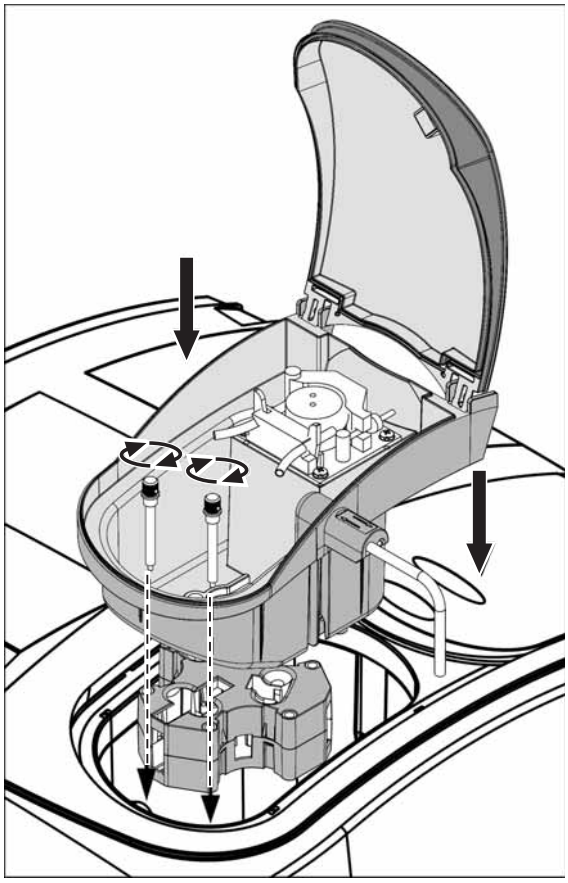
2. Turn the sipper module on its side. Pull the inlet tube and the drain tube through, respectively, the entry channel and the exit channel of the sipper. The inlet tube must be pulled through the guide tube. The bottom end of the guide tube must click into the channel. Avoid kinks in the tubes.

3. Hold the rubber fitting with the ridges over the grooves and push it firmly onto the guide tube and the waste tube.The rubber fitting must firmly enclose the guide tube and drain tube.



4. Open the cell compartment. Without the locking screws, insert the Multi Cell Holder into the cell compartment (refer to section 3.4.1 on page 14).

5. Place the Sipper Module on the Multi Cell Holder in such a way that the screw holes are positioned exactly one above the other and the lid of the Sipper Module can be opened towards the back of the instrument.



6. Secure the Sipper Module and the Multi Cell Holder with the two locking screws (Figure 9 on page 121).

7. The contact to the instrument has now been established. **SIPPER OPTIONS** is now available in Instrument Setup.

8. Pull the pump adjustment forward (item 1, Figure 10 on page 124) and open the pump tubing clamp (item 2, Figure 10). Wrap the white pump tubing around the pump and clamp the ends on the right and left in the two front retainers (item 3, Figure 10).The push-in connectors of the pump tubing must be positioned as in Figure 10.

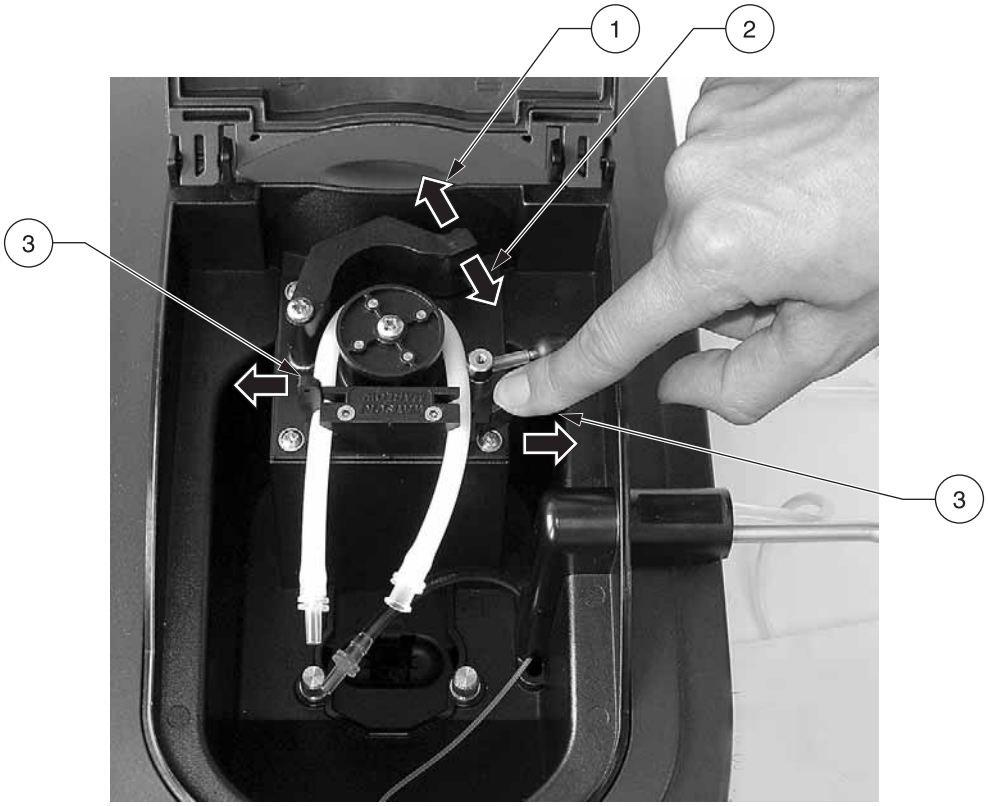
9. Clean the Sipper Cell with a lint-free cloth and insert the Sipper Cell (item 1, Figure 11 on page 124).

10. Use the outlet connector (item 2, Figure 11) to join the white pump tubing (item 3, Figure 11) to the Sipper Cell outlet (item 1, Figure 11).

11. Connect the drain tube (item 5, Figure 11) to the right end of the white pump tubing.

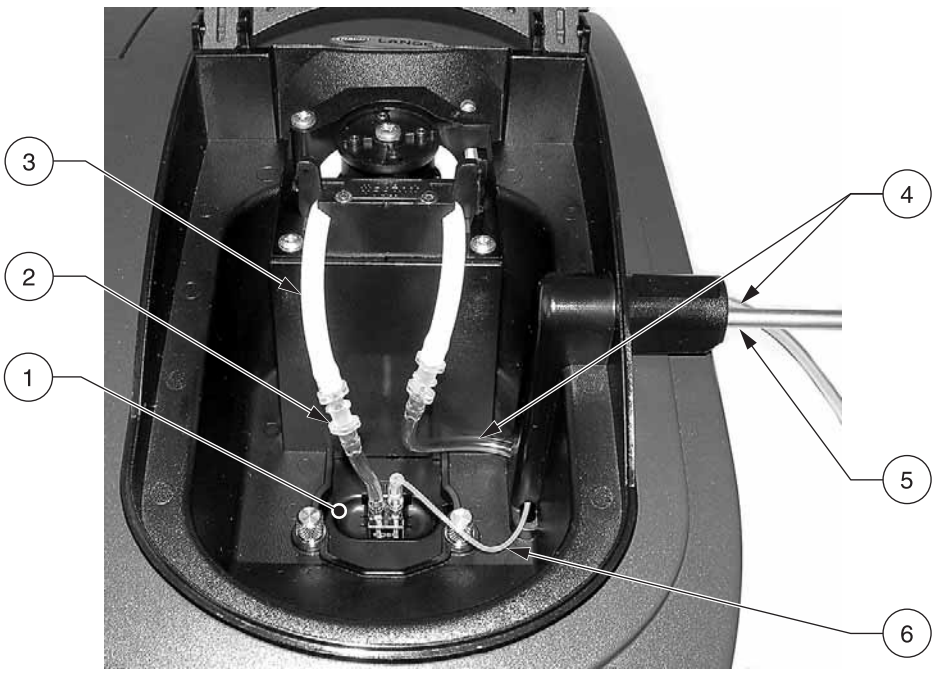
12. Connect the inlet tube to the inlet of the Sipper Cell (item 4, Figure 11).

Figure 10 Pump Adjustment



1. Pump Adjust Forward	**2.** Pump Tubing Clamp	**3.** Front Retainers

Figure 11 Sipper Module with Tubes in Place

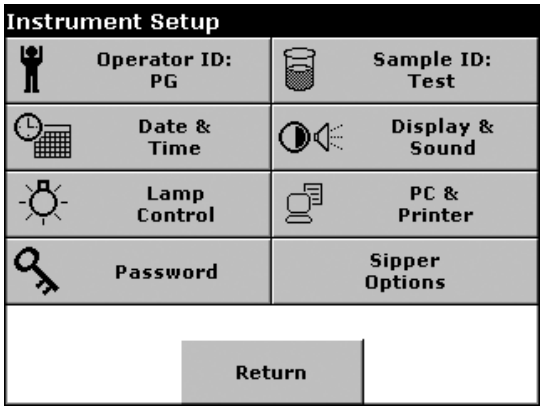


1. Sipper Cell	**4.** Sample/Inlet Tubing
2. Outlet Connector (from pump to drain)	**5.** Drain/Waste Tubing
3. Pump Tubing (white)	**6.** Guide Tube

B.4 Sipper Module Setup

When a Sipper Module is installed, **SIPPER OPTIONS** icon is available in Instrument Setup.

1. From Instrument Setup, press **SIPPER OPTIONS**.



2. Enter the times for the listed parameters.

B.4.1 Automatic Mode

The characteristics of the three basic sipper cycles can be defined in the automatic mode: Sip Time, Settle Time, and Purge Time.

- **Sip Time:** The sip time and the pump setting determine the sample volume that can be pumped into the cell.
- **Settle Time:** The settle time is the interval that must be allowed before the measurement is performed. In this time, air bubbles that may have formed during pumping can be eliminated and any turbulence in the sample can settle.
- **Purge Time:** The purge time determines the volume of air or purging solution that is pumped through the cell after the measurement.

Note: *If the Sipper Module is not in automatic mode, press the* ***PURGE START: MANUAL*** *key to change the mode to Auto.*

Press **ZERO** or **READ** to run the programs through the sipper cycles automatically. Press **READ** to run the program through the Sipper Module.

B.4.2 Manual Mode

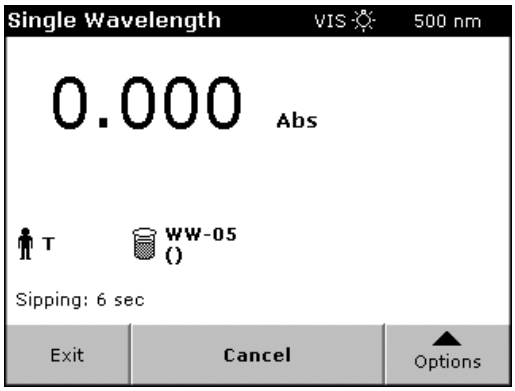
In the manual Sipper mode, the purge cycles can be activated manually. This mode can be useful during the input of the basic parameters, as an aid to determining which parameter values to work with in the automatic mode.

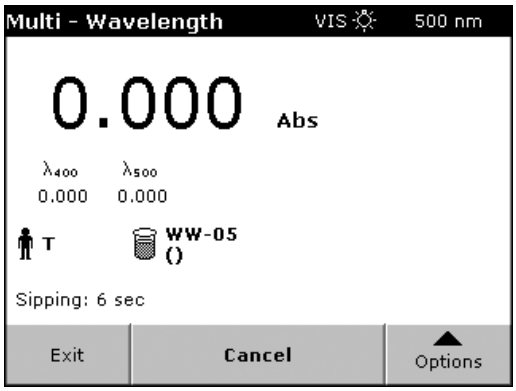
B.5 Performing a Single or Multi-Wavelength Measurement

1. Load and insert the Sipper Module. The **SIPPER OPTIONS** key will appear on the Instrument Setup screen.

2. Press **SIPPER OPTIONS** to select the Sipper Settings. Select the sipper settings and press **OK**.

3. Press **OPTIONS** on the Single or Multi-Wavelength menu to configure the parameters.





4. Route the drain tube to an appropriate drain or collection vessel.

5. Place the sample inlet tube into the blank and press **ZERO**. Leave the inlet tube in the sample until the Sipper pump stops and the settling cycle begins.

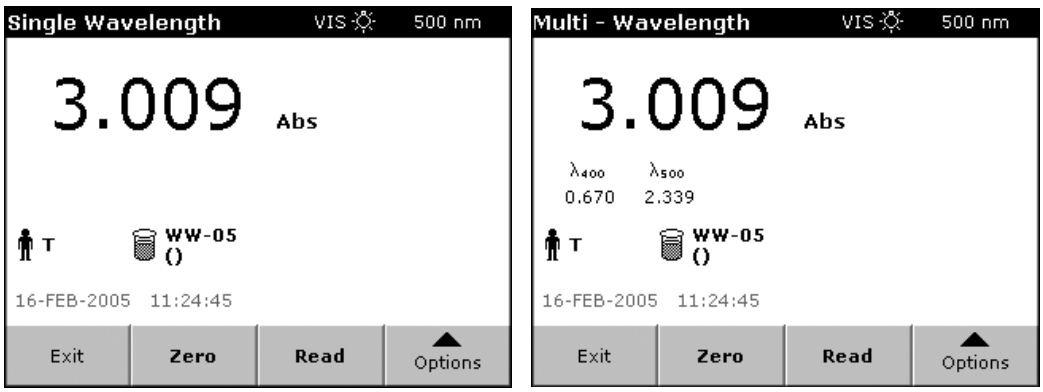
Note: *The remaining time in seconds is shown instead of the date on the display. Press* ***CANCEL*** *to stop the sip cycle.*

6. When the settling cycle is complete, the blank is displayed. In the automatic mode, the purge begins immediately after the reading without operator intervention. If the purge is set up for a manual start the instrument will wait for the operator to press **PURGE**.

Note: *Distilled water or the sample can be used as the rinsing liquid.*

7. Rather than wasting the sample, a distilled water purge can be placed at the sample inlet to rinse the sample cell between readings.

8. Leave the inlet tube in the purge solution until the Sipper pump stops.



Note: *The remaining time in seconds is shown instead of the date on the display. Press* ***CANCEL*** *during the purge interval to stop the purge cycle.*

9. When the sample purge is complete the instrument is ready for the next sample.

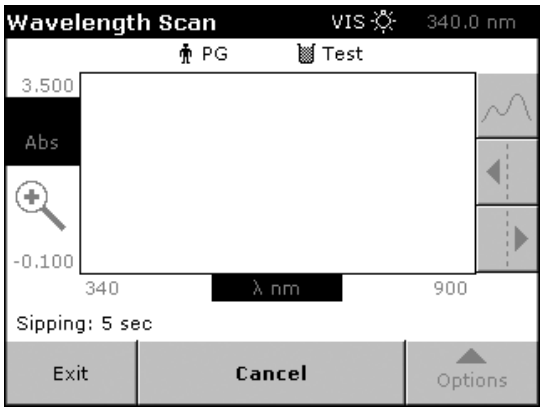
Note: *After starting the Reading sequence the* ***ZERO/READ*** *keys turn into a* ***CANCEL*** *key. Press* ***CANCEL*** *at any time to start over and to erase all readings from the current set of measurements.*

B.6 Performing a Wavelength Scan

1. Load and insert the Sipper Module. The **SIPPER OPTIONS** key will appear on the Instrument Setup screen.

2. Press **SIPPER OPTIONS** to select the Sipper Settings. Select the sipper settings and press **OK**.

3. Press **OPTIONS** on the Wavelength Scan menu to configure scanning parameters



4. 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 the samples.

5. Route the drain tube to an appropriate drain or collection vessel.

6. Place the sample inlet tube into the blank and press **ZERO**. Leave the inlet tube in the sample until the Sipper pump stops and the settling cycle begins. The remaining time in seconds is shown instead of the date on the display. Press **CANCEL** to stop the sip cycle.

7. When the settling cycle is complete, the blank is displayed. In automatic mode, the purge begins immediately after the reading. If the purge is set up for a manual start the instrument will wait for the operator to press **PURGE**.

Note: *Distilled water or the sample can be used as the rinsing liquid.*

8. Leave the inlet tube in the purge solution until the Sipper pump stops. The remaining time in seconds is shown instead of the date on the display. Press **CANCEL** during the purge interval to stop the purge cycle.

9. When the sample purge is complete the instrument is ready for the next sample.

Note: *After starting the Reading sequence the **ZERO/READ** keys turn into a **CANCEL** key. Press **CANCEL** at any time to start over and to erase all readings from the current set of measurements.*

B.7 Performing a Time Scan

1. Load and insert the Sipper Module. The **SIPPER OPTIONS** key will appear on the Instrument Setup screen.

2. Press **SIPPER OPTIONS** to select the Sipper Settings. Select the sipper settings and press **OK**.

3. Press **OPTIONS** on the Time Course menu to configure scanning parameters. After the parameters have been selected, the instrument must be blanked.

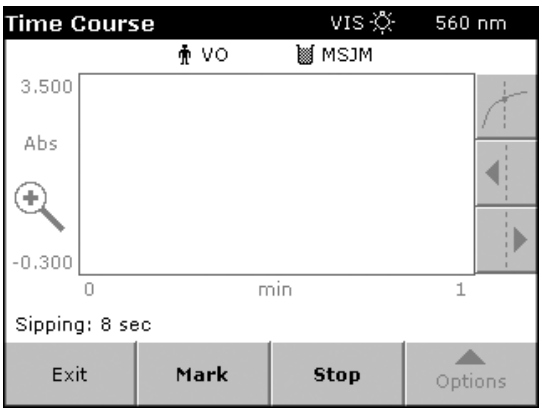
4. Route the drain tube to an appropriate drain or collection vessel.

5. Place the sample inlet tube into the blank and press **ZERO**. Leave the inlet tube in the sample until the Sipper pump stops and the settling cycle begins. The Remaining time in seconds is shown instead of the date on the display. Press **CANCEL** to stop the sip cycle.

6. When the settling cycle is complete, the blank is displayed. In the automatic mode, the purge begins immediately after the reading without operator intervention. If the purge is set up for a manual start the instrument will wait for the operator to press **PURGE**.

Note: *Distilled water or the sample can be used as the rinsing liquid.*

7. Leave the inlet tube in the purge solution until the Sipper pump stops. The remaining time in seconds is shown instead of the date on the display. Press **CANCEL** during the purge interval to stop the purge cycle.



8. When the sample purge is complete the instrument is ready for the next sample.

Note: *After starting the Reading sequence the **ZERO/READ** keys turn into a **MARK/STOP** key. Press **STOP** at any time to start over.*

B.8 Cleaning the Sipper Module

B.8.1 Sample Cell

Purge the cell with deionized water before and after each test session. If the cell is unusually dirty, repeat the sip and purge cycles several times with deionized water, or temporarily set the purge cycle to a higher setting before adjusting the timing parameters. Occasionally inspect the sample cell windows. If the windows appear dirty or hazy, remove the sample cell and soak it in a soap solution or dilute acid and rinse thoroughly with deionized water.

B.8.2 Module

If the module becomes dirty, wipe it clean with soap, water, and a soft cloth. DO NOT immerse the module or use solvents (e.g. acetone) to clean the module.

B.8.3 Cleaning the Tubes

The tubes should always be cleaned with deionized or distilled water after a measurement series has been completed.

The discharge tube in the pump zone and the sipper tube are subject to mechanical and chemical stresses and must be replaced. The number of operating hours for the tube sets depends on the type of pumped solutions.

Appendix C Pour-Thru Cell Module

CAUTION
Do not use the Pour-Thru Cell in tests that call for the use of organic solvents such as toluene, chloroform, trichloroethane, or cyclohexanone. These solvents may not be compatible with the plastic components of the Pour-Thru Cell, creating the potential for equipment damage and chemical exposure for the analyst.

Using the optional Pour-Thru Cell Module improves measurement accuracy. Because the same optical characteristics exist for both zeroing and measuring, or when comparing measurements of different samples, any error that would have resulted from optical differences between individual sample cells is eliminated. The Pour-Thru Module is designed to allow the sample to be introduced into the cell without handling the cell.

The Pour-Thru Cell Module is available in two pathlengths. The two cell types (1-inch and 1-cm cells) can be used over the entire wavelength spectrum.

C.1 Specifications

Specifications are subject to change without notice.

Path Length	2.42 cm (1 inch) 1 cm (0.394 inch)
Wavelength Range	190 to 1100 nm
Rinsing Volume	At least 20 mL for 1-inch path length At least 10 mL for 1-cm path length

C.2 Using the Pour-Thru Cell

The Pour-Thru Cell provides optimum convenience and precision when used with liquid reagents. Since these reagents can be added and mixed most easily, they contribute minimal turbidity to the sample, allowing measurements at very low absorbance values.

Several of the methods in the Procedure Manual specify use of the Pour-Thru Cell. These are generally identified as RL (Rapid Liquid) or ULR (Ultra-low Range) methods. The Stored Program calibrations for these methods were created using the Pour-Thru Cell with a light path of approximately 1 inch, and will provide precise measurements, even at very low concentrations, when used as directed.

It is also possible to use the Pour-Thru Cell with some of the methods that are designed to use the 1-inch square sample cells, with minor modifications. (See Table 17 and Table 18 on page 132 for exceptions.) Since the 10 mL sample volume specified in most of the methods in the Procedure Manual is not large enough to completely purge the system, it is necessary to use 30 mL of sample (and 3 times as much of each reagent) to use the Pour-Thru Cell. Methods which use a 25 mL sample can be used as written.

Since there is a slight difference in light path between the square 1-inch sample cells and the Pour-Thru Cell, it is necessary to adjust the calibration slightly. This is done by applying a dilution factor of 1.10 (see section 5.4.4 on page 38) or by performing a standard adjust (see section 5.4.5 on page 38). The dilution factor or standard adjust values are not saved once the program is exited. To save these factors, the modified program must be saved as a User Program.

Although the Pour-Thru Cell can be used for the methods in Table 17, the cell must be thoroughly purged with distilled water between individual samples.

Table 17 Pour-Thru Cell Methods Requiring Purging

Aluminum, Aluminon	Chlorine Dioxide, LR	Cobalt, PAN
Copper, Porphyrin	Hardness, Calmagite	Manganese, LR, PAN
Nickel, PAN	Nitrate, MR	Nitrate, HR

The Pour-Thru Cell can also be used to run Nitrogen, Ammonia, Nessler Method, and TKN chemistries. Clean the cell by pouring a few sodium thiosulfate pentahydrate crystals into the cell. Rinse out the crystals with deionized water.

In general, the Pour-Thru Cell **cannot** be used with the methods in Table 18.

Table 18 Methods that Cannot be used with the Pour-Thru Cell

Aluminum ECR	Arsenic	Barium	Boron, Carmine
Cyanuric Acid	Fluoride	Formaldehyde	Lead, LeadTrak
Mercury	Nickel, Heptoxime	Nitrite, HR	PCB
Phenols	Potassium	Selenium	Silver
Suspended Solids	Sulfate	TPH	Volatile Acids
Zinc	Surfactants, Anionic (Detergents)		

C.3 Cleaning the Pour-Thru Cell

Important Note: *Do not use solvents (e.g. acetone) to clean the Pour-Thru Cell. A dilute acid solution can be used for cleaning. Rinse thoroughly with deionized water.*

If windows are cloudy or soiled or bubbles form, add 50 mL of a detergent solution to the cell and wait for a few minutes to allow it to take effect. Then purge the cell thoroughly with distilled water. If necessary, the Pour-Thru Cell can be taken apart to be cleaned. Wipe the windows of the cell with a soft cloth only—paper towels and other paper products may scratch the glass.