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DR 2800

USER MANUAL

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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)
Wavelength Range	340–900 nm
Wavelength Accuracy	± 1.5 nm
Wavelength Reproducibility	< 0.1 nm
Wavelength Resolution	1 nm
Wavelength Calibration	Automatic at startup
Wavelength Selection	Automatic, based on method selection
Spectral Bandwidth	< 8 nm
Photometric Measuring Range	± 3.0 Abs in Wavelength Range 340–900 nm
Photometric Accuracy	0.005 Abs at 0.0–0.5 Abs 1% at 0.50–2.0 Abs
Photometric Linearity	0.5% at ≤ 2 Abs ≤ 1% at > 2 Abs with neutral glass at 546 nm
Stray Light	< 0.2% T at 340 nm with filter KV450/3 < 0.1% T at 340 nm with NaNO ₂
Data Storage	500 measured values (result, date, time, sample ID, user ID)
User Programs	50 programs
Physical and Environmental Specifications	
Dimensions	220 x 135 x 330 mm (8.6 x 5.3 x 12.9 in.)
Weight	4.06 kg (8.95 lb) without battery 4.38 kg (9.66 lb) with battery
Enclosure Rating	IP41 with lid closed IP42 with Protective Cover
Operating Requirements	10 to 40 °C (50 to 104 °F), max. 80% relative humidity (non-condensing)
Storage Requirements	–40 to 60 °C (–40 to 140 °F) max. 80% relative humidity (non-condensing)
General Specifications	
Power Requirements	DR 2800: 15VDC/30VA (output)
	External power supply: 100–240 VAC/50-60 Hz input Lithium battery pack, 11.1 V, 4.4 Ah, rechargeable
Interfaces	Use only shielded cable with maximum length of 3 m 1 USB for PCs only 1 USB reading device for memory cards and keyboard
Safety Class	Safety class II

Section 2 General Information

2.1 Safety Information

Please read this entire manual before unpacking, setting up, or operating this equipment. Pay attention to all danger 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.

In addition to the instructions in this manual, users must comply with the national general safety and accident prevention regulations of the country in which the instrument is used.

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. A symbol, if noted on the instrument, will be included with a danger or caution statement in the manual.

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

2.1.3 Class 1 LASER

A Class 1 LASER is installed in this instrument. Class 1 LASERS are products where the radiant power of the LASER beam accessible (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. However, Class 1 LASER products may contain LASER systems of a higher Class but 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. CDRH assessment number 0510555-01.

Data: 0.3 mW; wavelength = 650 nm

LASER CLASS 1	This symbol indicates that the instrument contains a Class 1 laser device. Data: 0,3 mW; λ = 650 nm
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2.2 Overview of Product/Function

The DR 2800 Spectrophotometer is a visible spectrum spectrophotometer with a wavelength range of 340 to 900 nm for laboratory and field analysis. The instrument comes with a complete set of application programs and multi-language support.

The DR 2800 Spectrophotometer contains the following application modes: Stored Programs (pre-installed tests), Barcode Programs, User Programs, Favorite Programs, Single Wavelength Mode, Multi-Wavelength Mode, and Time Course Mode.

The DR 2800 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 generate reports, statistical evaluations of generated calibration curves, and perform instrument diagnostic checks.

CAUTION

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

3.1 Unpacking the Instrument

The DR 2800 Spectrophotometer comes packaged with the following items:

- DR 2800 Spectrophotometer
- External power supply with country-specific adapter plugs
- Dust cover
- Two square glass cells, 10 mL, matched
- 3 cell adapters (A, B, and C)
- Light Shield
- Protective Cover
- DR 2800 User Manual
- Procedure manual on CD-ROM

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 service should be shipped in the original packaging material to protect against damage during transportation.

3.2 Operating Environment

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

- Place the instrument firmly on an even surface. Do not push any objects under the instrument.
- Maintain an ambient temperature of 10 to 40 °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 in.) clearance at the top and on all sides for air circulation to avoid overheating of electrical parts.
- Do not operate or store the instrument in extremely dusty, damp or wet locations.
- Keep the surface of the instrument, the cell compartment, and all accessories clean and dry at all times. Splashes or spills on and in the instrument should be cleaned up immediately ([section 7.1 on page 73](#)).

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

3.3 Power Connections

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

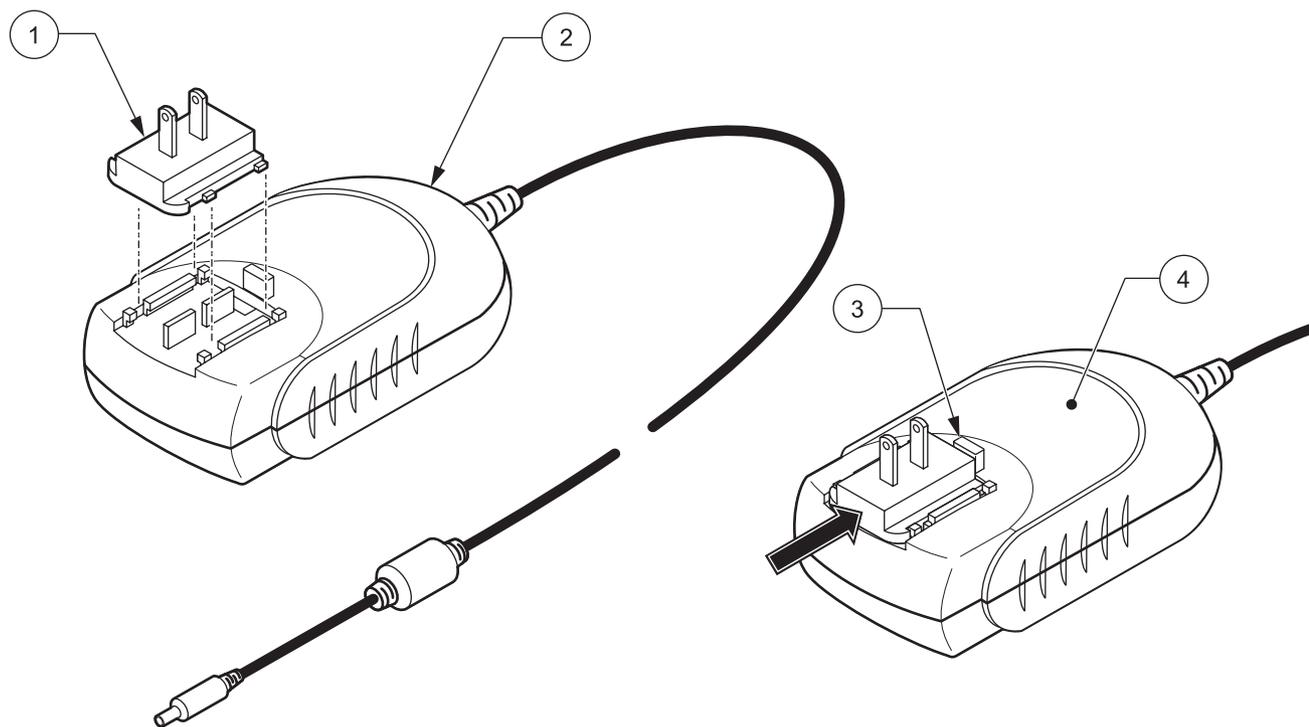


Figure 1 Power Adapter

1	Adapter Plug (US version shown)	3	Adapter Plug Lock/Release Button
2	Power Supply	4	Power Supply with Adapter Plug Installed

3.4 Battery Power

The DR 2800 can also be powered using an optional lithium battery pack. Refer to section 7.2 on page 74 for more information on battery replacement and charging.

3.5 Serial Printer and Personal Computer (PC) Connections

The DR 2800 has two USB interfaces as a standard feature, located on the back of the instrument (Figure 2). The USB Type A interface is used for communications with a printer, USB memory stick, or keyboard. A USB memory stick is used to update instrument software (section 6.6.2 on page 68).

The USB Type B interface is used for communications with a PC. The optional Hach Data Trans software (Cat. No. LZY274) must be installed on the PC for this use.

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



Figure 2 Interfaces

1 On/Off Switch	4 Cover
2 USB Type B for PC to DR 2800 connection	5 USB Type A: for printer, USB stick, or keyboard
3 External Power Supply Socket	

3.6 Cell Compartments, Cell Adapters, Light Shield, and Protective Cover

3.6.1 Cell Compartments and Adapters

The DR 2800 has two cell compartments (Figure 3). Cell Compartment #2 uses adapters (Figure 4) to accommodate different cell types. Only one cell type at a time can be used for a measurement.

Cell Compartment #1

- 13-mm TNTplus™ or 16-mm TNT round cells

Note: Cell Compartment #1 contains a barcode reader for TNTplus™ vials.

Cell Compartment #2

- 1-inch square or 50-mm rectangular cells (can be inserted directly into the cell compartment without using an adapter).
- Adapter A: 10-mm square cells
- Adapter B: Pour-Thru and multi-path cells

*Note: Pour-Thru cell **must** be used with Adapter B, not Adapter C.*

- Adapter C: One-inch round cells and AccuVac® Ampuls

*Note: One-inch round cells and AccuVac Ampuls **must** be used with Adapter C, not Adapter B.*

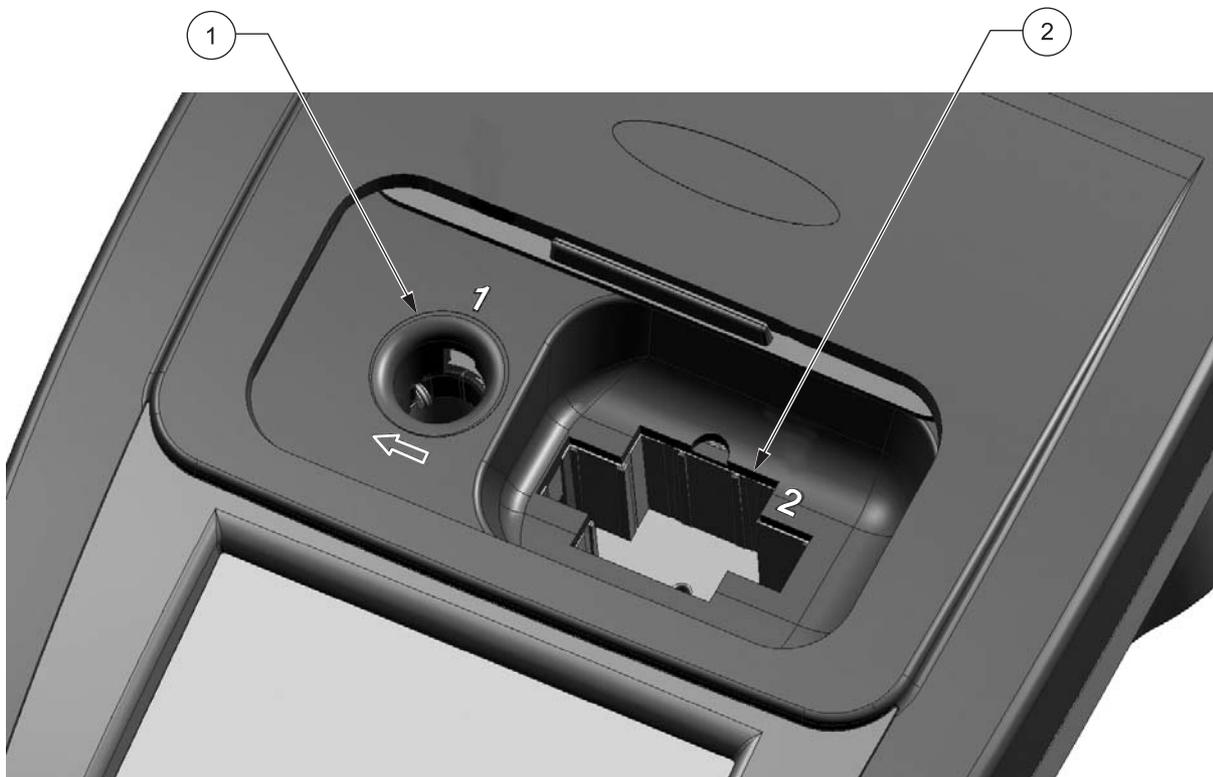


Figure 3 Cell Compartments

1 Cell Compartment #1	2 Cell Compartment #2
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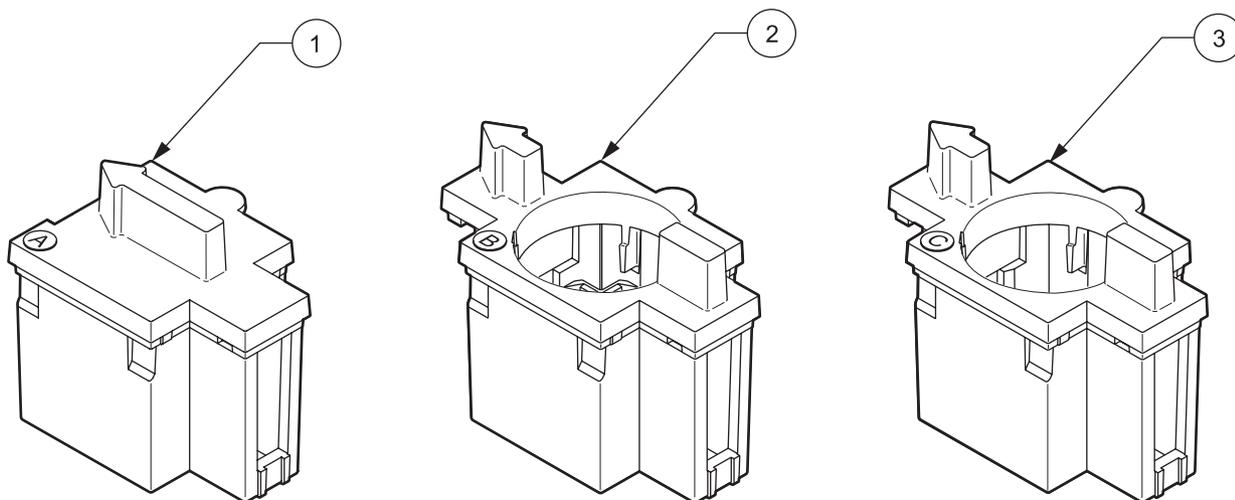


Figure 4 Cell Adapters

1	Adapter A (Cat. No. LZV583): 10 mm square cell adapter
2	Adapter B (Cat. No. LZV585): 1 inch Pour-Thru and multi-path adapter
3	Adapter C (Cat. No. LZV584): 1 inch round cell adapter

3.6.2 Installing Cell Adapters

1. Open the cell compartment.
2. Select the correct adapter for the cell type.
3. Insert the adapter so the arrow on top of the adapter points to the left and the orientation tab fits the groove in the compartment opening. The cell type imprint should be legible on the adapter (Figure 5).

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



Figure 5 Installing a Cell Adapter

3.6.3 Using the Light Shield for TNTplus or Test 'N Tube Measurements

The Light Shield (Figure 6) prevents light interference when using Test 'N Tube or TNTplus vials and must be in place before measurements can be taken in Cell Compartment #1. The Light Shield is required only when using Test 'N Tube or TNTplus vials.

The DR 2800 is shipped with the Light Shield installed. Remove the Light Shield before using Cell Compartment #2. The Light Shield can be stored in the Protective Cover (Figure 8 on page 16).

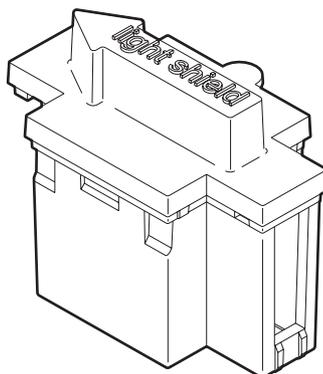


Figure 6 Light Shield (Cat. No. LZV646)

Installing the Light Shield

1. Open the cell compartment.
2. Insert the light shield so the arrow on the light shield points to the left and the orientation tab fits the groove in the compartment opening (Figure 7)

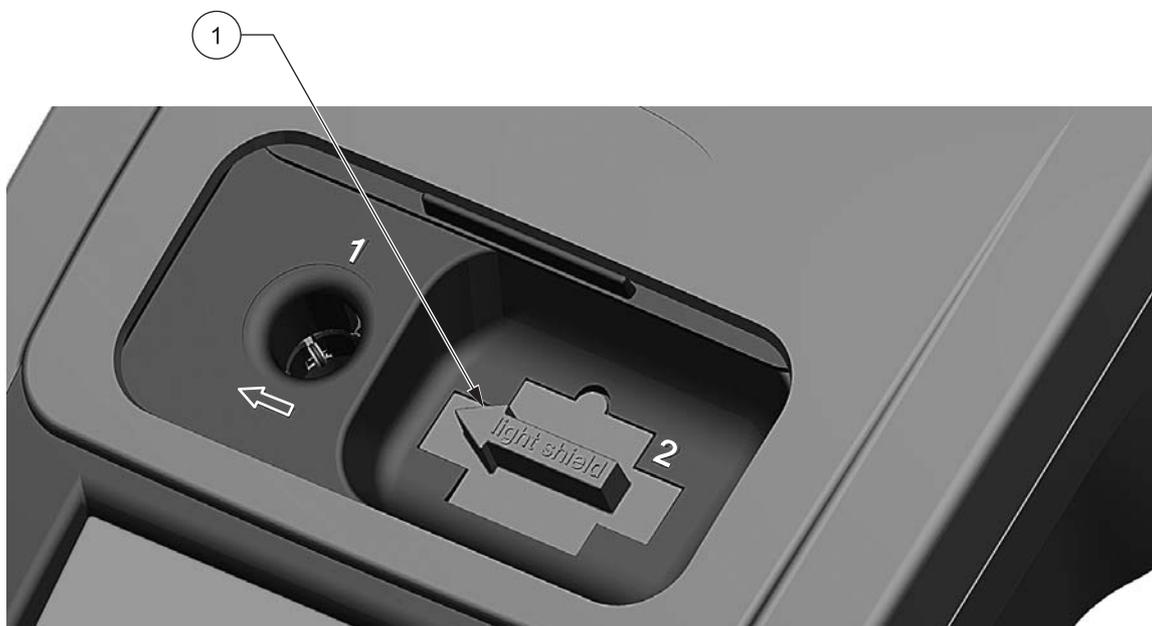


Figure 7 Light Shield Installed

3.6.4 Using the Protective Cover for Field Measurements

The Protective Cover (Figure 8) prevents bright light and rain from interfering with sample measurements. Use the Protective Cover when both of the following conditions occur:

1. Tall cells (multi-path or 25-mL sample cells) are used in Cell Compartment #2 (these cells prevent the sliding door from closing).

AND

2. The instrument is used outdoors in bright sunlight.

Most other conditions do not require use of the Protective Cover, however in some lighting conditions the error message “Too much ambient light! Move instrument into shade or close the lid!” may appear. If this warning appears, either close the lid, move the instrument away from direct sunlight, or place the Protective Cover over both sample compartments (Figure 9).

The Protective Cover can also be used in rainy weather to prevent water from entering the cell compartments. The enclosure rating of the instrument increases from IP41 to IP42 when the Protective Cover is in place.

The inside of the Protective Cover can be used for storage of three cell adapters (Figure 8). The cell adapter recesses in the Protective Cover are marked with the corresponding letters and arrows of the adapter. The arrows indicate the direction of insertion. When a cell adapter is in use and removed from the cover, the Light Shield can be stored in the Protective Cover.

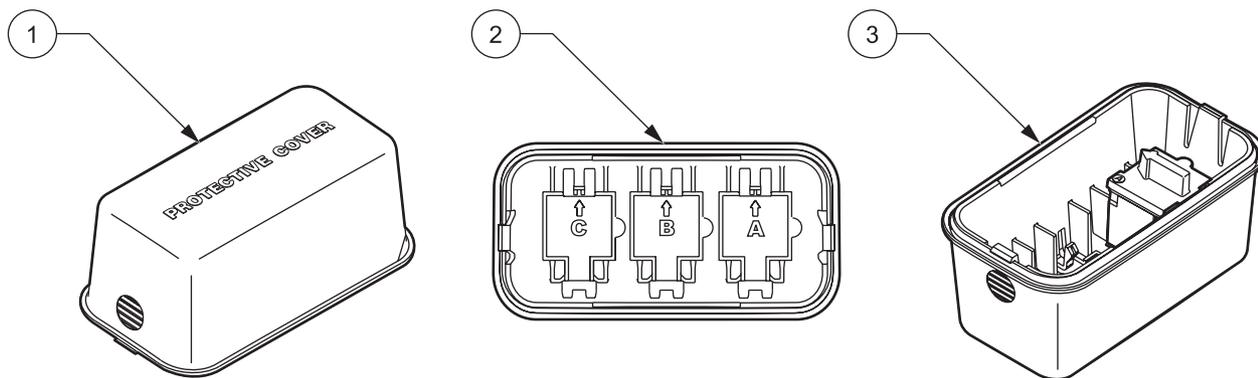


Figure 8 Protective Cover

1	Protective Cover (Cat. No: LZV642)	3	Protective Cover with adapter A stored in position A
2	Protective Cover (inside view)		

Positioning the Protective Cover

1. After the sample is placed in the cell compartment, position the Protective Cover over both cell compartments. The lettering “Protective Cover” must be readable from the display side of the instrument (Figure 9).

2. Press the Protective Cover lightly into the correct position until the cell compartment is completely sealed and the cover cannot slip off.



Figure 9 Protective Cover Installed

Section 4 Start Up

4.1 Powering the Instrument On and Off

1. Plug the external power supply into an electrical outlet, or insert the battery.
2. Press the On/Off switch for approximately one second to power on the instrument.
3. Press the On/Off switch for 3 to 5 seconds to turn the instrument off. An acoustical signal confirms that the instrument has been powered off.

Note: Do not switch the instrument off and on in rapid succession. Always wait about **20 seconds** before switching the instrument on again, otherwise you may damage the electronic and mechanical systems.

4.2 Language Selection

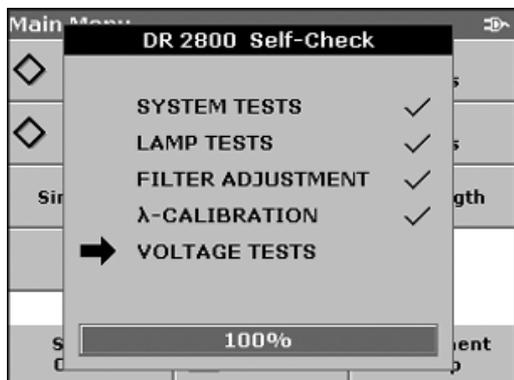


The DR 2800 Spectrophotometer software includes several language options. The first time the instrument is powered on, the language selection screen will appear.

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

Note: Once the language is selected, the instrument will 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.

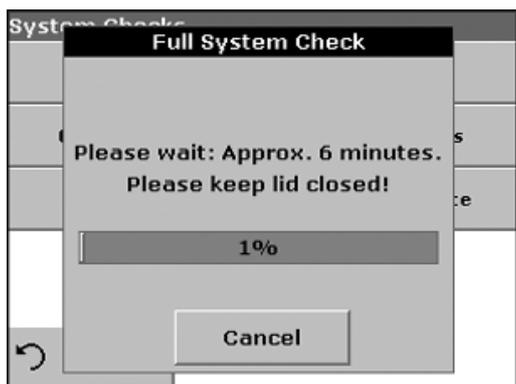
This procedure, which takes approximately two minutes, checks the system, lamp, filter adjustment, wavelength calibration, and voltage. Each test which functions correctly is confirmed with a check mark.

The Main Menu is displayed when power up diagnostics are completed.



If the instrument detects any deviation relative to the last calibration, it is recommended to perform a system check.

1. Remove the cell from the cell compartment, if present. Close the lid and press **START**.



The system check is carried out (duration approximately 6 minutes).

Note: For more information on error messages during self check, see [section Section 8 on page 79](#).

Section 5 Standard Operations

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 1](#).

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.

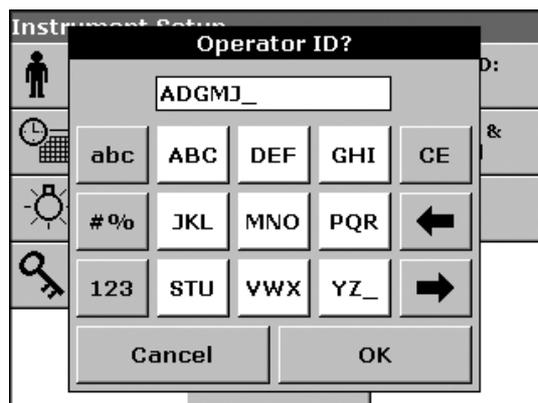
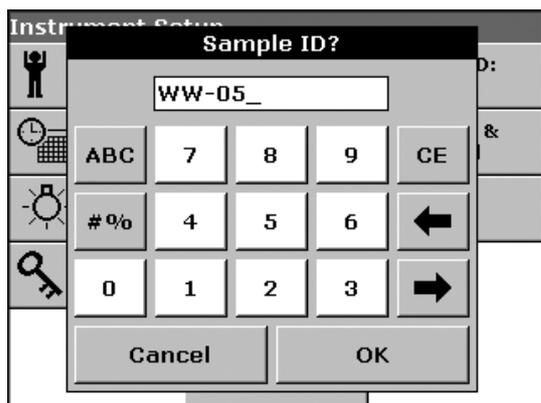
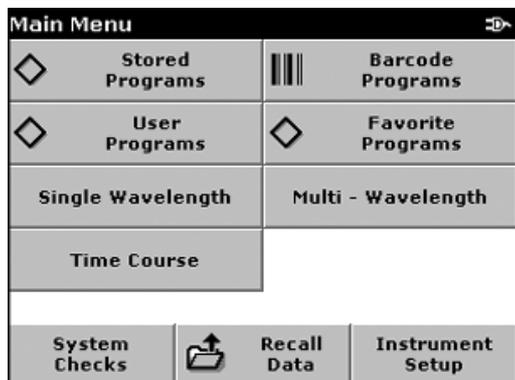


Table 1 Alphanumeric Keypad Functions

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 Main Menu

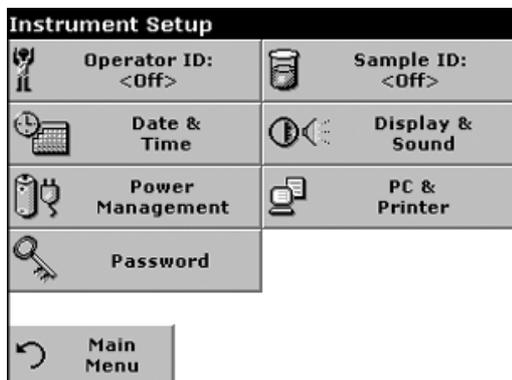


A variety of modes may be selected from the Main Menu. [Table 2](#) briefly describes each menu option.

Table 2 Main Menu Options

Option	Function
STORED PROGRAMS / BARCODE PROGRAMS	Stored programs are pre-programmed methods that make use of reagents, cell tests, and pipette tests. Refer to the DR 2800 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 methods they have developed themselves 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/tests selected by the user.
SINGLE WAVELENGTH	Single wavelength measurements are: Absorbance measurements: The light absorbed by the sample is measured in absorbance units. Transmittance measurements (%): The percentage of the light that passes through the sample and reaches the detector is measured. Concentration measurements: A concentration factor can be entered to enable the measured absorbance values to be converted into concentration values.
MULTI-WAVELENGTH	In the multi-wavelength mode, absorbance (Abs) or percent transmittance (%T) is measured at up to four wavelengths, and absorbance differences and absorbance relationships are calculated. Simple conversions into concentrations can also be carried out.
TIME COURSE	The time scan records the absorbance or % transmittance at a wavelength over a defined time.
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 called up, filtered, transmitted and deleted.
INSTRUMENT SETUP	In this mode, user-specific or method-specific settings can be entered: Operator-ID, Sample-ID, Date & Time, Display & Sound, Power Management, PC & Printer and Password.

5.2 Instrument Setup Mode



1. Select **INSTRUMENT SETUP** in the Main Menu.

A number of options are displayed to configure the basic instrument settings.

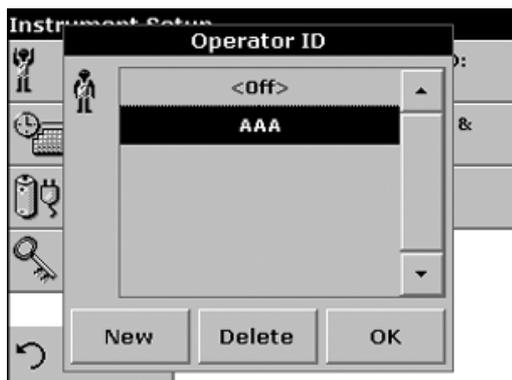
5.2.1 Setting the Operator ID



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, press **OPERATOR ID**.
2. Press **NEW** to enter a new Operator ID.
3. Use the alphanumeric keypad to enter a new Operator ID.

Note: Spaces cannot be used in this function. Use underscore symbols instead (on the key **YZ_**).

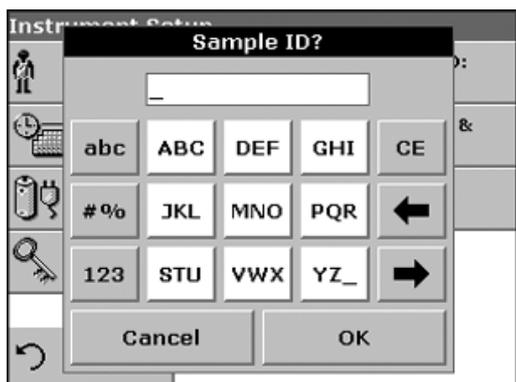
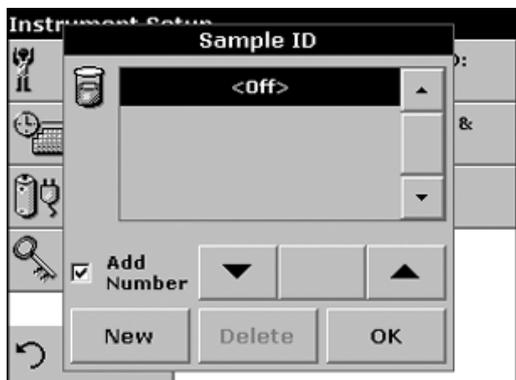


4. Press **OK** to confirm.
5. The display shows the chosen Operator ID.
6. Press **OK**. The instrument will return to Instrument Setup and show the selected operator identifier.
7. Operator ID is activated.

Note: To remove an Operator ID, highlight the ID and press **DELETE**.

Note: Alternatively, an Operator ID can be entered or changed in measurement mode. In the results screen, press **OPTIONS>MORE>INSTRUMENT SETUP**. If an Operator ID is already assigned, select the Operator ID symbol in the results screen.

5.2.2 Setting the Sample ID



Use this option to enter up to 30 Sample Identification tags (up to 13 characters each) into the instrument. Sample IDs can be used to specify the sample location or other sample specific information.

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

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

Note: Spaces cannot be used in this function. Use underscore symbols instead (on the key **YZ_**).

4. Press **OK** to confirm.

5. To number the Sample IDs sequentially (e.g. Inflow (01... etc.)), select Add Number.

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

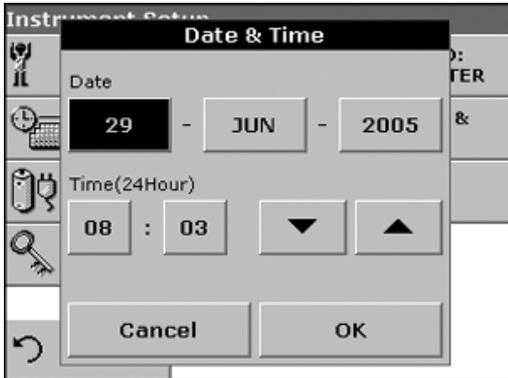
6. Press **OK** to return to the Instrument Setup menu.

7. The Sample ID is activated. Each Sample ID is automatically numbered in ascending order after a measurement. The number is shown in parentheses behind the Sample ID.

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

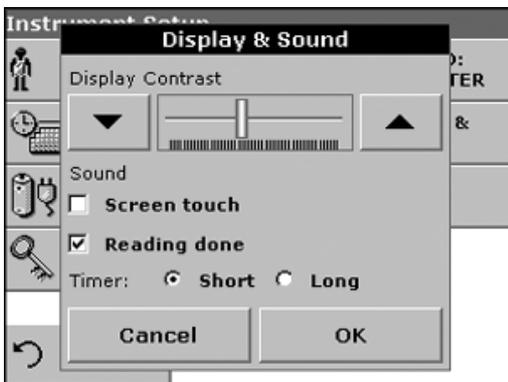
Note: Alternatively, a Sample ID can be entered or changed in measurement mode. In the results screen, press **OPTIONS>MORE>INSTRUMENT SETUP**. If a Sample ID is already assigned, select the Sample ID symbol in the results screen.

5.2.3 Setting the Date and Time



1. From Instrument Setup, press **DATE & TIME**.
2. The date and time are subdivided over a number of fields. Press the appropriate field and use the arrow keys to change the highlighted value.
3. Press **OK** to confirm. The instrument will return to Instrument Setup.

5.2.4 Setting the Display and Sound Preferences



1. From Instrument Setup, press **DISPLAY & SOUND**. The following options will be displayed:
 - 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. The instrument will return to Instrument Setup.

5.2.5 Setting the Power Management Options

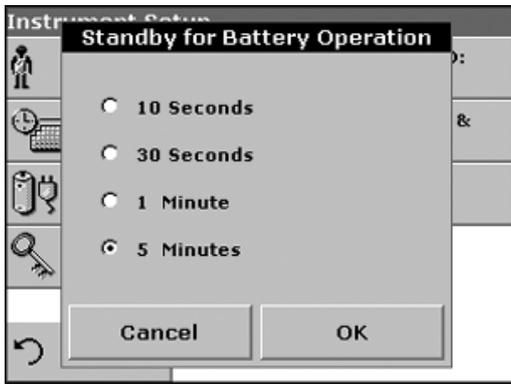
The power management option places the instrument in a standby mode or shuts the instrument off automatically after an idle period to prolong battery life. The battery is an optional accessory and is not included with the instrument.



1. From Instrument Setup, press **POWER MANAGEMENT**. The battery symbol indicates the battery life in %.

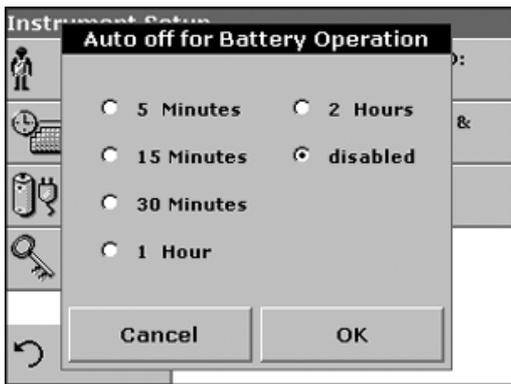
Note: The timer settings are only available when the instrument is using battery power.

Standard Operations



2. Select one of the options under Standby mode to set the length of the idle period that can elapse before the instrument switches to the Standby mode. Press **OK**.

Note: In Standby mode, the instrument backlight is turned off. To return the instrument to active operation, touch anywhere on the display.



3. Select one of the options under Auto off to set the length of the idle period that can elapse before the instrument automatically switches off. Press **OK**.

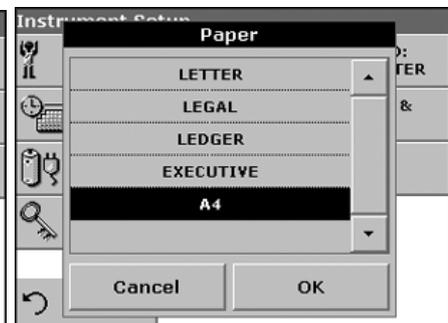
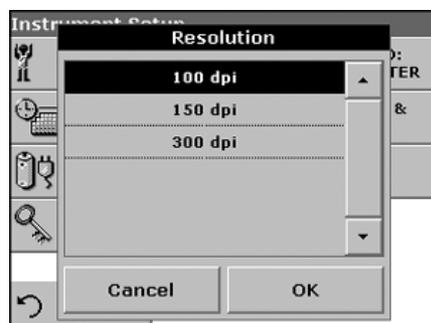
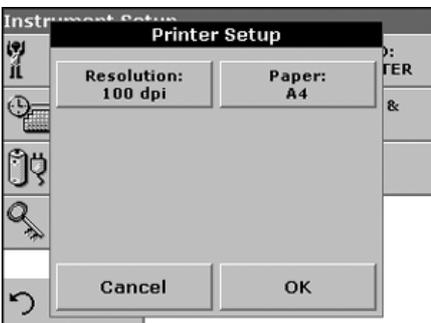
5.2.6 Printer and PC Communications

5.2.6.1 Printer Setup

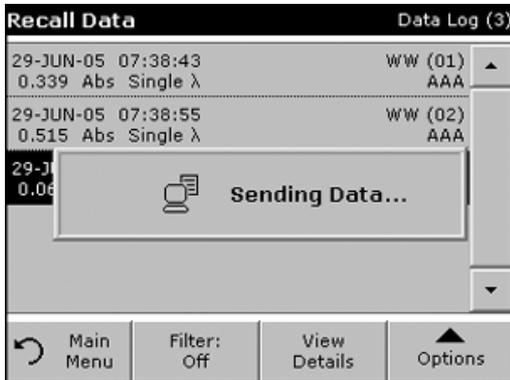


Note: For compatibility, the printer language must be HP PCL 3.

1. From Instrument Setup, press **PC & PRINTER**. A list of connection information will be displayed.
2. Press **PRINTER**.
3. Press **SETUP** to display the Printer Setup screen.
4. Select the resolution (100, 150, 300 dpi) and paper size (letter, legal, ledger, executive, A4). Press **OK** to confirm and press **OK** again to return to the Instrument Setup menu.



5.2.6.2 Printing Data



1. From the Main Menu, press **RECALL DATA**.
2. Select the data source, where the data to be printed are stored.
3. Select the data record that is to be printed from this list.
4. Press the **PRINTER** icon to send the data (table, graph) immediately to the printer.
5. Activate Single point, Filtered data, or All data and press **OK**. "Sending Data" is displayed until the data have been printed.

5.2.7 Setting Security Options (Password Protection)

The Password menu contains a variety of security settings to control access to various functions.



1. From Instrument Setup, press **PASSWORD**.
2. Select **SET PASSWORD** to activate the Security List.
3. Use the alphanumeric keypad to enter a new Password (up to 10 characters) and press **OK**. Access to the Security List is activated.



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

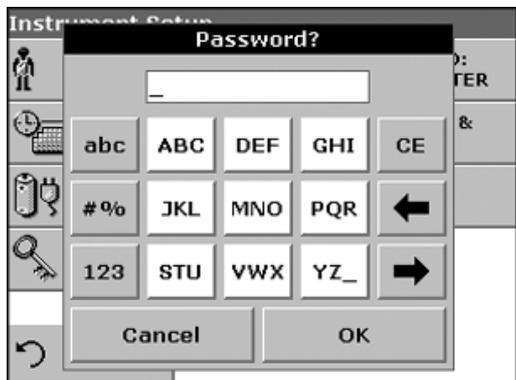


5. Activate the desired functions to control. Press **OK** to confirm the Security List. The Password menu will be displayed.
6. Press **ON** to activate the new settings of the Security List.
7. Enter the new Password again to confirm.
8. Press **OK** to return to Instrument Setup.

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

Standard Operations

5.2.7.1 Deleting or Changing a 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 back to the Password menu. Set a new password, refer to [section 5.2.7 on page 27](#).

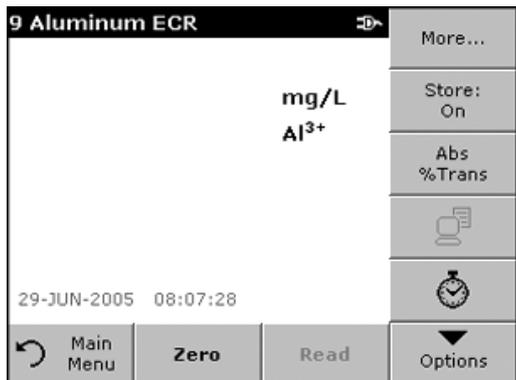
5.3 Storing, Recalling, Sending and Deleting Data

5.3.1 The Data Log

The Data Log will store up to 500 readings taken in the following modes: Stored Programs, Barcode 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

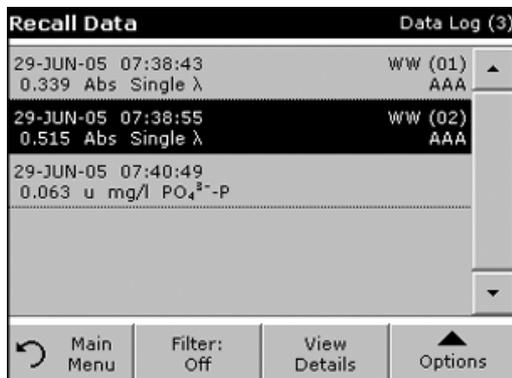
The data storage parameter indicates whether data are to be stored automatically or manually (in which case the user has to decide which data to store).



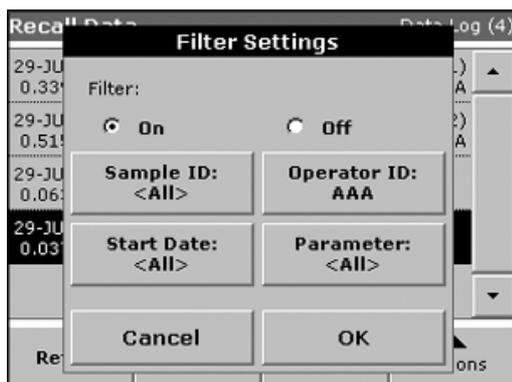
1. From the Options menu, press **STORE: ON/OFF**.
 - With the Store On setting, all measurement data are stored automatically.
 - With the Store Off setting, no measurement data are stored. However, this setting can be changed to Store On in the result display through Configuration. The reading currently shown in the display is then stored.

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

5.3.1.2 Recalling Stored Data from the Data Log



1. From the Main Menu, press **RECALL DATA**.
2. Press **DATA LOG**. A listing of the stored data is displayed.
3. Press **FILTER: ON/OFF**.



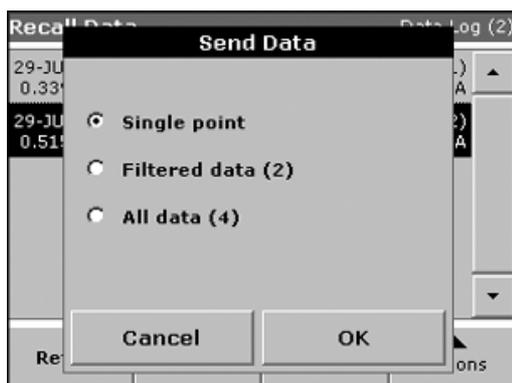
4. The function Filter Settings is used to search for specific items.
5. Activate On to turn on the filters to select data by Sample ID, Operator ID, Start Date, Parameter, or any combination of the four.
6. Press **OK** to confirm. The chosen items are listed.
7. Press **VIEW DETAILS** to get more information.

5.3.1.3 Sending Data from the Data Log

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

"DLYear_Month_Day_Hour_Minute_Second.CSV".

To send data to a printer, refer to [section 5.2.6.2 on page 27](#).

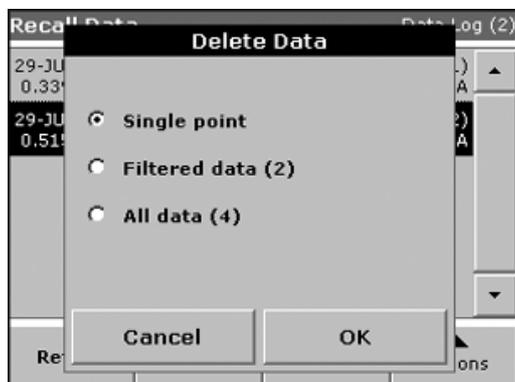


1. Plug in the USB device ([Figure 2 on page 11](#)).
2. From the Main Menu, press **RECALL DATA**. Press **OPTIONS** and then the **PC & PRINTER** icon.
3. Select the data to send to the memory stick and press **OK**.

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

Standard Operations

5.3.1.4 Deleting Stored Data from the Data Log



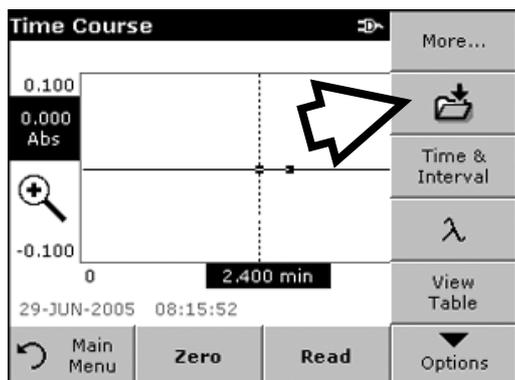
1. From the Main Menu, press **RECALL DATA**.
2. Press **DATA LOG>OPTIONS** and then **DELETE**.
3. Activate Single Point or Filtered data or All data and press **OK**.

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

5.3.2 Time Course

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

5.3.2.1 Data Storage from Time Course



1. After a reading is taken in Time Course mode, press **OPTIONS>STORE**. The Store Data List will display.

Date	Time	Wavelength	Duration
29-JUN-05	07:52:10	560 nm	5 min
29-JUN-05	07:52:10	560 nm	5 min
Run 3			
Run 4			
Run 5			

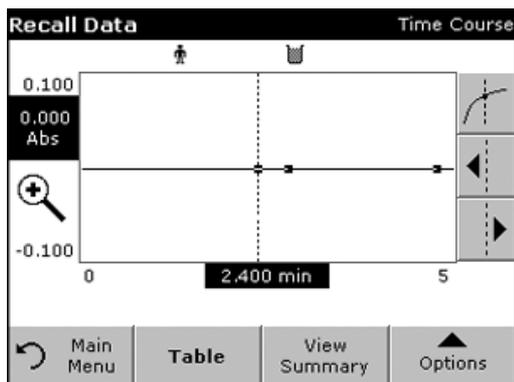
2. Press **STORE** to save the current scan to the highlighted numbered line. A scan can also be overwritten.

5.3.2.2 Recalling Stored Data from Time Course

Recall Data			Time Course
29-JUN-05	07:52:10		▲
Run 1	560 nm	5 min	
29-JUN-05	07:52:10		
Run 2	560 nm	5 min	
29-JUN-05	08:15:46		
Run 3	560 nm	5 min	
Run 4			
Run 5			▼

Main Menu Table Graph Options

1. From the Main Menu, press **RECALL DATA**. Select **TIME COURSE** to display the required data. If the program is already running, press **OPTIONS>MORE>RECALL DATA**.



2. Press **GRAPH** or **TABLE** to view data in a graph or table.

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

Recall Data			Time Course
min	Abs	Mark	
1.200	0.000		▲
1.600	0.000		
2.000	0.000		
2.400	0.000		
2.800	0.000	Mark	
3.200	0.000		▼

Main Menu View Summary Graph Options

5.3.2.3 Sending Data from Time Course

Recall Data			Time Course
29-JUN-05 07:52:10	Run 1	560 nm 5 min	▲
29-JUN-05 07:52:10	Run 2	560 nm 5 min	
29-JUN-05 08:15:46	Run 3	560 nm 5 min	
Run 4			Delete
Run 5			🖨️
↻ Main Menu	Table	Graph	Options ▼

Option1

The files will be automatically sent as CSV files (Comma Separated Value) to a "TCData" (Time Course Data) file, which can be processed using a spreadsheet program. The file name will be formatted as: "TCData_X.csv" X = number of scans (1-20).

1. From the Main Menu, press **RECALL DATA** and then **TIME COURSE** to send the data to a USB memory stick or to a printer.
2. Press **OPTIONS**, and then the **PC PRINTER** icon to print the data.

Options	
Scale & Units	🖨️ Send Data
Return	📁 Recall Data Instrument Setup

Option 2

The files will be automatically sent as CSV files (Comma Separated Value) to a "TCData" (Time Course Data) file, which can be processed using a spreadsheet program. The file name will be formatted as: "TCYear_Month_Day_Hour_Minute_Second.CSV" (Time Course Data)

1. Press **TIME COURSE** and then **OPTIONS>MORE>SEND DATA** to send the data to a USB memory stick or to a printer.
2. Press **OPTIONS**, and then the **PC PRINTER** icon to print the data.

5.3.2.4 Deleting Stored Data from Time Course

Recall Data			Time Course
29-JUN-05 07:52:10	Run 1	560 nm 5 min	▲
Run 2			
29-JUN-05 08:15:46	Run 3	560 nm 5 min	
Run 4			Delete
Run 5			🖨️
↻ Main Menu	Table	Graph	Options ▼

1. From the Main Menu, press **RECALL DATA** and then **TIME COURSE** or from the Options menu, **MORE>RECALL DATA**. A listing of the stored data is displayed.
2. Highlight any data to be deleted.
3. Press **DELETE** in the Options menu and press **OK**.

5.4 Stored Programs

The DR 2800 Spectrophotometer contains more than 200 programmed procedures that you can access through the Stored Programs menu.

5.4.1 Selecting a Stored Program

Stored Programs		
10	Aluminum Alumin.	0.800 mg/L
9	Aluminum ECR	0.250 mg/L
20	Barium	100 mg/L
30	Benzotriazole	16.0 mg/L
40	Boron	14.0 mg/L
45	Boron LR	1.50 mg/L
50	Bromine	4.50 mg/L
55	Bromine AV	4.50 mg/L
395	CD 2	6.00 g/l
395	CD 3	9.00 g/l

	Main Menu	Select by Number	Program Options	Start
--	-----------	------------------	-----------------	-------

1. From the Main Menu, press **STORED PROGRAMS** to view an alphabetical list of stored programs with program numbers.
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 specific program number. Use the alphanumeric keypad to enter the test number and press **OK**.
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.
4. Follow the chemical procedures described in the corresponding Procedures 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** for Parameter Setup. Refer to [Table 3](#) for stored program descriptions.

10 Aluminum Alumin.		More...
mg/L		Store: On
Al ³⁺		Abs %Trans
29-JUN-2005 08:18:13		
	Main Menu	Zero
		Read
		Options

Options			
	Send Data		Dilution Factor: Off
	Standard Additions		Standard Adjust: Off
	Chemical Form: Al ³⁺		Reagent Blank: Off
	Save as User Program		
Return		Recall Data	Instrument Setup

Table 3 Stored Program Options

Options	Description
Store Off/On	With STORE ON selected, all measurement data are stored automatically. With STORE OFF selected, no measurement data are stored.
% Trans/Conc/Abs	Switches to % transmittance, concentration, or absorbance readings
Send Data icon	Sends data to a printer, computer, or USB memory stick (Type A)
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 timer has no influence on the measurement program.

Table 3 Stored Program Options (continued)

Options	Description
Dilution Factor Off/On	A corrective dilution factor can be entered in order to take account of 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. Note: When a dilution is in effect, the DILUTION icon will appear on the display.
Standard Additions	Enables the accuracy of the measurements to be checked. The working procedure for a test parameter contains a detailed explanation of how to use this function.
Standard Adjust	The working procedure for a test parameter indicates whether a standard adjustment is necessary and, if so, how to proceed. Adjusts the pre-stored calibration for variations between reagent lots or instrument variation.
Chemical Form	For some stored programs, an alternate chemical form and corresponding test 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, without changing the shape or gradient of the curve. The effect corresponds to a y-axis intercept of the calibration straight line. This is made clear by the following equation: Concentration = [(Conc. factor) * Abs] – (reagent blank value).
Save as User Program	Stores the selected parameters as a User Program, see section 6.1 on page 47 .
Recall Data	Recalls saved measurement data, wavelength scans, or time courses, see section 5.3 on page 28 .
Instrument Setup	Basic operational settings of the instrument, see section 5.2 on page 23 .

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** icon on the display.
2. Press **OK** to start the first timer. The timer will count down on the screen.
3. To start the next timed activity for the Stored Program, press the **TIMER** icon and **OK**. The Timer will beep at the end of the running time.

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

Note: If necessary, press **CANCEL** to terminate the timer midway through the countdown.



A general purpose timer is also available in many programs. When the timer icon is visible, press the icon and select **GENERAL TIMER**. A new screen will appear. Enter the length of the timed interval and press **OK** to start the timer. The timer will beep when the timed interval ends.

5.4.4 Setting the Dilution Factor

The Dilution Factor function is used to calculate the original concentration of a sample that has been diluted by a known ratio. For example, dilution factor can bring the analyzed concentration within the test range.

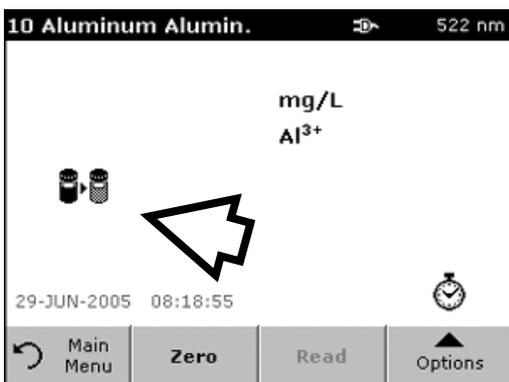


1. Press **OPTIONS>MORE>DILUTION FACTOR**.

The number entered at the dilution factor prompt will be multiplied by the result to compensate for the adjustment and display the concentration of the original (undiluted) sample.

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.

2. Press **OK** to confirm. Press **OK** again.



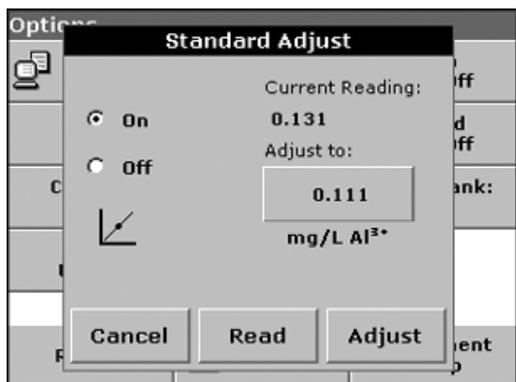
Note: When a dilution is in effect, the dilution icon will appear on the display.

Note: If using undiluted samples, set the dilution factor to 1 again.

5.4.5 Running a Standard Adjust

The Standard Adjust functions allows the calibration curve for a stored program to be adjusted based on analysis of a known standard solution. The Accuracy Check section of written procedures often suggests a standard solution concentration for this purpose.

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, turn it On.

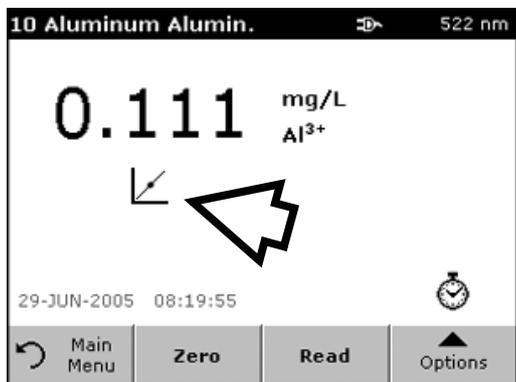
The Current Reading will show the concentration. The box on the right will show the suggested default standard value for the test, as mentioned in the procedure.

4. If the measurement used a standard concentration that is different from the one displayed in the box, press the box on the right to enter a different standard value and enter the new value. Press **OK** to confirm.

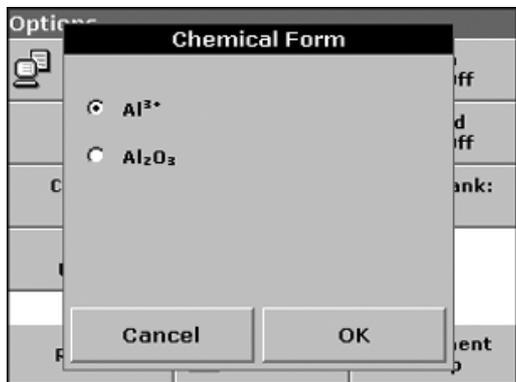
5. Press **ADJUST** to enable the Standard Adjust. The **STANDARD ADJUST** icon will appear.

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

Note: When a Standard Adjust is in effect, the **STANDARD ADJUST** icon will appear on the display.



5.4.6 Setting the Chemical Form



Some Stored Programs allow a variety of chemical forms to be selected.

Press the unit (e.g. mg/L) or the chemical representation of the evaluation form (e.g. Al³⁺). A list of available chemical forms is displayed. Select the required form by pressing the corresponding entry in the list.

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

Note: The stoichiometric conversion of the measurement result is carried out automatically.

Note: The selected Chemical Form will appear on the display. Test results will be calculated and displayed in this chemical form

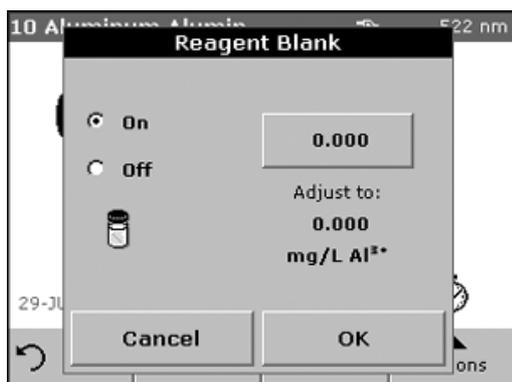
Alternatively, the standard setting can be changed by pressing **OPTIONS>MORE>CHEMICAL FORM**. Select the required form and press **OK**.

5.4.7 Running a Reagent Blank

Some of the stored tests/methods include the "Reagent Blank" function. This enables the reagent blank value to be measured and then taken into account in calculating the measurement result.

Measurement/Analysis of a Reagent Blank

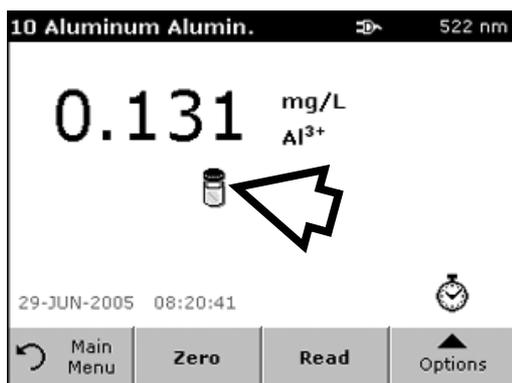
1. Prepare the Test/Method as specified with the working procedure. Instead of a sample, distilled water is used to determine the reagent blank value.
2. Select the test. If required by the working procedure, place the zero solution in the cell compartment. Press **ZERO**.
3. Place the prepared cell in the cell compartment and press **READ**. The result is displayed.
4. Press **OPTIONS>MORE>REAGENT BLANK**.
5. Press **On** to activate the Reagent Blank function.
6. The concentration shown on the key is the measured value of the reagent blank. To use this value for more analyses of this parameter, press **OK**.
7. If the measurement does need to be saved, press the key and use the alphanumeric keypad to enter a previously recorded reagent blank value.
8. Press **OK**.



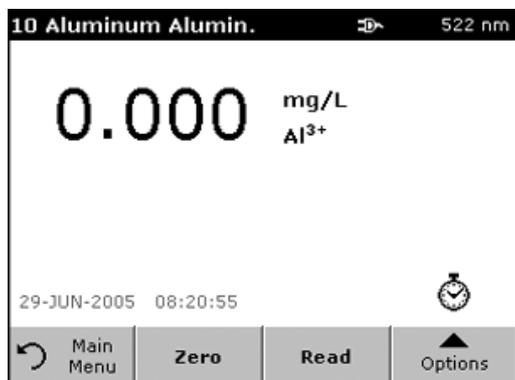
Note: The Reagent Blank function is deactivated when you leave the measurement program. To use the same blank value later for other tests using the same reagent lot, enter the value per step 7.

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

Note: The reagent blank icon is shown in the result display (see arrow) when the function is active.



5.4.8 Analysis of Samples



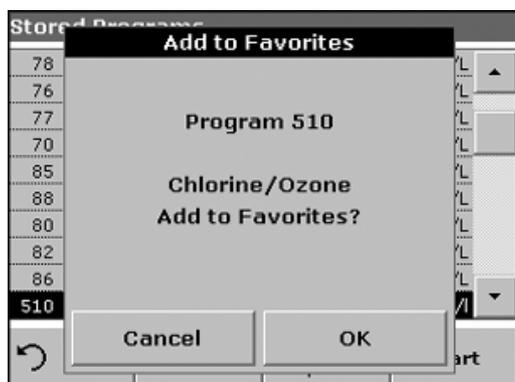
1. Press **STORED PROGRAMS** and select a program.
2. Insert the blank cell into the cell holder.
3. Press **ZERO**.



4. Remove zero solution cell and insert sample cell into the cell compartment. Press **READ**. The result will be displayed.
5. For data storage, see [section 5.3.1 on page 28](#).

5.4.9 Adding Stored Programs to the Favorite Programs List

The Favorites menu simplifies test selection by creating a list of the most frequently used tests from the Stored Programs and User Programs.



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 **ADD TO FAVORITES** and press **OK** to confirm.
4. The program can now be selected from **FAVORITE PROGRAMS** on the Main Menu.

5.5 Barcode Programs

A special barcode reader in the cell compartment automatically reads the coded information on each TNTplus™ (13-mm) vial while the vial completes a single rotation (Figure 10). The instrument uses the barcode identification to automatically set the correct wavelength for the analysis and calculates the result immediately with stored calibration information.

Multiple points around the vial are measured during the rotation. Outlier values are recognized and eliminated, and the average of the remaining readings is calculated. This method increases the precision of the measurement results and minimizes errors due to soiling of the vial.

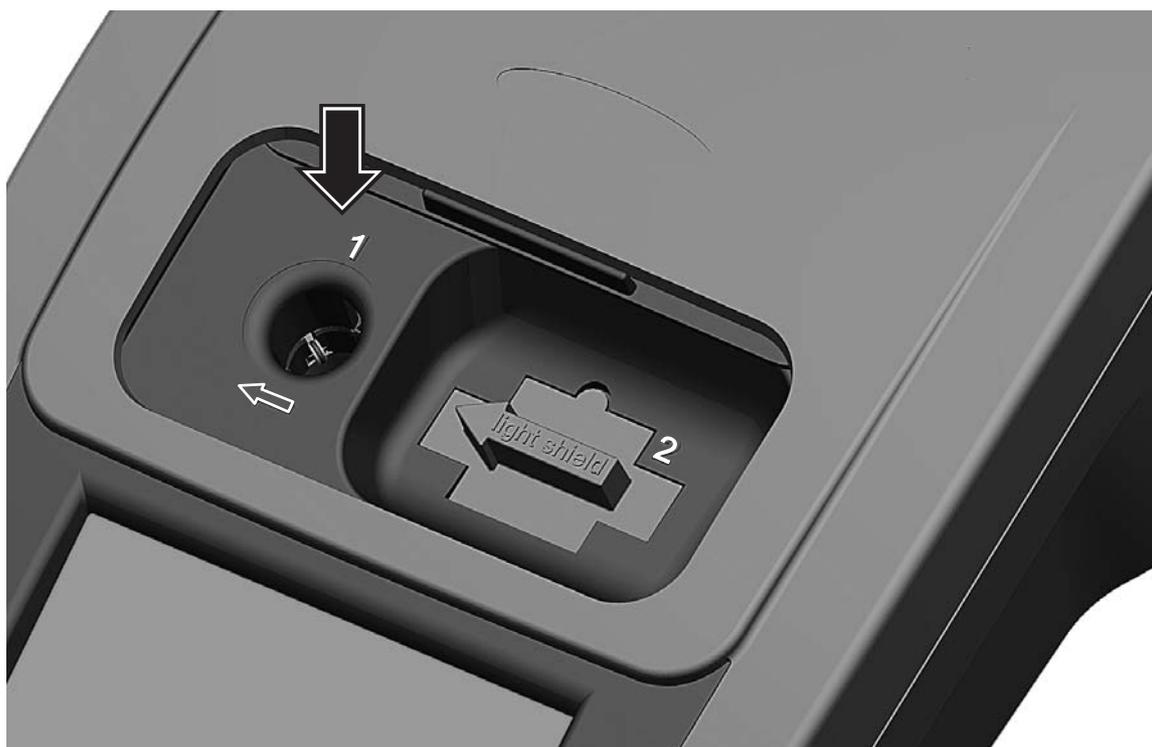
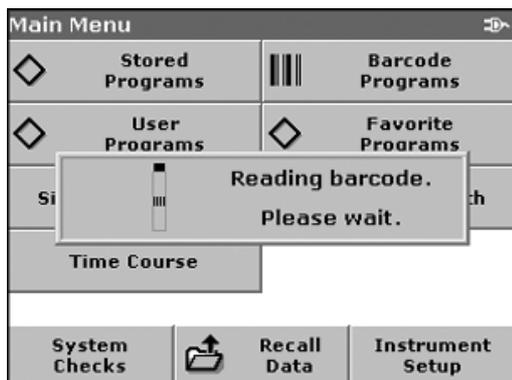


Figure 10 Cell Compartment #1 for 13 mm and 16 mm Round Vials

5.5.1 Performing a TNTplus Test



1. Insert the Light Shield in Cell Compartment #2.
 2. Prepare the TNTplus vial in accordance with the working procedure.
 - a. When a coded cell is placed in Cell Compartment #1 (Figure 10), the corresponding measurement program is activated in the Main Menu.
- OR
- b. From the Main Menu, press **Barcode Programs**.

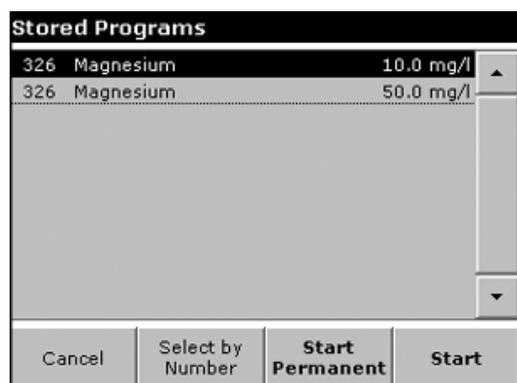


3. Insert the sample cell or blank (depending on the working procedure) into the cell compartment.

The measurement process and the result are displayed automatically.

To evaluate other TNTplus cell tests and other parameters, place the prepared cell in the cell compartment and read the result.

5.5.2 Selecting the Measuring Range



Some tests can be used for different measuring ranges. After the sample cell has been inserted, a list of the different measuring ranges is displayed.

Select the measuring range by pressing the appropriate line.

Press **START PERMANENT** if this measuring range is to apply to all subsequent measurements.

Changing the standard setting

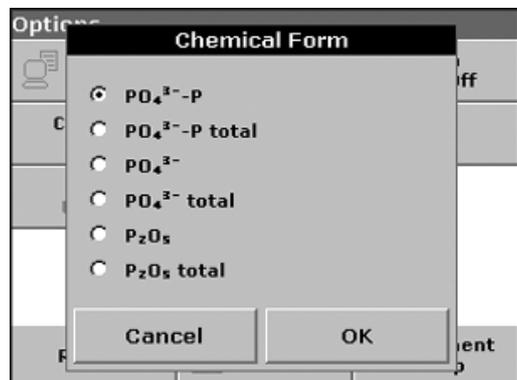
In the result display, press **OPTIONS>MORE>PERMANENT: ON**. The key now reads Permanent: Off.

5.5.3 Selecting the Chemical Evaluation Form

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

1. In the result display, press the unit (e.g. mg/L) or the chemical representation of the evaluation form (e.g. $\text{PO}_4^{3-}\text{-P}$). A list of possible evaluation forms is displayed, from which the required form can be selected. Press **OK** to confirm.

Another way of changing the standard setting is:



1. In the result display, press **OPTIONS>MORE>CHEMICAL FORM**. A list of available evaluation forms appears.
2. Press the required chemical form and confirm with **OK**.

Note: The selected chemical form is displayed, but does not become the default. To change the default form, see [section 5.5.3.1](#).

5.5.3.1 Changing the Chemical Form Default Setting

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

2. In the result display, press **OPTIONS>MORE>CHEMICAL FORM**.
3. A list of available evaluation forms appears. Select the default setting. 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.

5.5.4 Setting Basic Test and Sample Data Settings

1. Press **OPTIONS** to change test or sample specific settings.

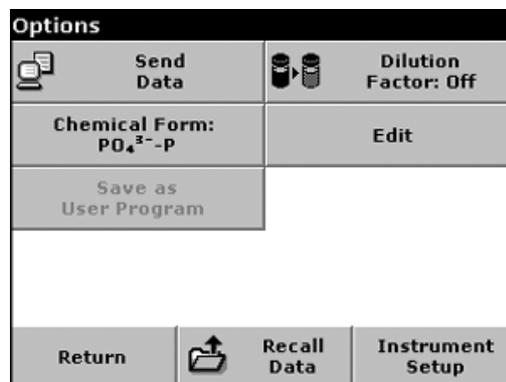
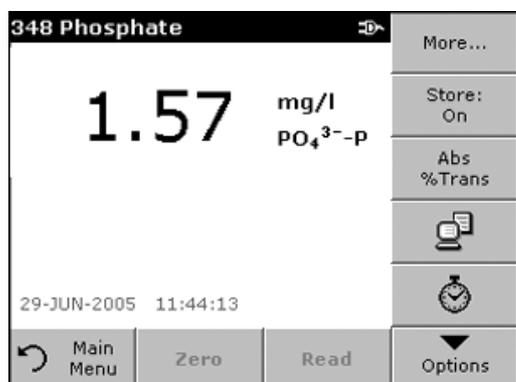


Table 4 Barcode Program Options

Options	Description
Store Off/On	With the Store On setting, all measurement data are stored automatically. With the Store Off setting, no measurement data are stored.
Abs % Trans	Switches to % transmittance or absorbance readings
Send Data icon	Sends data to a printer, computer, or USB memory stick (Type A)
Timer icon	Functions as a stopwatch. 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 acoustic signal is emitted. The use of the timer has no influence on the measurement program.
Dilution Factor Off/On	A corrective dilution factor can be entered in order to take account of 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. Note: When a dilution is in effect, the dilution icon will appear on the display. Note: If you are using undiluted samples, set the dilution factor to 1 again.
Chemical Form	For some stored programs, an alternate chemical form and corresponding text can be selected.
Edit	Modifies an existing program
Save as User Program	Stores the selected parameters as a User Program, see section 6.1 on page 47 .
Recall Data	Recalls saved measurement data, wavelength scans, or time courses, see section 5.3 on page 28 .
Instrument Setup	Basic operation settings of the instrument, see section 5.2 on page 23 .

5.5.5 Sample Blank



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

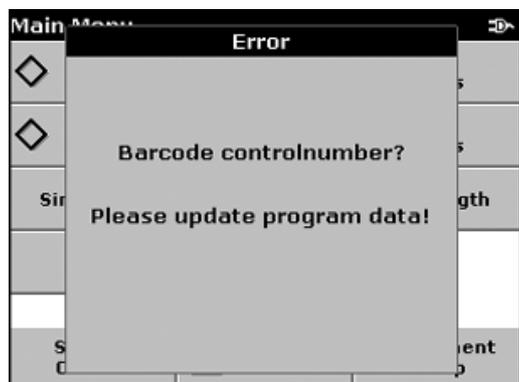
The influence of turbidity and/or color can be eliminated or reduced by taking a sample blank reading.

In the barcode mode, a special cell (LCW919) containing the sample blank is placed in the round cell 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.

5.5.6 Updating a Barcode Test

5.5.6.1 Manually Updating a Barcode Test

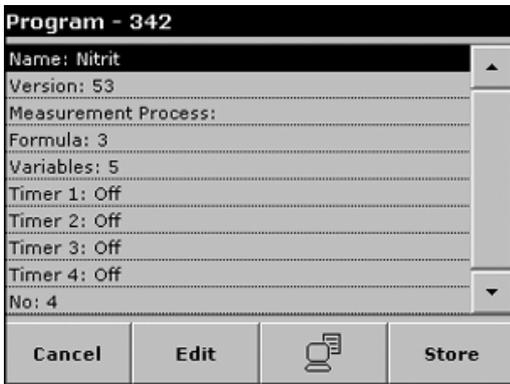


Using the data provided in the barcode, the instrument automatically sets the measurement wavelength and factors. If a discrepancy is detected between the barcode data and the stored data, or a new test is identified, the instrument requests an update.

Data types are described in [Table 5](#). Instructions for editing values are in the sections following [Table 5](#).

Table 5 Program Update Options

Program point	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 carried out, the number of absorbance measurements needed, the keys to be used, any waiting periods between measurements, etc.
Formula	Definition of the 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	This function can be used to enter abbreviations and defined times for up to four timers. Activate the appropriate line and press 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.



Enter the Name

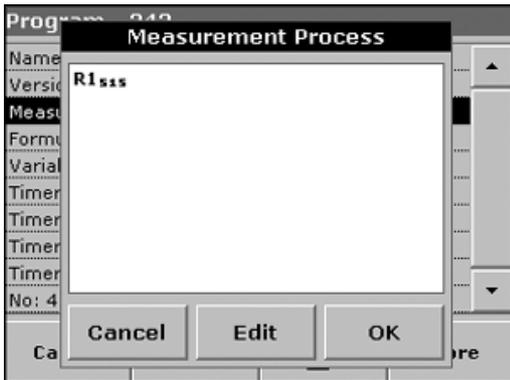
Check the working procedure in advance to determine whether this point needs to be changed.

1. Highlight the line containing Name and press **EDIT**. Use the alphanumeric keypad to enter the name indicated in the working procedure.
2. Press **OK** to confirm.



Enter the Version

1. Activate the line containing Version and press **EDIT**. Use the alphanumeric keypad to enter the name indicated in the working procedure.
2. Press **OK** to confirm.

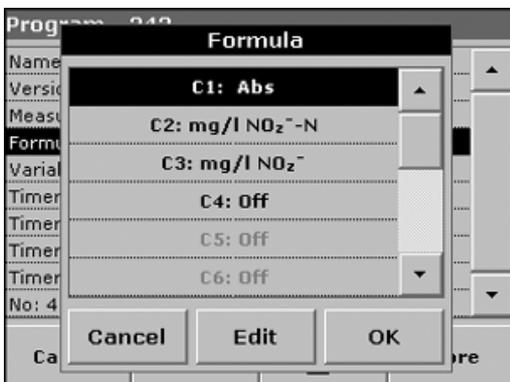


Enter the Measurement Process

For detailed information on entering the measurement process, see [section B.1 on page 91](#).

Check the working procedure in advance to determine whether this point needs to be changed.

1. Activate the Measurement Process line in the data overview and press **EDIT**.
2. Press **EDIT**, select the sequence to be edited and press **DELETE**.
3. Press **NEW** and use the alphanumeric keypad to enter the process indicated in the working procedure.

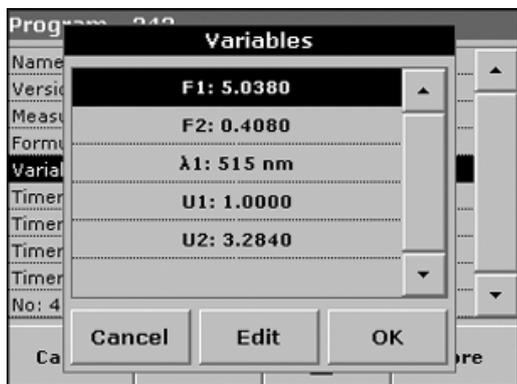


Enter the Formula, Concentration Units, Designation, Measuring Ranges

For detailed information on entering a Formula, see [section B.2 on page 93](#).

Check the working procedure in advance to determine whether this point needs to be changed.

1. Activate the Formula line in the data overview and press **EDIT**.
2. Select the formula to be edited, press **EDIT** and use the alphanumeric keypad to enter the data specified in the working procedure (for C1=, C2=, units, name, measuring range limits, etc.).



Enter the Variables (Factors, Wavelength and Conversion Factors)

For detailed information on entering Variables, see [Appendix B Free Programming on page 91](#).

Check the working procedure in advance to determine whether this point needs to be changed.

1. Activate the Variables line in the data overview and press **EDIT**.
2. Select the variable to be edited, press **EDIT** and use the alphanumeric keypad to enter the data specified in the working procedure (for F1, F2, λ 1, U1 etc.). Confirm each entry with **OK**.

Abbreviation of Variables:

- F1: Factor 1
- F2: Factor 2
- λ 1: Wavelength 1
- U1: Conversion Factor 1 for the first chemical form
- U2: Conversion Factor 2 for additional chemical forms, etc.

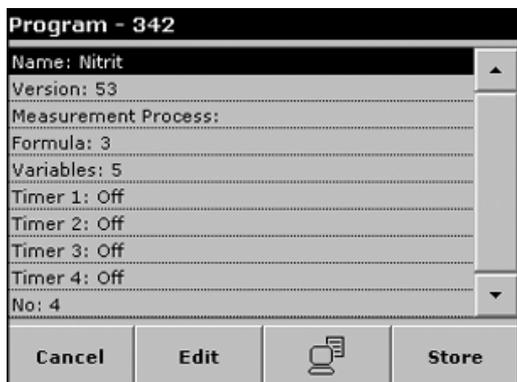


Timer 1, Timer 2, Timer 3, Timer 4:

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.

5.5.6.2 Updating an Existing Barcode Test

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

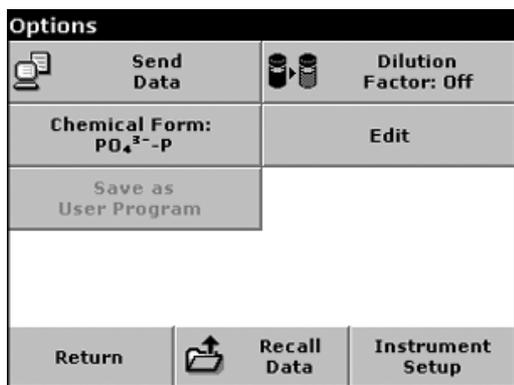


Option 1: Manual Update of Test Data

1. Insert the Light Shield in Cell Compartment #2.
2. The instrument needs to be at the Main Menu or press **BARCODE PROGRAMS** in the Main Menu.
3. Insert the sample cell or blank (depending on the working procedure) into the cell compartment.
4. After "Barcode controlnumber?", a data overview is displayed, including the specifications of the test that is to be revised.

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

5. Highlight the corresponding line and press **EDIT**.
6. When finished programming, press **STORE** and then **CANCEL** to return to the User Programs menu.
7. Press **START** to start the test with the new data.



Option 2: Manual Check/Revision of Test Data

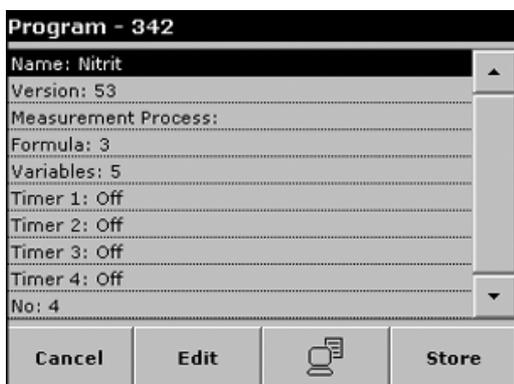
If an incorrect entry was made during the data update and is not recognized via the barcode of the cell (e.g. an incorrect measuring range), another option is available for checking, and if necessary revising, the test data.

1. Insert the Light Shield in Cell Compartment #2.
2. The instrument needs to be at the Main Menu or press **BARCODE PROGRAMS** in the Main Menu.
3. Insert the sample cell or blank (depending on the working procedure) into the cell compartment.
4. Press **OPTIONS>MORE>EDIT**.
5. 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.

5.5.6.3 Programming a New Barcode Test



1. Insert the Light Shield in Cell Compartment #2.
2. The instrument needs to be at the Main Menu or press **BARCODE PROGRAMS** in the Main Menu.
3. Insert the sample cell or blank (depending on the working procedure) into the cell compartment.



4. After "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.).
5. Highlight the corresponding line including the specifications of the test that is to be programmed and press **EDIT**.
6. When finished programming, press **STORE** and then **CANCEL** to return to the User Programs menu.
7. Press **START** to start the test with the new data.

Section 6 Advanced Operations

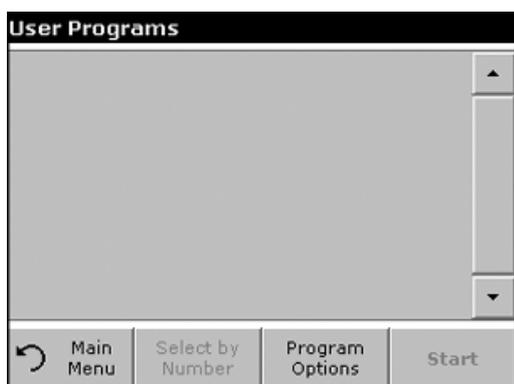
6.1 User Programs

User programs provide the opportunity of performing "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 specific needs. Here are a few examples of entries:

- Programming of user-created procedures. The analysis procedure must be developed first, before it can be programmed. The user must define or determine the program sequences, calculation formulas, measurement wavelengths, factors, measuring range limits, etc.
- Modified tests.
- Assignment of user programs to the favorites menu for frequently used 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 contains several input and editing options ([Table 6](#)).

Table 6 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 an existing user program to the list of frequently used programs.
Edit	Select EDIT to modify an existing user program.
Delete	Select DELETE to remove a program from the list of user programs. The program will be simultaneously deleted from the Favorites list.

6.1.1 Programming a New User Method

All input steps and their significance and options are explained in the following sections.

1. From Program Options, select New.



Program Number:

Specific test number, with which the program can subsequently be called up from the selection list in the User Programs menu or the Favorites menu.

2. Use the alphanumeric keypad to enter a program number between 950 and 999. The lowest available number appears automatically.
3. Press **OK**.

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 the existing program.



Program Name:

4. Use the alphanumeric keypad to enter a program name. The name can be a maximum of 28 characters long. Repeat a key press to select another of the three letter options. Use the underscore key for spaces.
5. Press **BACK** to go to the previous program point or press **NEXT** to continue with the input of the program data.



Program Type:

6. Select the required option ([Table 7](#)) and press **NEXT**.
7. If the Single Wavelength ([section 6.1.1.1 on page 49](#)) or Multi-wavelength ([section 6.1.1.2 on page 50](#)) is selected, define the unit, wavelength, absorbance formula, wavelength λ_x , concentration factor K_x , concentration resolution, chemical form and calibration equation. See [Appendix B on page 91](#) for information on Free Programming parameters.

Table 7 Program Descriptions

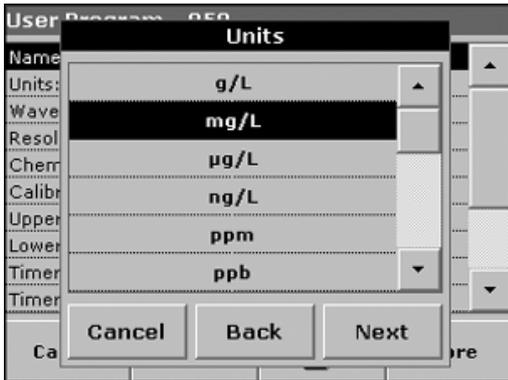
Program Type	Description
Single Wavelength	Measurements at a defined wavelength.
Multi Wavelength	In the Multi Wavelength mode, absorbance values can be measured at up to four wavelengths and the results can be mathematically processed to obtain sums, differences and relationships.
Free Programming	This is an advanced form of programming for original user-developed methods. In Free Programming, the user defines the measurement process, variables, and calculations involved in obtaining a reading. See Appendix B on page 91 for information on Free Programming parameters.

6.1.1.1 Single Wavelength Programming

Selecting Units of Measure

Select the required unit from the list and press **NEXT**.

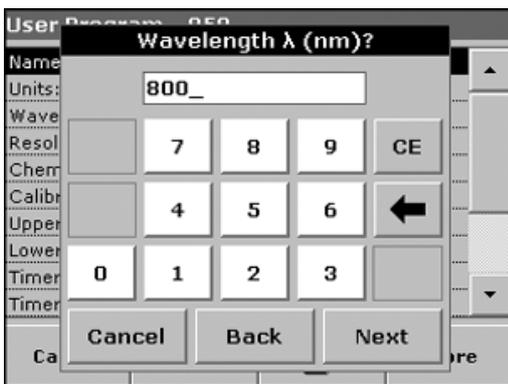
Note: Units of measure not included in this list can be added in the edit program under **PROGRAM OPTIONS>EDIT**. Select **UNITS>EDIT>NEW**. There is no “/” character available.



Defining the Wavelength

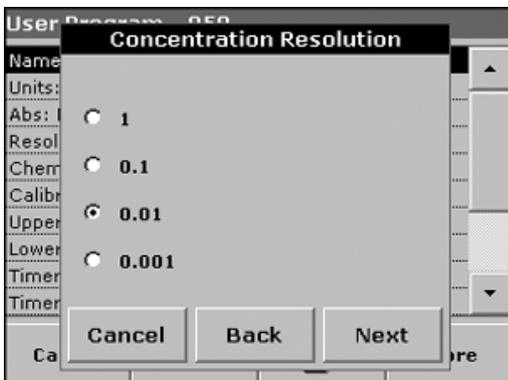
Use the numeric keypad to enter the measurement wavelength. The entered wavelength must be in the range from 340–900 nm.

Press **NEXT** to proceed.



Concentration Resolution

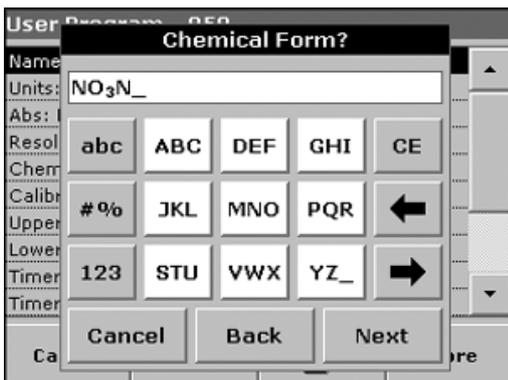
Select the required number of decimal places from the displayed list and press **NEXT**.



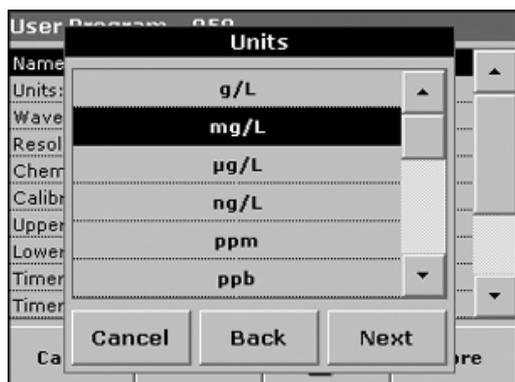
Setting the Chemical Form

Enter the chemical formula used in the display to represent the analysis parameter.

Use the alphanumeric keypad to enter the chemical form and press **NEXT** to enter Calibration settings. Go to [section 6.1.1.3 on page 51](#) to continue with Calibration.



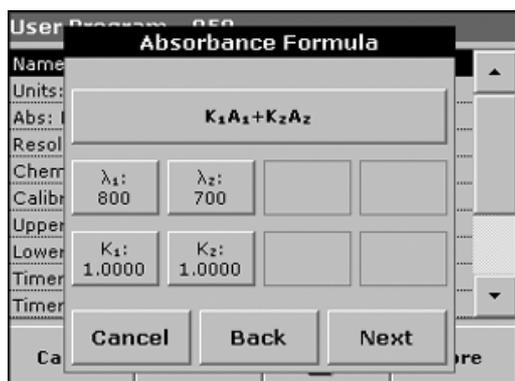
6.1.1.2 Multi-wavelength Programming



Units of Measure

Select the required unit from the list and press **NEXT**.

Note: A user-specific unit that is not included in this list can be added in the edit program under **PROGRAM OPTIONS>EDIT**.



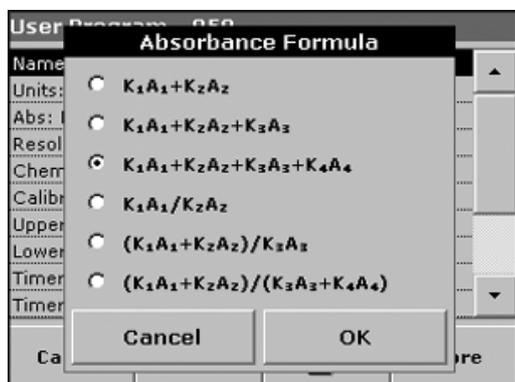
Absorbance Formula

The Absorbance Formula menu is used to define the wavelengths and the coefficients used in the formula. The absorbance formula defines the calculation for the multi-wavelength measurement.

Press the appropriate key to edit the input.

Press the **FORMULA** key.

In the displayed list, select the formula for the program and press **OK** to confirm.



List of available Absorbance Formulas

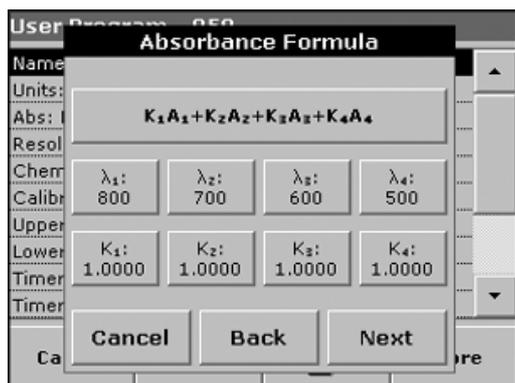
A_1 is the absorbance at wavelength 1,

A_2 is the absorbance at wavelength 2 and so on

K_1 is the factor at wavelength 1,

K_2 is the factor at wavelength 2, and so on

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



Wavelength λ_x (Multi-wavelength)

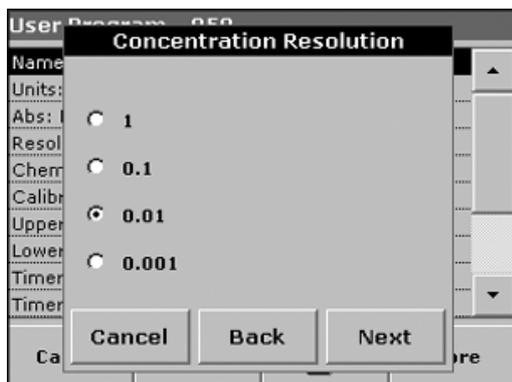
Press a λ_x key and use the alphanumeric keypad to enter a wavelength. Press another λ_x key and enter the next wavelength. If necessary, repeat until all the wavelengths for the formula have been entered. The wavelengths must be in the range from 340 - 900 nm. Press **OK**.

Concentration Factor K_x (Multi-wavelength)

Multiplication factor for converting absorbance values into concentration values.

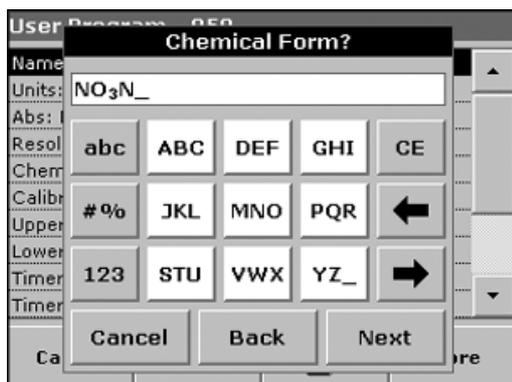
Press a factor key and use the alphanumeric keypad to enter a factor. If the formula includes more than one factor, press another factor key and enter another factor, and repeat until all the factors have been entered. Press **OK**. When all the relevant data have been entered, press **NEXT**.

Note: Up to five digits can be entered, including a maximum of 4 decimal places to the right of the decimal.



Concentration Resolution (Single and Multi-wavelength)

Select the required number of decimal places from the displayed list and press **NEXT**.



Chemical Form (Single and Multi-wavelength)

Chemical representation of the analysis parameter in the result display.

Use the alphanumeric keypad to enter the chemical form and press **NEXT** to enter Calibration settings (see [section 6.1.1.3 on page 51](#)).

6.1.1.3 Calibration Settings for Single and Multi Wavelength Mode

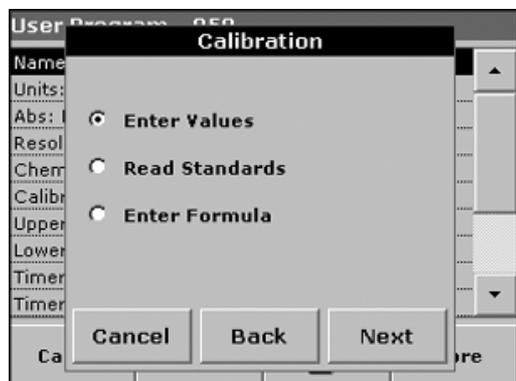
A method is calibrated by determining the absorbance values of several standard solutions of known concentration.

There are three ways to create and store a calibration curve. Instructions for each method follows [Table 8](#).

Table 8 Calibration Settings

Mode	Descriptions
Enter Values	A calibration table is created by entering the concentration values and the absorbance values of the analyte solution. The absorbance values are plotted versus standard concentrations and the calibration curve is displayed as a graph (page 52).
Read Standards	A calibration table is created by entering the concentration values of the standard solutions and then measuring the absorbance of the analyte solutions. The absorbance values are plotted versus standard concentrations and the calibration curve is displayed as a graph (page 53).
Enter Formula	If the calibration curve can be determined from the mathematical relationship between concentration and absorbance by linear regression, etc., the corresponding formula can be selected (linear, 2nd or 3rd order polynomial) from a list and the appropriate factors can be entered (page 54).

Calibration by Entering Calibration Values



1. Select the Enter Values and press **NEXT**.

Calibration Values	
mg/L	Abs
0.0000	0.000
1.0000	0.200
2.0000	0.400
3.0000	0.600
4.0000	0.800
5.0000	1.000

2. To enter the standard concentrations and corresponding absorbance values in the displayed table, press the "+" symbol. Use the alphanumeric keypad to enter the values.

Note: For faster data entry, enter all the concentration values, then all the absorbance values, or vice versa.

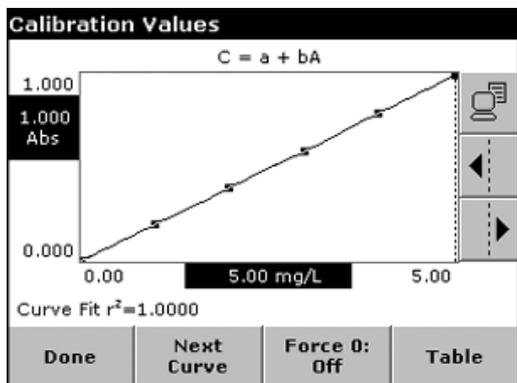
Press **OK** and enter the corresponding absorbance value. Press **OK**.

The entered data are displayed in the table. Repeat the sequence for each data point you need to enter.

3. To change a value in the table, activate the appropriate line, press the unit key (e.g. mg/l) or Abs and enter the changed value via the alphanumeric keypad.

4. When the data have all been entered, press **GRAPH** to display the curve that results from plotting the entered data.

Note: The correlation coefficient (r^2) is shown on the left below the axes.

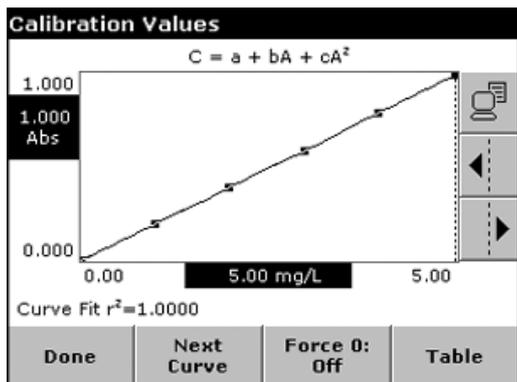


5. The linear equation corresponds to the standard setting. Press **NEXT CURVE** to display the polynomial 2nd order curve. Press **NEXT CURVE** again, to display the polynomial 3rd order curve.

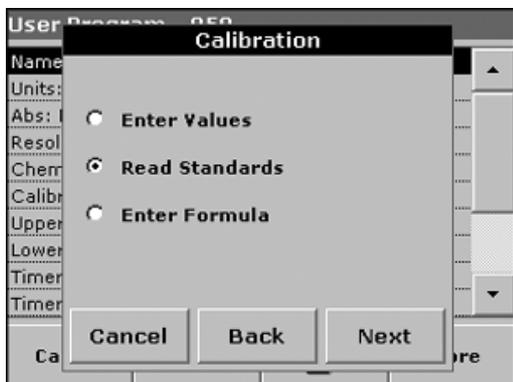
6. Press **FORCE 0** to change the setting from Off to On. The curve now passes through the origin of the coordinate system.

7. Press **TABLE** to display the table again.

8. When the table has been completed and the curve type has been chosen, press **DONE** when the graph is displayed or **EXIT** when the table is displayed. Go to [section 6.1.1.4 on page 54](#).



Calibration by Reading Standards



Read Standards	
mg/L	Abs
0.0000	0.000
1.0000	0.200
2.0000	0.400
3.0000	0.600
4.0000	0.800
5.0000	1.000

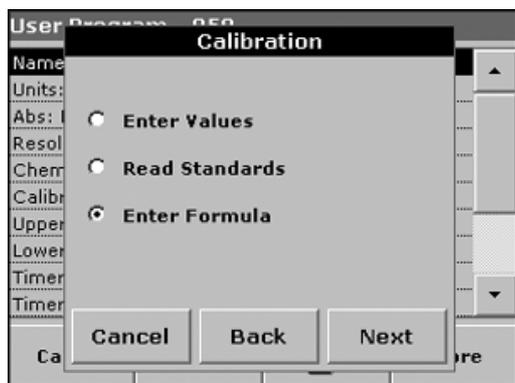
Exit Zero Read Graph

1. Select Read Standards and press **NEXT**.
2. To enter the standard concentrations in the displayed table, press the "+" symbol. 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) have been entered.
4. Highlight the appropriate concentration line for the first standard and insert the cell with the corresponding standard solution.
5. Highlight the zero concentration line. Place the zero solution in the cell compartment. Close the compartment. Press **ZERO**.
6. Highlight the appropriate concentration line for the first standard and insert the cell with the corresponding standard solution. Press **READ**.
7. Highlight the second standard line. Place the second standard solution in the cell compartment. Press **READ**. Repeat this sequence until all the standard solutions have been measured (maximum of 24 solutions).

The entered and measured data are displayed in the table.

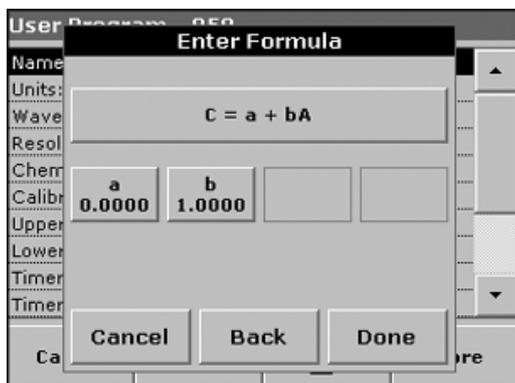
Note: To delete a standard concentration, select the appropriate line and press the Delete icon.

8. When the data have all been entered and the measurements have all been performed, press **GRAPH** to display the curve that results from plotting the entered data.
9. The linear equation 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.
10. Press **FORCE 0** to change the setting from Off to On. The curve then passes through the origin of the coordinate system.
11. Press **TABLE** to display the table again.
12. When the table has been completed and the curve type has been chosen, press **DONE** when the graph is displayed or **EXIT** when the table is displayed. Go to [section 6.1.1.4 on page 54](#).



Calibration by Entering the Formula

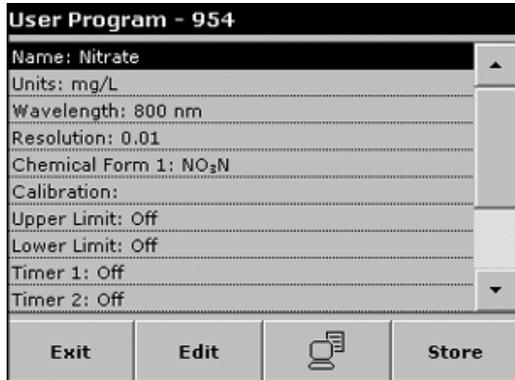
1. Select Enter Formula and press **NEXT**.



2. Press the formula key (key that contains an equation).
A list of available formulas (linear and 2nd and 3rd order polynomial) is displayed. Up to 4 coefficients can be entered, depending on the selected formula. Press the required formula.
3. Depending on the selected formula, the required coefficients (a, b, c...) are displayed. Press the coefficient keys and enter the corresponding values via the alphanumeric keypad. After each entry, press **OK** to confirm.

Note: The coefficients can have up to 5 digits and can have a positive or a negative sign.

6.1.1.4 Storing a User Program



The input of the basic method data is now complete. An overview of the variable program data is displayed.

1. To enter more specifications or change existing information, highlight the appropriate line and press **EDIT**.
2. Select **STORE** to save the user program.

6.1.1.5 Additional User-defined Parameters and Functions

In addition to the previously defined basic data, additional parameters and functions can be defined for user programs:

- measuring range upper and lower limits
- timer functions
- chemical forms



Upper and Lower limits of the Measuring Range

Enter a maximum (upper) and minimum (lower) measurement value to define when an error message is displayed for readings above the upper limit or below the lower limit.

1. Highlight the appropriate line in the overview of the program data and press **EDIT**.
2. Select **On** and press the **0.000** key to enter the measuring range limit using the numeric keypad. Press **OK** to confirm.



Timer 1 / Timer 2 / Timer 3 / Timer 4:

This function can define time intervals for up to four timers. Timer designations such as Shake, Wait, and Swirl can be assigned.

1. Highlight the appropriate line in the overview of the program data and press **EDIT**.
2. The timers are activated or deactivated with the check boxes in the left part of the display. In the next column, a selection can be made from a list of names that designate the corresponding work step. In the third column, the times for each timer are entered (in mm:ss).

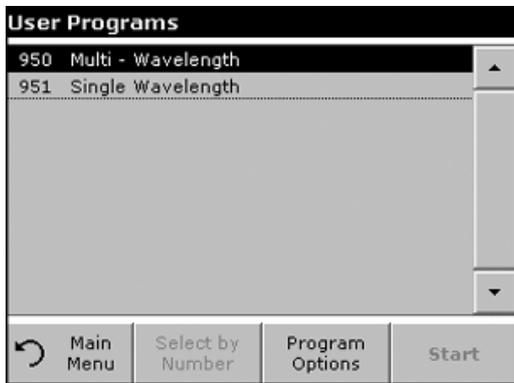


Chemical Form 2 / Chemical Form 3 / Chemical Form 4:

If Chemical Form 1 has been defined, up to three additional alternative forms can be entered.

1. Highlight the appropriate line in the overview of the program data and press **EDIT**.
2. Select or deselect the check boxes to activate or deactivate the chemical forms.
3. Press the left key to enter another chemical form with the alphanumeric keypad and press **OK** to confirm. Press the right key to enter the conversion factor to calculate the concentration of the additional chemical form from the concentration of Chemical Form 1 and press **OK** to confirm.
4. Press **STORE** to save the program data. Press **CANCEL** to return to the Main Menu.

6.1.2 Selecting a User Program



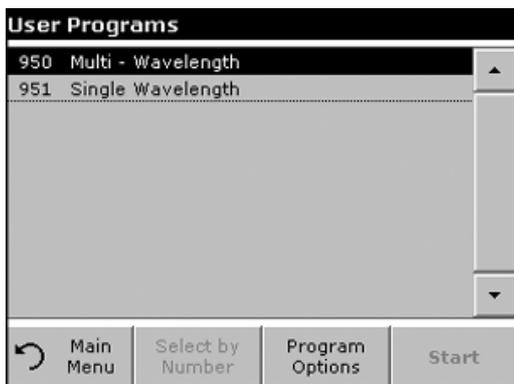
1. From the Main Menu, press **USER PROGRAMS** to view an alphabetical list of user programs with program numbers. The User Programs list will appear.

Note: Highlight the selection by pressing it or press **SELECT BY NUMBER** to search for the program by number.

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

6.1.3 Adding, Editing, and Deleting User programs to the Favorites List

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



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

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

Note: Use the scroll bar to scroll through the list quickly. Use the alphanumeric keypad to enter the test number (program number), and press **OK** to confirm.

3. Press **PROGRAM OPTIONS**.

4. Press **ADD TO FAVORITES**, **EDIT** or **DELETE** and press **OK**.

Note: If the stored program is deleted in User Programs, it will also be deleted in Favorites Programs.



6.2 Standard Additions—Monitoring/Checking Results

Refer to [section 6.2.1 on page 58](#) for instructions on how to perform a standard addition using the DR 2800.

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.

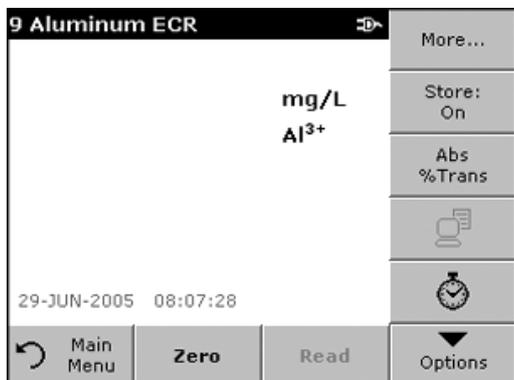
Standard Additions is performed by adding a known amount of a standard solution to a sample. If results are not close to 100% recovery, an identifiable problem exists.

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.

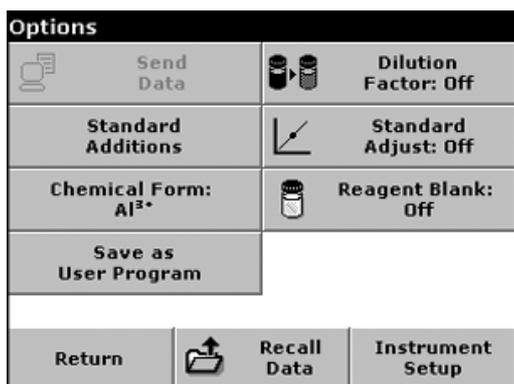
If the results are about 100% recovery for each addition, they are likely correct. Results can be verified by running a standard solution through the test. Poor recovery indicates that a problem exists. For example, to test for interference in the sample, repeat the standard additions using deionized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

1. For poor recoveries with the deionized water, use the following list to find the problem:
 - 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?
2. Consult the procedure in the DR 2800 Procedure Manual to answer these questions.
3. Follow the instructions in [Troubleshooting on page 79](#) to check the performance of the instrument.
4. Check the reagents. Repeat the standard additions using fresh reagents. If the results are now good, the original reagents were probably bad.
5. If nothing else is wrong, the standard is almost certainly bad. Repeat the standard additions with a new standard.
6. If the problem persists, contact Technical Support.

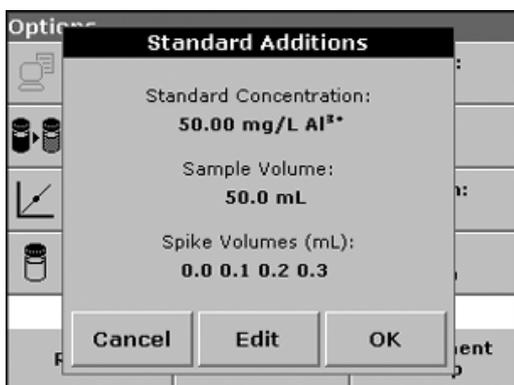
6.2.1 Using the Standard Addition Option



1. From the Main Menu, select **STORED PROGRAMS**. Select the required programs.
2. Press **START**.
3. Analyze a sample without added standard solution in accordance with the instructions in the Procedures Manual. When the measurement is complete, leave the sample cell in the cell holder.

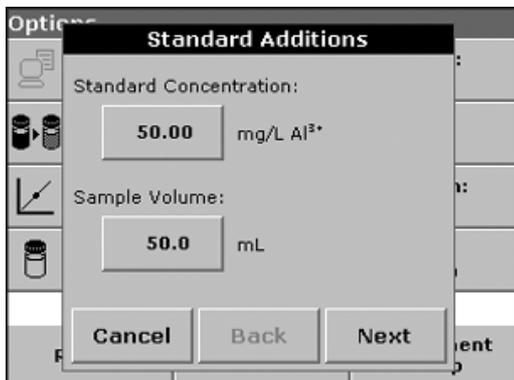


4. Press **OPTIONS>MORE>STANDARD ADDITION**.

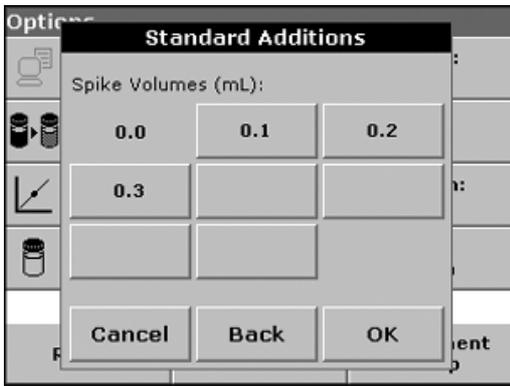


An overview of the data of the standard addition procedure is displayed.

5. Press **OK** to accept the standard values for standard concentration, sample volume (total) and standard addition volume. Press **EDIT** to change any of these values.



6. Press the key of the value you want to change. Use the alphanumeric keypad to change the value and press **OK>NEXT**.



7. Press the keys to enter the standard addition volumes. Use the alphanumeric keypad to enter the new data and press **OK**.

mL Standard	mg/L Al ³⁺	% Recovery
0.0	0.236	100
0.1	0.321	96.6
0.2	0.420	98.1

8. A table of the reading is displayed.

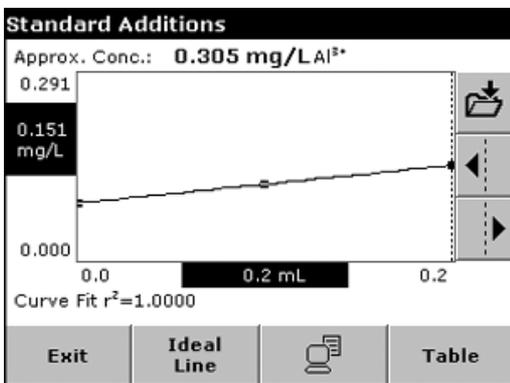
- The first column shows the standard addition volume. 0 mL stands for a sample containing no added standard.
- The second column shows the reading of the samples with and without added standard.
- The third column shows the detection rate of the added standard.
- The black highlighted line is active.

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

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

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

Repeat the procedure from [step 9](#) with all the other standard addition solutions.



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

The regression line through the standard addition data points is displayed.

The correlation coefficient r^2 indicates how close the data points are to the line.

If 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.

Note: Press **TABLE** to display all the data in the table again.

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

6.3 Single Wavelength Mode

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

6.3.1 Setting Up Single Wavelength Mode

1. From the Main Menu, press **SINGLE WAVELENGTH**.
2. Press **OPTIONS** for Parameter Setup.

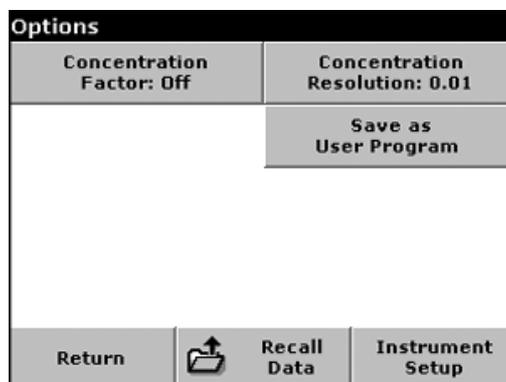
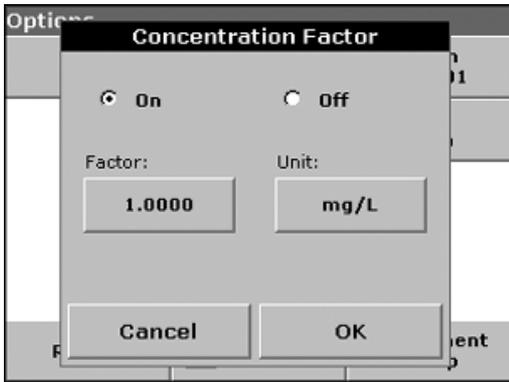


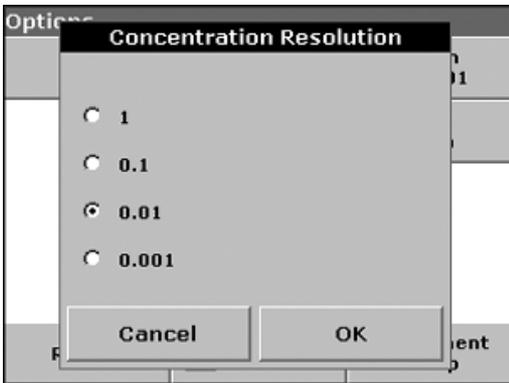
Table 9 Single Wavelength Setup Options

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 (Wavelength)	Enters the measurement wavelength. Use the alphanumeric keypad to enter the measurement wavelength. The entered wavelength must be in the range from 340–900 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	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.
Save as User Program	Stores the selected parameters as a User Program (section 6.1 on page 47)
Recall Data	Recalls saved measurement data, wavelength scans, or time courses (section 5.3 on page 28).
Instrument Setup	Basic operation settings of the instrument (section 5.2 on page 23).



Setting the Concentration Factor

1. From the Options menu, press **CONCENTRATION FACTOR: OFF**. Select On to activate this feature.
2. Press the **FACTOR** key and use the alphanumeric keypad to enter the factor by which absorbance readings are to be multiplied. Press the **UNIT** key to select the units for concentration measurements or to create a new unit.
3. Press **OK** to confirm.



Selecting the Concentration Resolution

1. From the Options menu, press **CONCENTRATION RESOLUTION**.
2. Select the resolution and press **OK**.

6.3.2 Performing a Single Wavelength Measurement



1. Insert the blank cell into the cell holder. Press **ZERO**.
*Note: The **READ** key is only active after the zero measurement has been performed.*
2. Insert the sample cell into the cell holder. Press **READ**.
3. For data storage, see [section 5.3.1 on page 28](#).

6.4 Multi-Wavelength Mode

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.

6.4.1 Setting the Reading Mode at Different Wavelengths

1. From the Main Menu, press **MULTI WAVELENGTH**.
2. Press **OPTIONS** for Parameter Setup.

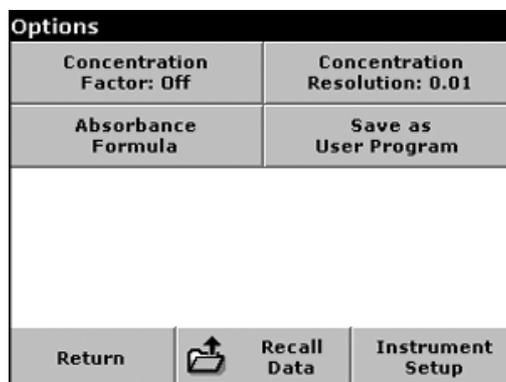
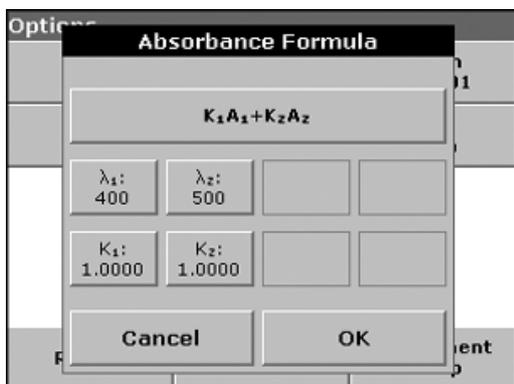


Table 10 Multi-Wavelength Setup Options

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 . 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 (Wavelength)	Enter the measurement wavelengths. Use the alphanumeric keypad to enter the measurement wavelengths. The entered wavelengths must be in the range from 340–900 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	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 (section 6.1 on page 47).
Recall Data	Recalls saved measurement data, wavelength scans or time courses (section 5.3 on page 28).
Instrument Setup	Basic operation settings of the instrument (section 5.2 on page 23).



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, press the top key, select a formula from the displayed list, and press **OK**. When a new formula is selected, the number of variables changes to match.

The following formulas are available:

$$K_1 A_1 + K_2 A_2$$

$$K_1 A_1 + K_2 A_2 + K_3 A_3$$

$$K_1 A_1 + K_2 A_2 + K_3 A_3 + K_4 A_4$$

$$K_1 A_1 / K_2 A_2$$

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

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

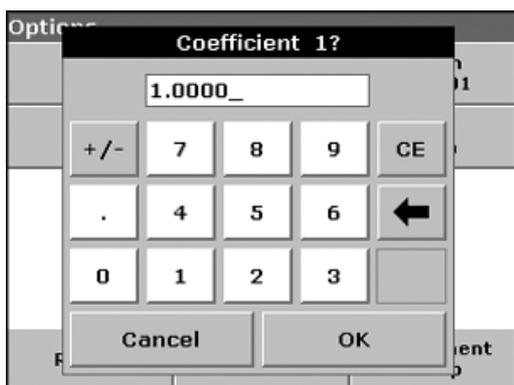
A_1 refers to the absorbance at wavelength 1

A_2 refers to the absorbance at wavelength 2, etc.

K_1 refers to the coefficient at wavelength 1

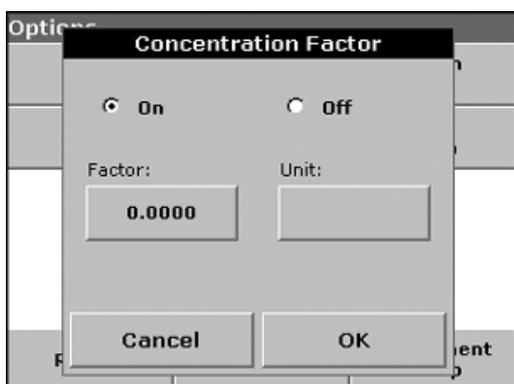
K_2 refers to the coefficient at wavelength 2, etc.

Coefficients can be set negative where subtraction is required.



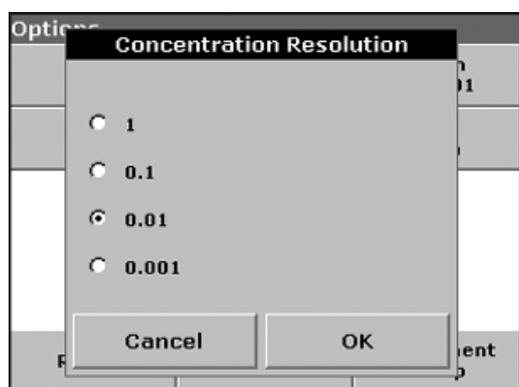
3. To change a wavelength, press one of the "λx:" keys. Enter the desired wavelength into the numeric keypad. Press **OK** to confirm.
4. To change a coefficient, press one of the "Kx:" keys. Enter the desired coefficient into the numeric keypad. Press **OK** to confirm.

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



Setting the Concentration Factor

1. From the Options menu, press **CONCENTRATION FACTOR: OFF**. Select **On** to activate this feature.
2. Press the **Factor** key to enter the factor by which absorbance readings are to be multiplied. Press the **Unit** key to select the units for concentration measurements or to create a new unit.
3. Press **OK** to confirm.



Selecting the Concentration Resolution:

1. From the Options menu, press **CONCENTRATION RESOLUTION**.
2. Select the resolution and press **OK**.

6.4.2 Performing a Measurement in the Multi-Wavelength Mode



1. Insert the blank cell into the cell holder. Press **ZERO**.
*Note: The **READ** key does not become active until the zero measurement has been performed.*
2. Insert the sample cell into the cell holder. Press **READ**.
3. For data storage, see [section 5.3.1 on page 28](#).

6.5 Time Course Mode

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

6.5.1 Time Course Setup Parameters

1. From the Main Menu , press **TIME COURSE**.
2. Press **OPTIONS** to configure parameters.

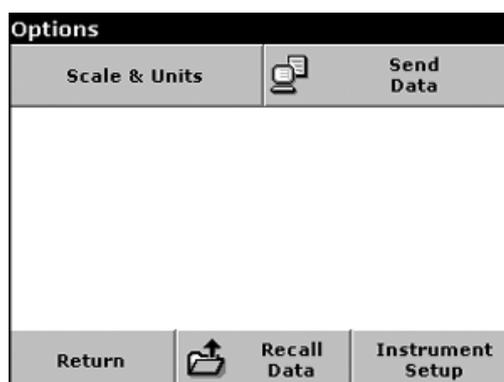
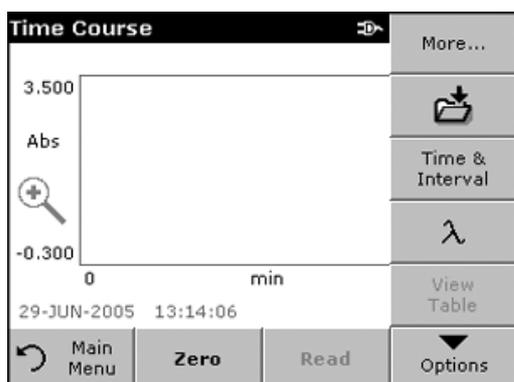


Table 11 Time Course Setup Options

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 (Wavelength)	Enters the wavelength setting.
View Table	Displays readings in absorbance or % transmittance. 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 range 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 on page 28).
Instrument Setup	Basic operational settings of the instrument (section 5.2 on page 23).

Setting the Time and Interval

1. From the Options, press **TIME & INTERVAL**.
2. Input the total time and the reading time and press **OK**.

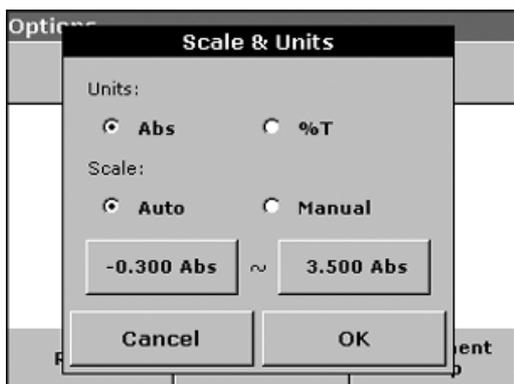
Note: In total 500 measuring steps are possible. If a total time and a time interval is selected that would cause this number of measurements to be exceeded, the time interval is defined automatically and the **OK** key is inactivated.



Setting the Scale and Units

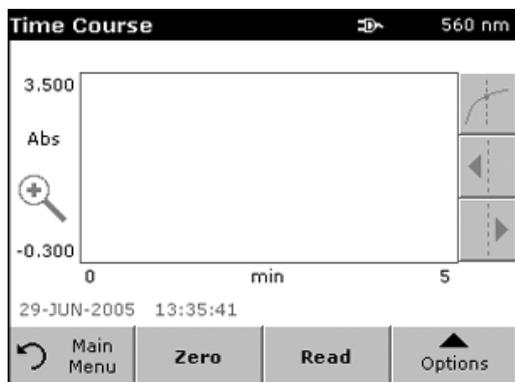
1. From the Options menu, press **SCALE & UNITS**.
2. Select Abs or %T as the required units.
3. Select Auto or Manual scaling on the graph's y-axis.

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



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

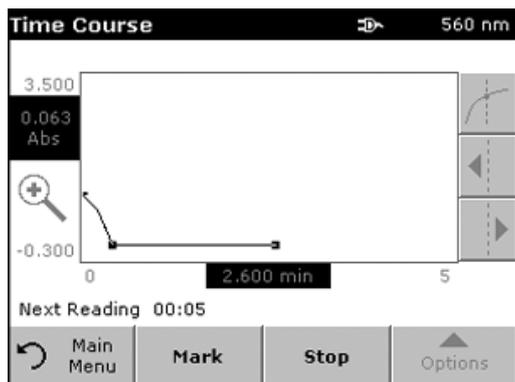
6.5.2 Time Course Scan Reading



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

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

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



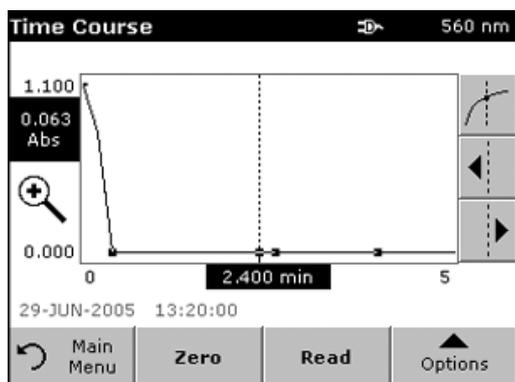
3. Select **MARK** to mark the next data point collected. This mark may indicate a significant event, such as the addition of a sample or other reagent. The mark is also shown in the table. Select **STOP** to stop taking the sample readings.

6.5.3 Analysis of Time Course Data

After the data are collected, the following manipulations can be done on the graphic data:

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

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



6.5.3.1 Navigating a Time Scan Graph or Analysis

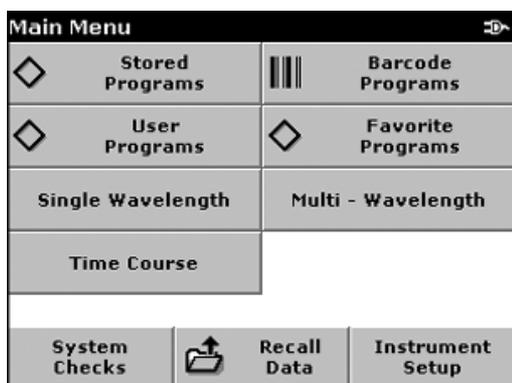
After a time scan has been performed, the time and the absorbance/transmittance data are displayed as a curve.

The corresponding absorbance and the elapsed time is highlighted where the cursor is positioned on the curve.

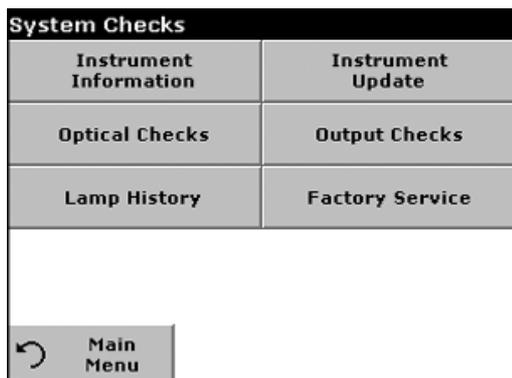
Table 12 Navigating the Time Scan

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. 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 slope 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.

6.6 System Check



1. From the Main Menu, press **SYSTEM CHECKS**.



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

6.6.1 Instrument Information



1. Press **INSTRUMENT INFORMATION**.
2. The model, serial number, and software version are displayed.

6.6.2 Upgrading the Instrument Software

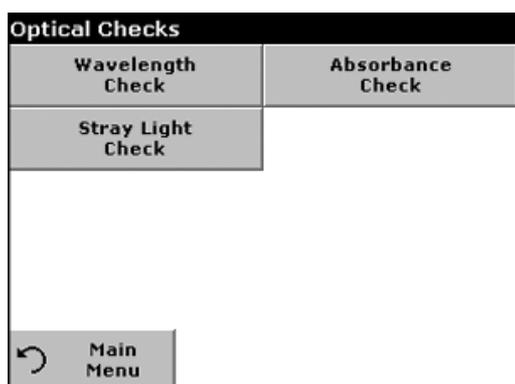


Obtain the software for the update from the Internet at www.hach.com.

1. Go to <http://www.hach.com>
2. On the DR 2800 product page, click **DOWNLOADS>SOFTWARE**.
3. Locate the appropriate download and follow the prompts for saving the file(s) to the USB memory stick.
4. On the DR 2800, press **INSTRUMENT UPDATE**.
5. Connect the USB stick to the USB interface on the DR 2800 (Figure 2 on page 11). Press **OK**. The link is established automatically and the software is updated.
6. Press **OK** to return to the System Checks menu.

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

6.6.3 Optical Checks



1. From the System Checks menu, press **OPTICAL CHECKS**.

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

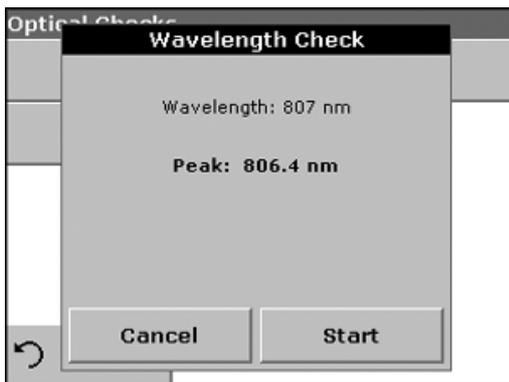
An optional test aid kit (Cat. No. LZV537) containing six precision glass filters, target values, and instructions is available as an aid for carrying out comprehensive in-house instrument checks.

6.6.3.1 Wavelength Check



The Wavelength Check test is used to check wavelength accuracy at 807 nm. The wavelength check requires the Filter Set (Cat. No. LZV537).

1. From the Optical Checks menu, press **WAVELENGTH CHECK**.
2. Insert Adapter A for 10-mm rectangular cells in Cell Compartment #2 and insert the sample cell (Neodym or BG20/2) in the adapter. Close the cell compartment. Touch **Start**.



3. The result is displayed and is to be compared with the nominal data of the sample cell.
4. Press **CANCEL** to return to Optical Checks.

6.6.3.2 Absorbance Check



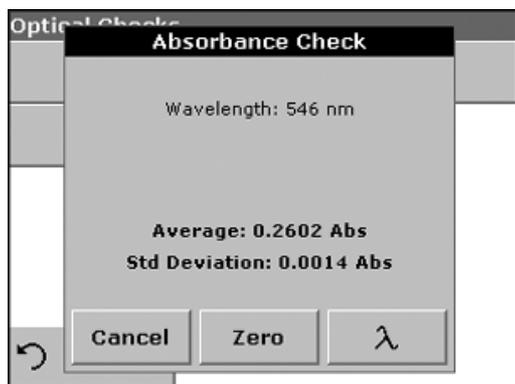
The Absorbance Check test is used to test the photometric accuracy and repeatability of the instrument.

1. From the Optical Checks menu, press **ABSORBANCE CHECK**.
2. Press λ to input the wavelength.
3. Input the wavelength and confirm with **OK**.
4. Remove any cells from the cell compartment and press **ZERO**.



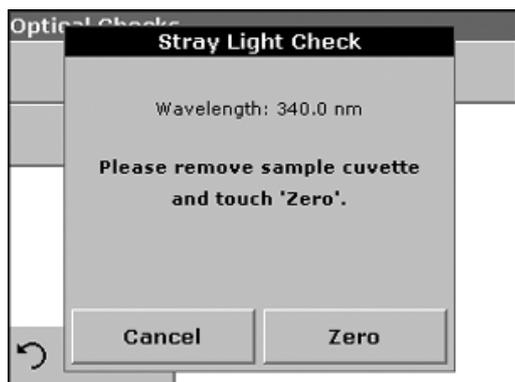
5. Insert the sample cell into the cell compartment and press **READ**.
6. Five replicates of blanking and reading lead to results.

Advanced Operations



7. The result is displayed and is to be compared with the nominal data of the sample cell.
8. Press **CANCEL** to return to Optical Checks.

6.6.3.3 Stray Light Check



The Stray Light test is used to measure the stray light in the instrument at 340 nm.

1. From the Optical Checks menu, press **STRAY LIGHT CHECK**.
2. Remove any cells from the cell compartment.
3. Insert the Adapter A for 10-mm rectangular cells in Cell Compartment #2. Press **ZERO**.



4. Insert the sample cell into the Cell Compartment #2. Close the cell compartment. Press **START**.



5. The Average and Standard Deviation are calculated from three successive absorbance measurements. The result is displayed and is to be compared with the nominal data of the sample cell.
6. Press **CANCEL** to return to Optical Checks.

6.6.4 Output Checks

From the System Checks menu, press **OUTPUT CHECKS**.

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

6.6.5 Lamp History

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

From the System Checks menu, press **LAMP HISTORY**.

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

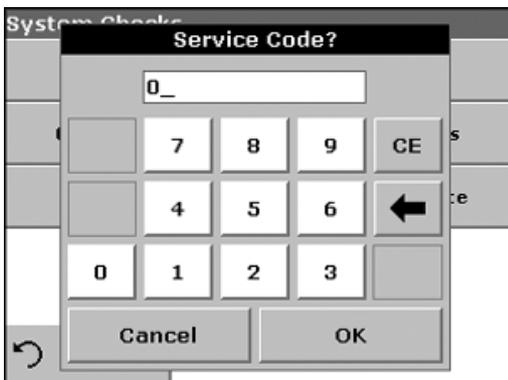
1. Press **RESET VIS** and the Visible Lamp will be reset.

A system check is performed. The duration of the check is 6 minutes.

2. Press **OK** to return to System Checks.



6.6.5.1 Factory Service



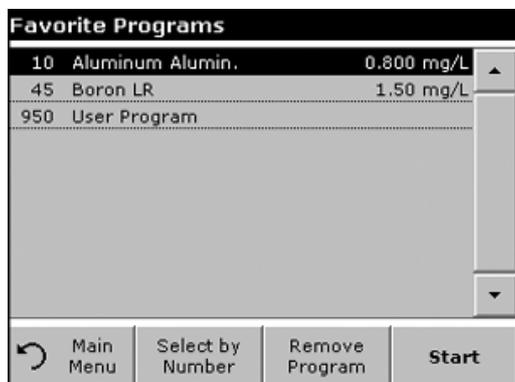
The Factory Service menu is password protected. This menu is not intended for customer use.

6.7 Favorite Programs

The most frequently used tests/methods in the Stored Programs menu and the 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 favorites list or the favorite programs, see [section 6.1.3 on page 56](#).

6.7.1 Recalling a Favorite Program



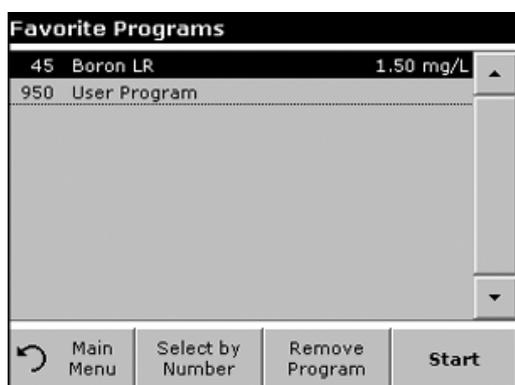
1. From the Main Menu, press **FAVORITE PROGRAMS**. The Favorite Programs list will appear.
2. Highlight the selection by pressing it or press **SELECT BY NUMBER** to search for the program by number.

Note: Use the scroll bar to scroll through the list quickly.

Note: Use the alphanumeric keypad to enter the test number (program number), and press **OK** to confirm.

3. Press **START**.

6.7.2 Deleting a Favorite Program



1. From the Main Menu, press **FAVORITE PROGRAMS**. The Favorite Programs list will appear.
2. Highlight the selection by pressing it or press **SELECT BY NUMBER** to search for the program by number.

Note: Use the scroll bar to scroll through the list quickly.

Note: Use the alphanumeric keypad to enter the test number (program number), and confirm your input by pressing **OK**.

3. Press **REMOVE PROGRAM** and press **OK**.

Note: If a favorites program is removed, it will not be deleted from User Programs or Stored Programs.

Note: If a stored program is deleted 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 and remove the battery from the DR 2800 before attempting any cleaning operations.

7.1.1 Spectrophotometer

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

7.1.2 Display

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.

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 or water is necessary as a final treatment step before the cells are dried.

- Clean glass cells with cleaning agents and water.
- Avoid scratching the optical surfaces with brushes or other cleaning devices.
- Afterwards, rinse the cells several times with tap water and then thoroughly with deionized water.

7.1.3.2 Plastic Cells

- Clean with detergent and water, or with mild acid (brief exposure).
- Avoid scratching the optical surfaces with brushes or other cleaning devices.
- Rinse with deionized water.

7.2 Battery Replacement

CAUTION

Pay special attention to the following information for the Lithium battery pack:

- Do not short-circuit the contacts.
- Keep the battery away from fire.
- Do not expose the battery to temperatures above 60°C (such temperatures may occur, for example, in a car left in the sun, or in direct sunlight). The performance of the battery decreases with the temperature.
- Ensure that the battery does not become wet.
- Take care that the battery is not exposed to impacts, blows, etc.
- Do not take the battery apart or modify it in any way.

CAUTION

For quality and safety reasons, only the manufacturer's lithium batteries (Cat. No. LZV551) should be used for this instrument. Use of non-instrument specific battery types may impair the functioning of and/or damage the instrument electronics by overloading them, or depending on battery types can result in fire or explosion.

1. Remove the sample cell from the cell compartment.
2. Switch the instrument off.
3. Unplug the power cord.
4. Turn the instrument over carefully and place it on a soft surface.
5. Use a screwdriver to remove the screw from the cover.
6. Remove the cover.
7. Remove the old battery by lifting the end over the cover screw insert and pulling to remove ([Figure 11](#)).
8. Carefully place the new battery into the compartment, with the label facing up.
9. Push in the battery so that the instrument contacts plug into the battery socket.

Important Note: Make sure that the battery contacts are always clean. Soiled contacts can result in contact heating and voltage drop, interfering with the proper operation of the spectrophotometer.

10. Use a screwdriver to replace the screw securing the cover.
11. Carefully stand the instrument upright.
12. Plug in the power supply. The Instrument is now ready for use. The instrument can be operated using line power while the battery charges.

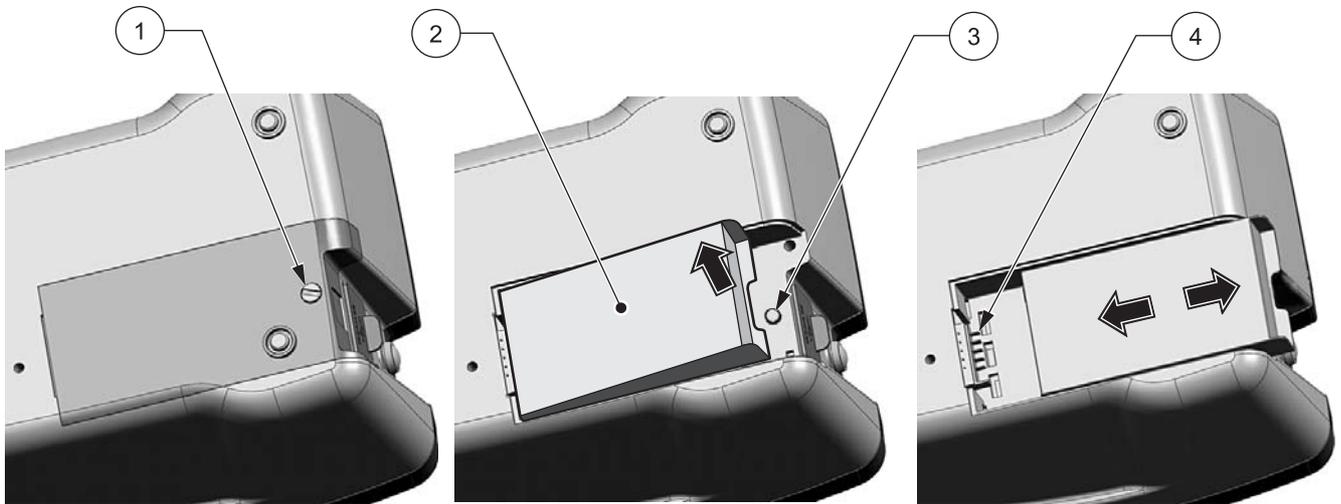


Figure 11 Battery Replacement

1	Cover Screw	3	Cover Screw Threaded Insert
2	Battery	4	Instrument Contacts

7.2.1 Charging the Battery

CAUTION

Use only the manufacturer's specified external power supply to operate the instrument and charge the internal lithium battery pack. The specified power supply and its plug shape, voltage rating (12V, 2A) and electromagnetic characteristics are critical to ensure DR 2800 performance and the safety of the user.

Important Note: *Optimal ambient temperature for charging the lithium battery to 100% is 10–30 °C (50–86 °F).*

The battery is charged automatically when the plug-in power supply is connected and is plugged into a mains socket (100–240 Volt/50–60 Hz).

The time required to charge a newly installed battery is about 3.5 hours.

Operating time of a fully charged battery:

If a battery is charged to 100% capacity, and the user carries out 10 measurements per day, and the instrument is left on after each measurement for the full 15 minutes before it automatically switches off, the battery can be used for 7 days before it needs recharging.

7.2.2 Battery Life

The battery has a limited lifespan. The more it is used, the more its capacity is reduced. If a fully charged battery only allows the instrument to be used for a relatively short time, replace the battery with a new one.

Note: *The battery does not need to run down completely before recharging. Recharging the battery with a residual charge does not reduce capacity.*

7.3 Lamp Replacement

The source lamp operates at high temperatures. To avoid a possible electric shock, disconnect the instrument from the power source before servicing the lamp. Make sure that the instrument cannot be accidentally switched on again.

To prevent a possible burn, allow the lamp to cool at least 30 minutes before handling.

CAUTION

If the instrument has been in use, wait until the lamp cools down. Contact with the hot lamp can cause burns.

1. Remove the cell from the cell compartment, if necessary.
2. Switch the instrument off.
3. Unplug the power cord.
4. Turn the instrument over carefully and place it on a soft surface.
5. Use a screwdriver to remove the screw from the cover.
6. Remove the cover.
7. Remove the battery, if installed ([Figure 11 on page 75](#)).
8. Use a Phillips screwdriver to remove the screws from the lamp housing ([Figure 12 on page 77](#)).
9. Carefully lift the lamp housing from the instrument.
10. Carefully remove both knurled screws ([Figure 13 on page 77](#)).
11. Remove the halogen lamp with the plug panel.
12. Carefully unplug the halogen lamp from the plug panel.

Important Note: *Hold the lamp by the base only. To prolong lamp life, do not touch the glass.*

13. Plug a new halogen lamp (Cat. No. LZV565) into the plug panel.
14. Insert the halogen lamp into the lamp housing with the rounded part of the lamp base pointing down.
15. Secure the lamp firmly with the two knurled screws.
16. Carefully insert the lamp housing into the instrument.
17. Use a screwdriver to replace the screws securing the lamp fitting.
18. Reinstall the battery and cover, see [section 7.2 on page 74](#).
19. Use a screwdriver to replace the screw securing the cover.
20. Carefully stand the instrument upright.
21. Plug in the power supply. The Instrument is now ready for use.

22. Reset the Lamp History, see [section 6.6.5 on page 71](#).

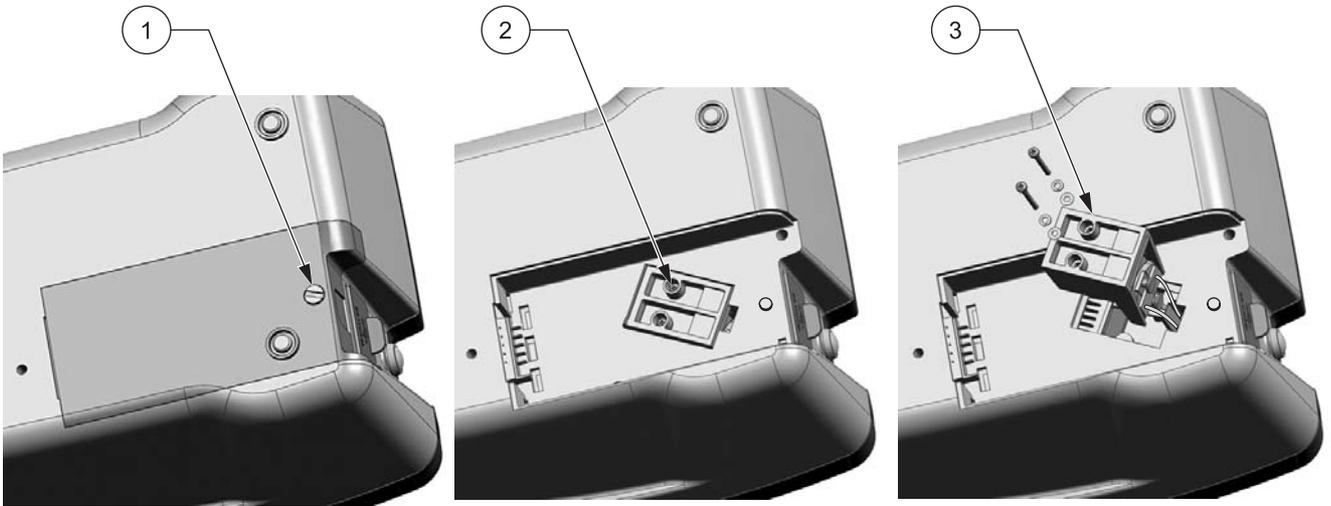


Figure 12 Removing the Lamp

1 Cover Screw	3 Lamp Housing
2 Lamp Housing Screw (2X)	

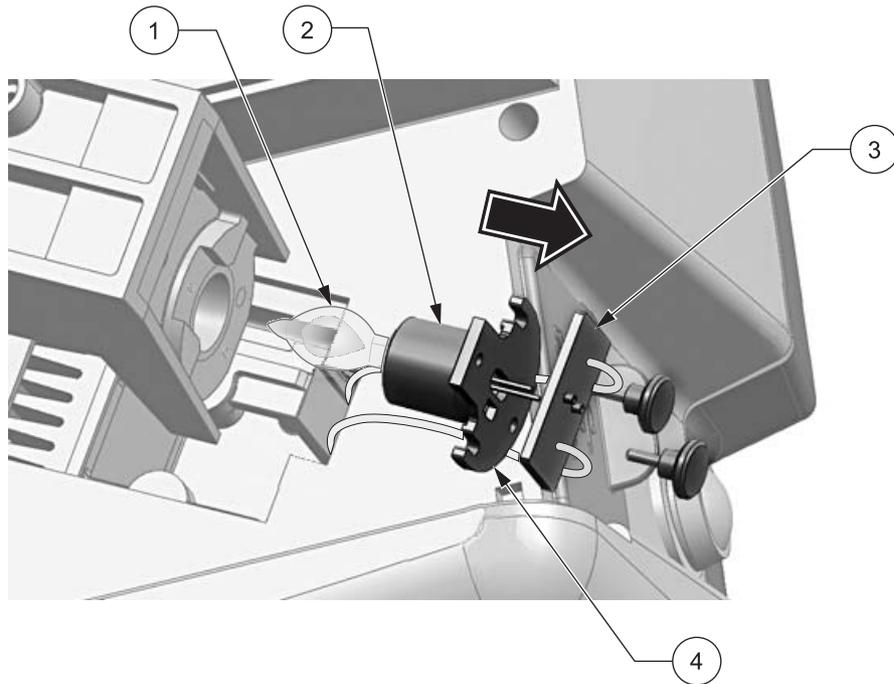


Figure 13 Replacing the Lamp

1 Halogen Lamp	3 Plug Panel
2 Lamp Base	4 Rounded Part of Lamp Base

Section 8 Troubleshooting

Problem/Display screen	Likely Cause	Action
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 Barcode control number? Please update program data!	Discrepancy between barcode test data and stored information.	Data updating
Error Program not available. Please update program data!	Barcode test missing	Data updating
Error Clean Cuvette	The cell/cuvette is soiled or there are undissolved particles in the cuvette	Clean the cuvette; allow the particles to settle
Error Selfcheck stopped. Please check the lamp. Please close the lid.	Self Check Test stops while starting the instrument	Check the lamp and replace it if necessary. Close the lid and press START AGAIN .
Error Selfcheck stopped. Please remove the cuvette	Self Check Test stops while starting the instrument	Remove the cell and press OK .
Hardware error.	Electronic defect	Contact the manufacturer or a sales representative
It's recommended to execute a Full System Check Please remove cuvette. Please close the lid.	The instrument needs a new Full System Check.	Remove cell; close the lid and press START..
Negative result!	The calculated result is negative	Check the concentration of the sample
No evaluation!	Error in the test database / user database	Check the programming Contact the manufacturer or a sales representative
Over measuring range	The measured absorbance is above the calibration range of the test	Dilute the sample and repeat the measurement
Please check the lamp.	The lamp output is too low	Check the lamp and replace it if necessary
Too much ambient light! Move instrument into shade or close the lid!	The instrument sensors detect too much ambient light.	Close the lid, shade the instrument, or place the protective cover over sample cell compartments
Under measuring range	The measured absorbance is below the calibration range of the test	If possible, select a test with a lower measurement range or use a cuvette with a longer path length
Unstable lighting conditions!	Fluctuating ambient light conditions during the measurement	Close the lid or place the protective cover over sample cell compartments and repeat the measurement.

Section 9 Replacement Parts and Accessories

9.1 Replacement Parts

Description	Catalog Number
Battery, rechargeable lithium	LZV551
Cell Adapter Set (sample cell adapters A, B, and C)	LZV647
Cell Adapter A, 10 mm square	LZV583
Cell Adapter B, Pour-Thru Cell	LZV585
Cell Adapter C, 1 inch round	LZV584
Dust Cover	HYH019
Filter set, certified, for self-checks (6 precision glass filters with target values)	LZV537
Hach Data Trans (PC software for data transfer)	LZY274
Lamp, tungsten	LZV565
Light Shield	LZV646
Pour-Thru Cell Kit	5940400
Power Supply, external	LZV610
Protective Cover/adaptor holder	LZV642
Sample Cell, 10-mL, 1-inch glass square matched pair	24954-02
Sample Cell, 25-mL, 1-inch glass square matched pair with stoppers	26126-02
Sample Cell, 10-mL round glass, with cap, each	21228-00
Sample Cell, multi-path 10 and 25 mL, plastic, with caps, pk/6	59405-06
Sample cell, 25 mL, 1-inch square plastic, with cap, pk/12	24102-12
USB-Barcode Scanner (hand-held scanner)	LZV566
USB-Interface Cable (1 m)	LZV567
USB-Keyboard (keyboard layout: US)	LZV582
USB-Memory Stick	LZV568

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)
- Billing address
- Your name and phone number
- Shipping address
- Purchase order number
- Catalog number
- Brief description or model 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.

Appendix A Pour-Thru Cell

CAUTION

Do not use the Pour-Thru Cell in tests that call for the use of organic solvents such as alcohol, 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.

The Pour-Thru module is an optional accessory for the DR 2800 Spectrophotometer. Working with the module improves measurement accuracy, as zeroing, measurements, and measurement comparisons are carried out under the same optical conditions. As the samples all flow through the same cell, errors attributable to the different optical characteristics of individual cells are excluded. The module is designed to allow the sample to be introduced into the cell without having to handle the cell in any way.

The Pour-Thru cell can be oriented to provide two pathlengths:

- Approximately 1 inch
- 1 cm

These two pathlengths can be used over the entire wavelength spectrum of the DR 2800 Spectrophotometer.

A.1 Pour-Thru Module Specifications

Specifications are subject to change without notice.

Path length	22 mm (approximately 1 inch), 1 cm (0.394 inch)
Wavelength Range	340 to 900 nm
Rinsing Volume	At least 25 mL

A.2 Unpacking

Remove the Pour-Thru module from its shipping carton and inspect it for damage. The Pour-Thru Module set includes:

- Pour-Thru cell
- Stand including mountings for glass funnel and stand pipe
- Plastic tube: inside diameter 1/8" for the cell inflow and outflow
- Stand pipe
- Rubber tube: Inside diameter 1/4" (drain tube for stand pipe)
- Glass funnel
- Instruction sheet

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

A.3 Assembling the Pour-Thru Module

Installing the Pour-Thru Cell

1. Open the cell compartment.
2. Insert the Pour-Thru Cell Adapter B in Cell Compartment #2 so that the light path arrow on the adapter points left (see [Figure 5 on page 14](#)).

Note: Do not use Adapter C. It places the cell too low and does not prevent rotation of the Pour-Thru Cell.

3. Clean the Pour-Thru Cell with a lint-free cloth and insert it fully in the cell holder so that the cell is oriented for the necessary pathlength and cannot rotate in the adapter.

Note: For the 1-inch orientation, the inlet and outlet fittings are parallel to the light path. For the 1-cm orientation, the inlet and outlet fittings are perpendicular to the light path.

4. Connect the cell inflow and outflow tubes to the Pour-Thru Cell.

Note: Make sure there are no kinks in tubes to impair functionality and prevent proper bubble removal.

A.3.1 Installing the Sample Inflow and Outflow

Refer to following instructions to install the sample inflow and outflow.

1. Connect the Inflow Tube to the fitting at the bottom of the glass funnel and clamp the glass funnel to the stand.
2. Connect the Outflow Tube to the top fitting of the stand pipe.
3. Connect the Drain Tube (black rubber tube) to the bottom fitting of the stand tube and clamp the stand pipe to the stand.
4. Connect the free end of the rubber tube to an appropriate waste vessel.

Note: The drain tube must flow freely to the drain or waste vessel. Shorten tubes to minimize flow restrictions.

The funnel height and orientation may be adjusted. The funnel height determines the speed of sample flow through the cell. The higher the funnel, the faster the flow. To minimize air bubbles, adjust the funnel so that it drains completely with the final level of liquid in the tube about 5 cm (2 inches) below the tip of the funnel.

Take instrument readings after the solution has stopped flowing through the cell. Always rinse the cell thoroughly with deionized water after each series of tests, or as often as specified in the procedure.

Refer to the instruction sheet included with the Pour-Thru Cell for more information.

A.4 Using the Pour-Thru Cell

The Pour-Thru Cell is intended primarily for those methods that specifically call for its use. These use liquid reagents, and are typically denoted as ULR or Rapid Liquid methods. These methods obtain maximum benefit from the Pour-Thru Cell by avoiding turbidity from un-dissolved reagents, and provide the precision and sensitivity required to determine very low concentrations. These methods require no modification when the Pour-Thru Cell is used.

It is possible to use the Pour-Thru Cell for other methods, with a few minor modifications. The cell requires a minimum volume of 25 mL for proper flushing of any previous solution from the cell - so methods that utilize a 10 mL sample volume cannot be used directly. Tripling the sample and reagent volumes on these methods (or use of 25 mL reagents and sample volumes) will provide enough liquid to use the cell - however, an additional modification is needed. Since the Pour-Thru Cell has a slightly shorter 1-inch pathlength than the square cells for which most methods are calibrated, it is necessary to multiply the results by a pathlength factor of 0.95, or to perform a standard adjustment ([section 5.4.5 on page 36](#)) on any method that utilizes 1-inch square cells. Always confirm results with a standard solution, to make sure modifications have been performed correctly.

Although the Pour-Thru cell can be used for the methods described in [Table 13](#), the cell must be thoroughly purged with distilled water between individual samples.

Table 13 Methods that Require Additional 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.

Important Note: In general, the Pour-Thru Cell **cannot** be used for the methods described in [Table 14](#).

Table 14 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)		

A.5 Pour-Thru Cell Maintenance

Important Note: Do not use solvents (e.g. acetone or alcohol) 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. Purge the cell thoroughly with distilled water. Wipe the windows of the cell with a soft cloth only. Paper towels and other paper products may scratch the plastic windows.

Appendix B Free Programming

The screenshot shows a software interface titled "User Program - 950". It contains several input fields: "Name: CK", "Version:", "Measurement Process:", "Formula: 1", "Variables: 0", "Timer 1: Off", "Timer 2: Off", "Timer 3: Off", "Timer 4: Off", and "No: 0". At the bottom, there are four buttons: "Cancel", "Edit", a printer icon, and "Store".

Free Programming is an advanced option for entering original user-developed methods. When the Free Programming option is selected, an overview of the specifications of the programmed test is displayed. Each input option can be modified to develop the user method. Refer to [Table 15](#) for more information. To modify an input option, select the appropriate line and press **EDIT**.

Important Note: Perform steps 1–6 of *Programming a New User Method* ([section 6.1.1 on page 48](#)) before proceeding with Free Programming.

Table 15 Free Programming Options

Input Option	Description
Name	Name of the analysis parameter.
Version	An abbreviation or version number assigned by the user 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 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.

B.1 Measurement Process

The measurement process defines 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.

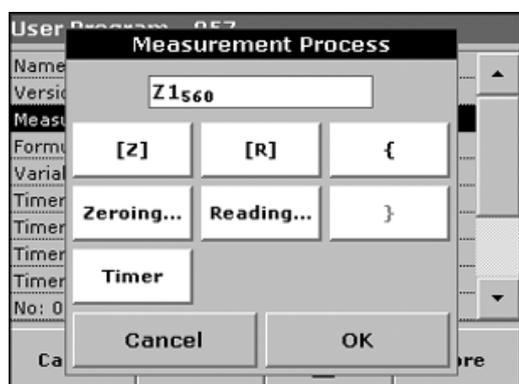
B.1.1 Entering a New Element of a Measuring Sequence



Important Note: Each component of the measurement process **must** be entered in the order in which it will be performed.

1. Highlight the Measurement Process line in the data overview and press **EDIT**.
2. Press **EDIT** again and then **NEW**.

Content and Definition of the Keys



[Z] Key / Zeroing

1. Press the **[Z]** key to program a zero measurement and press **OK**.
2. Press **NEW** and then **ZEROING**. Use the alphanumeric keypad to enter the wavelength at which the zero measurement is to be performed and press **OK**. Press **OK** again to confirm the input.

3.

Note: The entered measurement sequence is displayed.

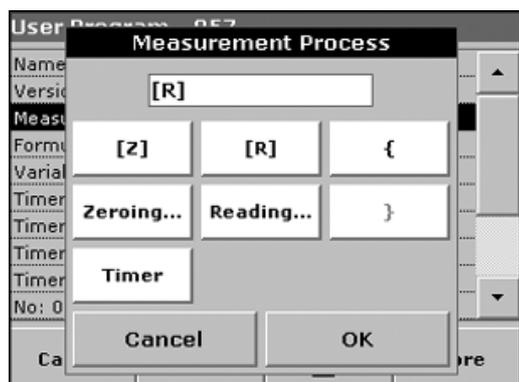


Timer Key

1. 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 and press **OK**. Press **OK** again to confirm the input.

Note: This time is integrated directly into the measurement process.

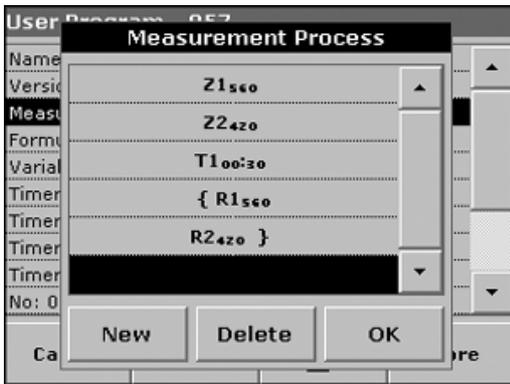
Note: The entered measurement sequence is displayed.



[R] Key / Reading

1. Press the **[R]** key to program a measurement of the substance that is to be analyzed and press **OK**.
2. Press **NEW** and then **READING** and use the alphanumeric keypad to enter the wavelength at which the measurement is to be performed and press **OK**. Press **OK** again to confirm the input.

Note: The entered measurement sequence is displayed.



{ } Key

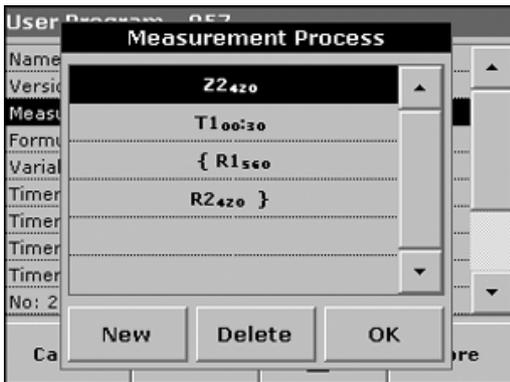
Elements of the measurement sequence that are to be repeated are placed in brackets.

The left bracket "{" marks the start of the sequence that is to be repeated and the right bracket "}" marks the end.

Note: The key showing the right bracket remains inactive until a left bracket is entered.

1. Press {.
2. Press the key that defines the sequence that is to be repeated: [Z] or [R] and press OK to confirm.
3. Press **NEW** and then press **ZEROING** or **READING** and use the alphanumeric keypad to enter the wavelength at which the measurement should be performed. Press **OK** to confirm.
4. Press } to end the sequence.

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



Deleting an element of a measuring sequence

Select the appropriate line and press **DELETE**. The element is deleted.

Inserting an Element of a Measuring Sequence

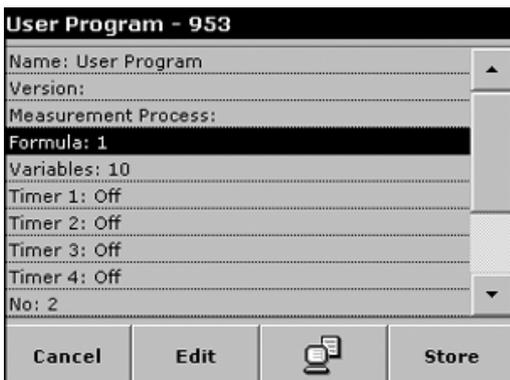
Select the line in the measuring sequence where the insertion is to be made and press **NEW**.

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.

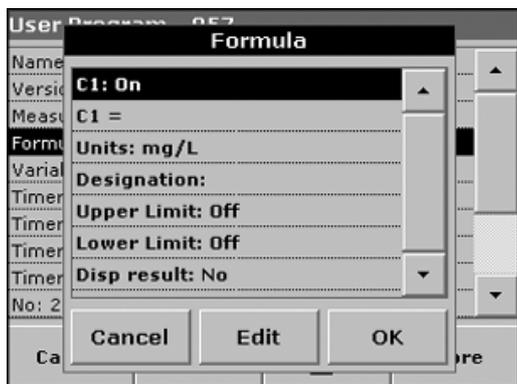
B.2 Entering the Calibration Formula (Evaluation Formula)

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.



Entering Calibration Formula C1

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



2. Select the line C1: Off and press **EDIT**.
3. Select C1: Off again and press **EDIT**. The display changes to C1: On.
4. Select the next line C1 = to define the formula and press **EDIT**. Refer to [Table 16](#) for detailed information on the Edit formula keys.

Note: The evaluation formula is built successively in the display in accordance with the input.

Note: The **ARROW** key deletes the most recently entered element of the formula.

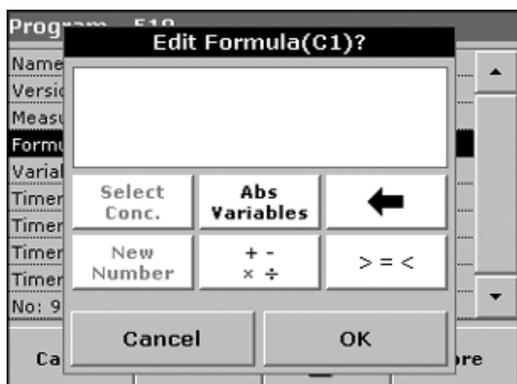
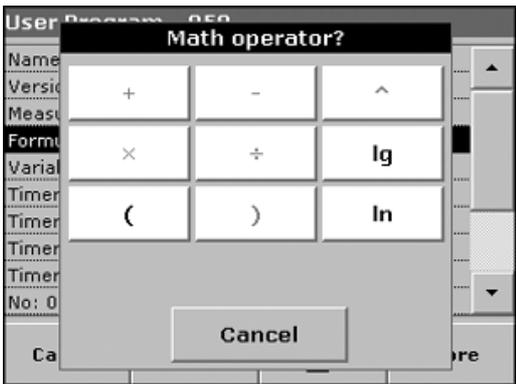
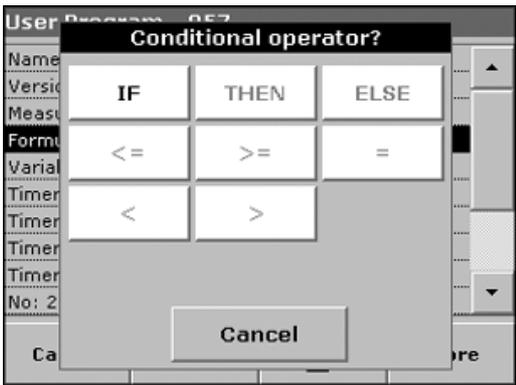
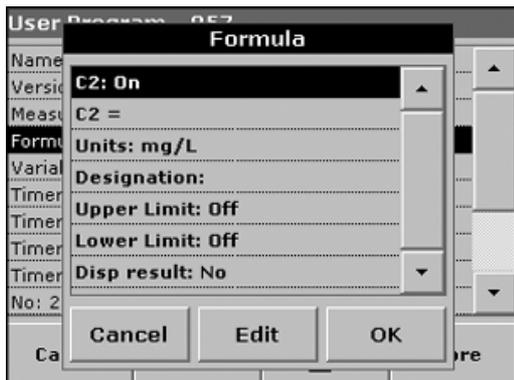


Table 16 Edit Formula Key Descriptions

Screen	Key	Description
<p>The screenshot shows an 'Abs/Variables?' screen with a list of variables: Z1, R1, F1, U1, U2. At the bottom are 'Cancel' and 'OK' buttons.</p>	ABS/VARIABLES	Press the SELECT ABS key to select, from the displayed list, the required element of the defined measuring sequence and therefore the corresponding measurement wavelength, so that this can be taken into account in the formula.
<p>The screenshot shows a 'New Number' screen with a numeric keypad. The display shows '0.0000_'. At the bottom are 'Cancel' and 'OK' buttons.</p>	NEW NUMBER	Press NEW NUMBER to enter a new factor or constant.

Table 16 Edit Formula Key Descriptions (continued)

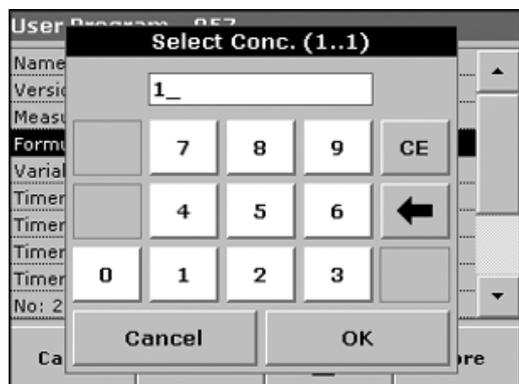
Screen	Key	Description
	+/*	<p>Press +/*, to enter a mathematical operation. Select the operation and confirm your input by pressing OK.</p> <p>The available choice of mathematical operations depends on the defined formula.</p> <p>This means that functions such as "()" or "ln"/"log" etc. are only active if a term in parentheses or the calculation of a logarithm is mathematically permissible in the defined formula (this also applies to all further basic mathematical operations).</p> <p>The following basic mathematical operations are available: + (Addition), - (Subtraction), / (Division), * (Multiplication), ^ (Exponent), Ln (Natural logarithm), Log (Common logarithm)</p>
	>=<	<p>Press >=< to include logic statements/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, ELSE</p> <p>When the evaluation formula C1 has been entered completely, press OK to confirm. Press OK again to return to the Formula display.</p> <p>When the formula C1 has been entered and confirmed, the parameter name, upper and lower limits of the measuring range and display result (yes, no) can be entered.</p>



Entering the Next Calibration Formula (C2 or Cn)

1. Select C2: Off and press **EDIT**.
2. Select C2: Off again and press **EDIT**. The display switches to C2: On.
3. Activate the next line C2 = to define the formula, and press **EDIT**.

In addition to the keys described in [Table 16](#), only one other function is available:



Select Conc. Key

If an already defined formula, in this case C1, is to be taken into account in the formula for C2, press **SELECT CONC.**

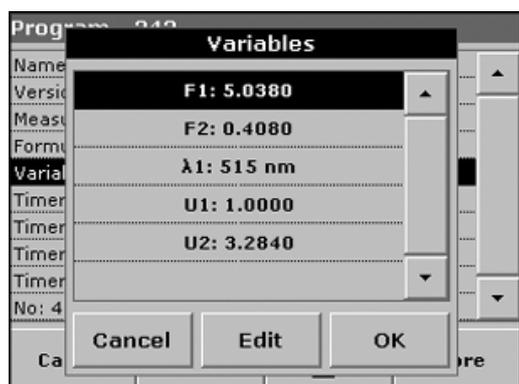
Enter the number of the formula (e.g. 1 for C1) and press **OK** to confirm.

Cn can now be linked with a mathematical operation.

Note: The Cn concentrations that are 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.

B.3 Entering Variables



See [Table 17 on page 96](#) for variable definitions.

1. Select the Variables line in the data overview and press **EDIT**.
2. Select the variable to be edited, press **EDIT** and use the alphanumeric keypad to enter the data specified in the working procedure (for F1, F2, λ1, U1 etc.). Press **OK** to confirm each entry.

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 additional chemical forms, etc.

Table 17 Free Programming Variable Definitions

Variable	Definition
Z	Zero
R	Reading
U	Chemical form factor. U1 is the default chemical form factor and is always equal to 1
F1–F4	Calibration factors
K1–K4	Wavelength weighting factors; the sum or difference of the absorbance measured at different wavelengths. K-values can be fractions (e.g. K=0.75) or negative (e.g. K=-1).
C1	Absorbance as a function of the Reading and Zero values (C1=R1-Z1)
C2	Concentration as a function of calibration factors and absorbance values. The concentration formula is: (F1+F2 x C1+ F3 x C1 ² + F4 x C1 ³) x U1

B.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.).