



Catalog Number 48316-18

DR/4000 SPECTROPHOTOMETER

MODELS 48000 and 48100

USER MANUAL

08/04 3ed



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Hach Company certifies that this instrument was thoroughly tested, inspected, and found to meet its published specifications upon factory shipping.

The Model DR/4000 Spectrophotometer is certified and has been tested as indicated to the following instrument standards:

Product Safety: (Note: Edison Testing Labs, ETL, mark is owned by Intertek Testing Services, ITS).

Listed by ETL to UL 3101-1 (Listing # H0492805390)

Certified by ETL to CSA C22.2 No. 1010.1 (Certification #H0492805390)

Certified by Hach to EN61060-1 (IEC1010-1), supporting test records by ETL.

Immunity:

EN 50082-1 (European Generic Immunity Standard) per 89/336/EEC/EMC: Supporting test records by Hach Company, certified compliance by Hach Company.

Required Standard(s) include:

IEC 801-2, EN 61000-4-2 “1995” (IEC 1000-4-2) Electro-Static Discharge

IEC 801-3, ENV 50140 “1993” Radiated RF Electro-Magnetic Fields

IEC 801-4, EN 61000-4-4 “1995” (IEC 1000-4-4) Electrical Fast Transients/Burst

ENV 50141 “1993” Conducted Disturbances Induced by RF Fields

ENV 61000-4-8 “1994” (IEC 1000-4-8) Power Frequency Magnetic Field

EN 61000-4-11 “1994” (IEC 1000-4-5) Voltage Dips, Interruptions and Variations.

Additional Standard(s) include:

EN61000-4-5 “1995” (IEC 1000-4-5) Surge

Emissions:

Emissions per **89/336/EEC EMC**: Supporting test records by Intellistor OATS, certified compliance by Hach Company.

Required Standard(s) include:

EN 55011 (CISPR 11) Emissions, Class B limits

Canadian Interference-Causing Equipment Regulation, IECS-003, Class A:

Supporting test records by Intellistor OATS, certified compliance by Hach Company.

This Class A digital apparatus meets all the requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

FCC Part 15, Class “A” Limits: Supporting records by Intellistor OATS, certified compliance by Hach Company.

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

1. This device may not cause harmful interference
2. This device must accept any interference received, including interference that may cause undesirable operation.

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

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

1. Disconnect power from the DR/4000 Spectrophotometer to verify that it is the source of the interference.
2. If the DR/4000 Spectrophotometer is plugged into the same outlet as the device with which it is interfering, try another outlet.
3. Move the DR/4000 Spectrophotometer away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above steps.

Section 2

Specifications

Specifications are subject to change without notice.

*Wavelength Range:	190 to 1100 nm (DR/4000U), 320 to 1100 nm (DR/4000V)
*Wavelength Accuracy:	±1 nm
*Wavelength Reproducibility:	±0.1 nm
*Wavelength Resolution:	0.1 nm
*Wavelength Calibration:	Internal, automatic at power-up with visual feedback
*Wavelength Slew Rate:	15,000 nm/minute
*Scan Speed:	400 nm/minute at 2.0 nm steps 200 nm/minute at 1.0 nm steps 100 nm/minute at 0.5 nm steps 40 nm/minute at 0.2 nm steps 20 nm/minute at 0.1 nm steps
Spectral Bandwidth:	4 nm nominal
Source Lamp:	Tungsten and Deuterium (DR/4000U), Tungsten (DR/4000V)
Source Lamp Change:	Automatic changeover
Photometric Range:	0 to 3 ABS, 0.1 to 100%T (-3.0 to 3.0 ABS, 0.1 to 200%T relative)
Photometric Reproducibility- Single-cell module:	±0.001 ABS at 1 ABS, 546.1 nm
Photometric Reproducibility- Carousel module:	±0.002 ABS at 1 ABS, 546.1 nm, all setup modes, using matched sample cells
Photometric Linearity:	±0.002 ABS from 0 to 1 ABS at 546.1 nm
Stray Light:	3.3 ABS minimum or 0.05%T maximum at 220 nm and 340 nm
Sample Path Length:	100 mm
Monochromator Design:	Seya-Namioka split-beam
Grating:	1200 Lines/mm; 8 nm/mm dispersion
Outputs:	Parallel printer port and Serial I/O (RS232)
Display:	Backlit, graphic, liquid crystal display with adjustable viewing angle and contrast control
Storage Temperature:	-17 to 60 °C, 85% relative humidity, non-condensing
Operating Temperature:	10 to 40 °C; 95% relative humidity, non-condensing at 25 °C, 75% relative humidity, non-condensing at 40 °C
Readout Modes:	Concentration, absorbance, or transmittance
Line Power Requirements:	AC line power selectable for 115/230 Vac ±17%; 50/60 Hz, 230 VA maximum
Sample Compartment:	Modular, easily accessible, interchangeable for diverse testing requirements
Dimensions:	42W x 39D x 21H cm (16.5 x 115.5 x 8.25 inches)
Shipping Weight:	9 kg (20 lb.)

* Patent number 5,625,270



Before attempting to unpack, set up, or operate this instrument, please read this entire manual. Pay particular attention to all warnings, cautions and notes. Failure to do so could result in serious injury to the operator or damage to the equipment.

Use of Hazard Information

If multiple hazards exist, the signal word corresponding to the greatest hazard shall be used.

DANGER

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

WARNING

Indicates a potentially hazardous situation that could result in death or serious injury.

CAUTION

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

NOTE

Information that requires special emphasis.

Precautionary Labels

Please pay particular attention to labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

 This symbol, if noted on the instrument, references the Instruction Manual for operational and/or safety information.

 **1.2.1 Applying Power**

 **1.10 Optional Modules**

 **2.1.1 Taking Hach Program Measurements**

 **6.1.1 Taking Single Wavelength Measurements**

 **7.1.3 Taking Wavelength Scan Measurements**

 **8.1.3 Taking Multiple Wavelength Measurements**

 **9.1.3 Taking Time Course Measurements**

 **10.1.4 Flow-cell and Sipper Modules**

 **10.2.1 Tungsten Lamp Replacement**

 **10.2.2 Deuterium (UV) Lamp Replacement**

 **10.3 Fuse Replacement**

4.1 Unpacking

Remove the DR/4000 Spectrophotometer and accessories from the shipping container, and inspect each item for any damage that may have occurred during shipment. Both the visible (DR/4000V) and ultraviolet/visible wavelength (DR/4000U) models are shipped with the following:

- Model DR/4000 Laboratory Spectrophotometer
- Dust Cover
- Power Cord
- Single-cell Module
- Square Glass 1-inch Sample Cells (2, matched)
- Round 25 x 54 mm (1-inch) Sample Cell (for use with AccuVac[®] chemistries)
- 1-cm Cell Adapter
- AccuVac/1-inch Round Cell Adapter
- 16-mm COD/Test Tube Adapter
- Square 1-inch Cell Adapter
- Illustrated Procedures Manual
- Instrument Manual
- DR/4000 Accessory Kit (contains two replacement fuses, one cotton glove, and one tungsten lamp replacement)

Additional items included with the DR/4000U ultraviolet/visible wavelength model are as follows:

- Carousel Module
- 1-inch Carousel
- 1-cm Carousel
- 1-cm Quartz Sample Cells (2)

If any items are missing or damaged, please contact the Hach Customer Service Department in Loveland, Colorado. Do not return the instrument without prior authorization. In the United States, call 1-800-227-4224. Outside the United States, contact your nearest Hach sales office or dealer.

4.2 Instrument Description

The DR/4000 Spectrophotometer is a direct reading instrument which is programmed with calibrations for many tests. Available in two models, the

Model DR/4000V is used for visible wavelengths, and the Model DR/4000U is used for testing in both ultraviolet and visible wavelengths. User-entered calibrations can also be stored in the instrument.

The DR/4000 Spectrophotometer provides digital readouts in direct concentration units, absorbance, or percent transmittance. When a user-generated or Hach programmed method is selected, the on-screen menus and prompts direct the user through the test. This menu system also can be used to generate reports, statistical evaluations of generated calibration curves, and to report instrument diagnostic checks.

The DR/4000 monochromator is capable of producing wavelengths from 190 to 1100 nm. A halogen gas-filled tungsten lamp produces light in the visible spectrum (320 to 1100 nm), and a deuterium lamp available in the Model DR/4000U produces light in the ultraviolet spectrum (190 to 380 nm). The instrument is fully assembled when shipped from the factory. Attach the supplied power cable to the rear of the instrument before use.

The Model DR/4000U (UV/VIS) Spectrophotometer comes equipped with two modules*. The Single-cell Module includes a 1-cm cell adapter, a 16-mm test tube adapter (also fits COD and Test 'N Tube vials), an AccuVac adapter (also fits 1-inch round cells), and a 1-inch square cell adapter (see *Figure 1*). The Carousel Module includes two interchangeable carousels: a 4-place, 1-inch-cell carousel (for 1-inch square cuvettes), and a 6-place 1-cm-cell carousel (for 1-cm cuvettes). The Carousel Module is an optional accessory for the Model DR/4000V (VIS only) Spectrophotometer.

Other optional equipment for the DR/4000 includes a 1-cm micro-cell adapter, long-path cell adapters (5-cm and 10-cm), and a 5-place COD Carousel adapter. Hach also offers a Flow-cell Module, a Sipper Module, a 2-mL Micro Sipper Module, a selection of plastic, glass and quartz sample cells, HachLink™ data capture software, and an Epson® graphics printer.

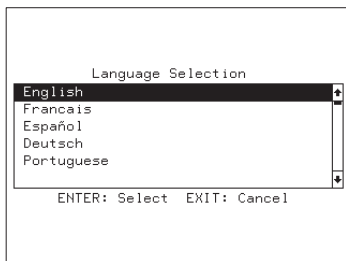
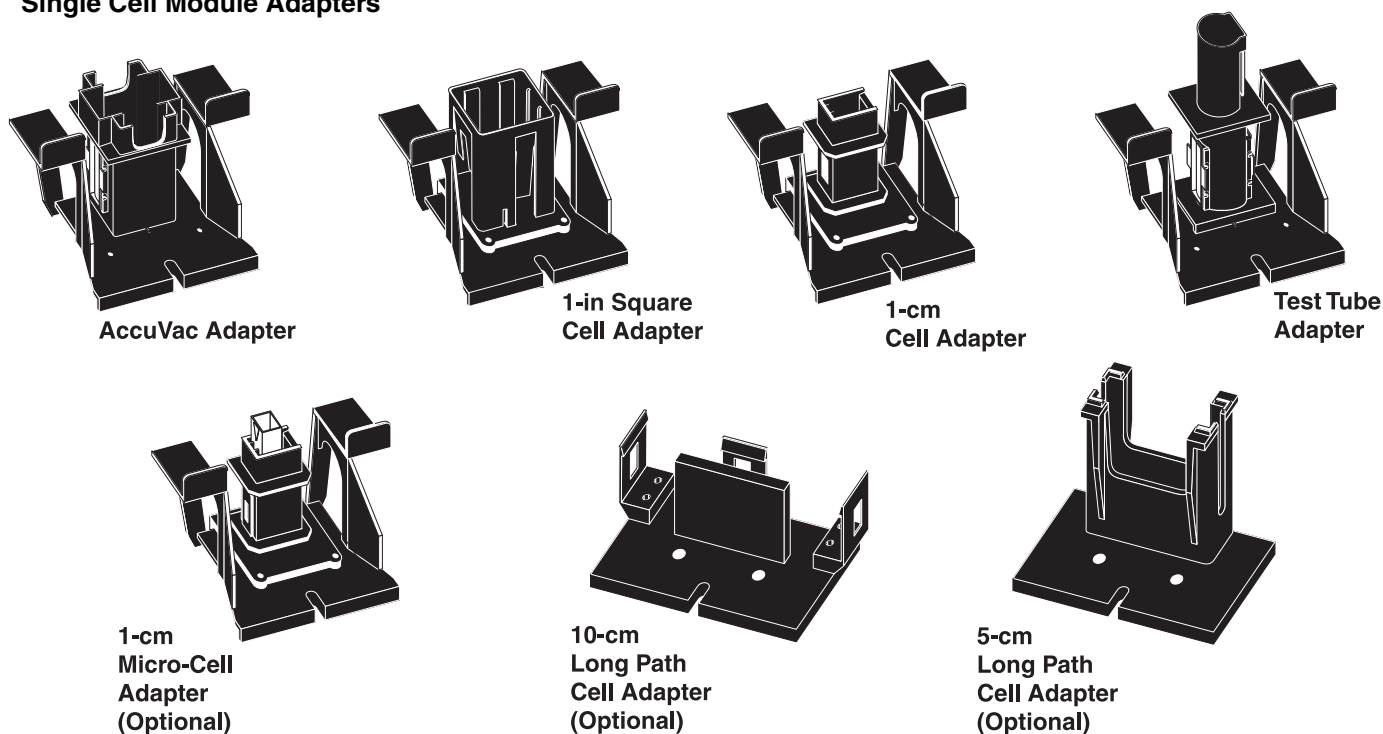
4.2.1 Applying Power

A UL/CSA approved 115 Vac power cord with a NEMA 5-15P style plug is supplied with the North American DR/4000 models (Cat. No. 48000-00 and 48100-00). A 230 Vac Harmonized power cord with a Continental European plug is supplied with the European DR/4000 models (Cat. No. 48000-02 and 48100-02). Customers wanting to power the North American DR/4000 models with 230 Vac must replace the supplied 115 Vac power cord with a UL/CSA approved 230 Vac power cord with a NEMA 6-15P style plug.

A module must be installed in the instrument before turning the power on. Make sure the module's sample cell compartment is empty and close the module lid. Plug the power cord into the back panel of the instrument and turn the power switch on (see *Figure 10*).

* Patent number 5,638,171

Figure 1
Single Cell Module Adapters

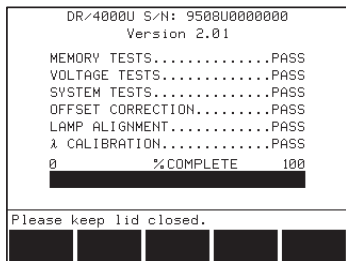


4.2.2 Language Selection

The DR/4000 instrument software includes several language options. To choose a language other than English, hold down any key while turning the instrument on. The display shows a list of languages to choose from.

Use the **UP** and **DOWN** arrow keys on the keypad to select a language, and press the **ENTER** key to confirm the selection. The instrument will display in the selected language until a new selection is made.

4.3 Initial Instrument Use



4.3.1 Diagnostic Self-tests

Upon power-up, a self-test procedure begins. This procedure, which takes approximately two minutes, checks the memory, voltage, systems, offset correction, lamp alignment, and the wavelength calibration. The screen reads **PASS** to denote that each of these areas are functioning properly. If all functions do not pass (see *Section 11*).

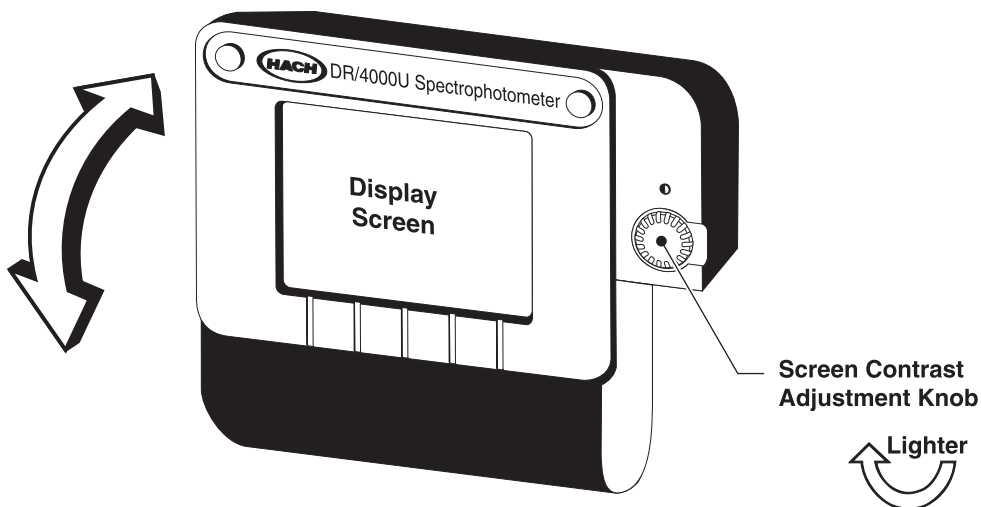
The instrument serial number and software version are displayed at the top of the screen at this time.

NOTE: Press the **START** soft key to rerun the self-test procedure if any of the tests fail on warm-up.

4.3.2 Display Adjustments

The LCD screen for the DR/4000 Spectrophotometer is hinged for rotation to reduce glare and increase viewing comfort. A knob, which controls screen contrast, is located to the right of the screen. Rotate the knob counterclockwise to darken the display and clockwise to lighten the display.

Figure 2
Display Adjustment



4.3.3 Operating Environment

Maintain an ambient temperature of 10 to 40 °C (50 to 104 °F) for proper instrument operation. Leave at least a 15 cm (6 inch) clearance at the top and on all sides for air circulation. Keep the air vents in the bottom of the chassis and the fan in the back of the instrument clean and free of materials that might obstruct the air flow.

4.4 Keypad and Display

4.4.1 Keypad Description

The keypad is organized into four main sections: soft keys, numeric keys, data storage keys, and control keys (see *Figure 3*).

The five **SOFT KEYS** located at the top of the keypad match the menu options displayed on the bottom of the screen. Select a menu item by pressing the **SOFT KEY** below the menu option.

NOTE: Use the **SETUP** key as a decimal point key during numeric entry.

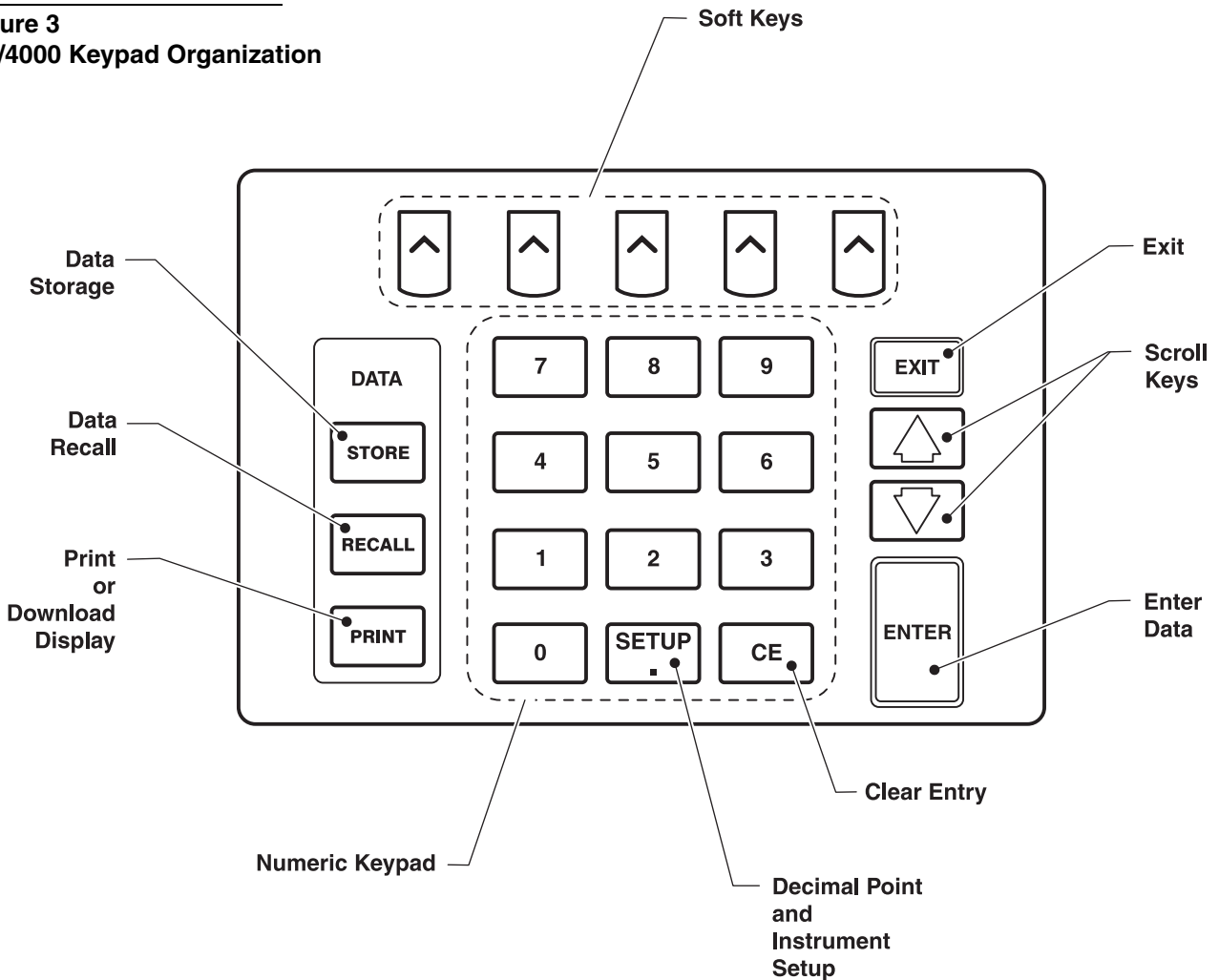
The numeric keys include digit keys, a **CE** (clear entry) key, and a decimal point/**SETUP** key. Use the digit keys, decimal point key, and **CE** key to directly enter values on instrument prompts and timer settings. The **SETUP**

key is used to change defaults and specify user preferences. See *Section 4.6 Instrument Setup* for more specific information.

The left side of the keypad contains the **STORE**, **RECALL**, and **PRINT** keys. These keys facilitate saving, retrieving, and printing data. Refer to *Section 10, Data Handling* for more information on these functions.

The four control keys located at the far right of the keypad include the **ENTER**, **EXIT**, and arrow (scroll) keys. Use the arrow keys to move up and down through menu options. Use the **ENTER** key to accept keyed-in values. Exit a menu at any time by pressing the **EXIT** key.

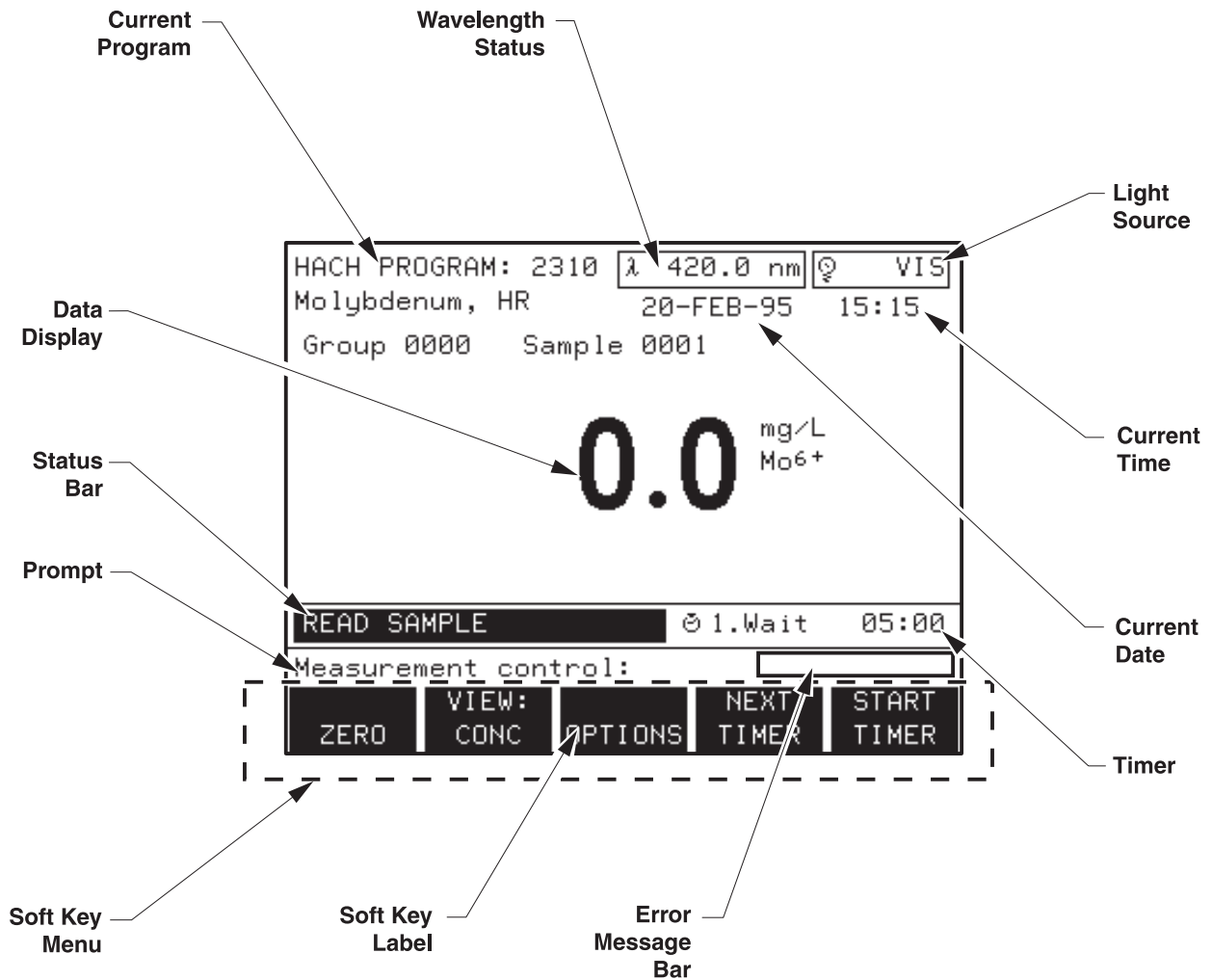
Figure 3
DR/4000 Keypad Organization



4.4.2 Display Organization and Menu Selection

The display changes as different modes of operation are selected. The following screen shows many of the common and important features of the DR/4000 display.

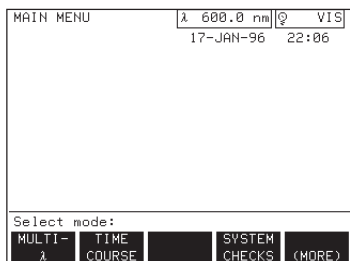
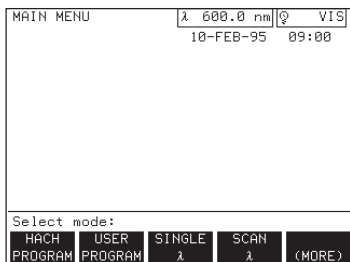
Figure 4
DR/4000 Display Organization



4.5 Main Menu

The main menu is displayed after the self tests are finished and all diagnostics PASS. The display identifies the current mode at the top left of the screen and indicates the current wavelength selection, the date and time, and the status of the visible and ultraviolet light source.

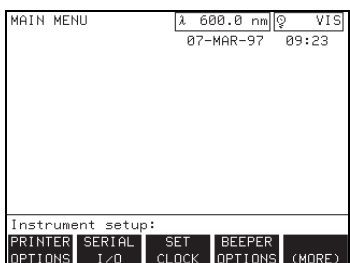
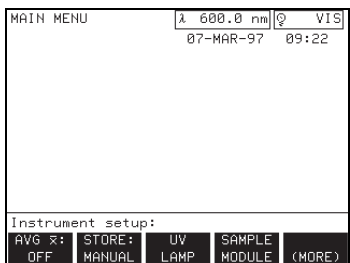
A variety of modes may be selected from the main menu. The following table briefly describes each menu option. Press the **(MORE)** soft key to view additional options in the main menu.



Soft Key	Function
HACH PROGRAM	Selects programmed procedures using Hach chemistries. Refer to the DR/4000 Spectrophotometer Procedures Manual for illustrated, step-by-step procedures for analysis with Hach programs.
USER PROGRAM	The User Program Mode lets the operator recall saved programs, and create custom calibration curves and analysis procedures.
SINGLE λ	The Single Wavelength Mode measures absorbance (ABS) or percent transmittance (%T) at a single wavelength. Simple conversions to concentration may also be performed.
SCAN λ	The Scan Wavelength Mode shows how a sample absorbs light over a range of wavelengths. This feature can be used to optimize instrument sensitivity with a given chemistry. The scan is plotted on the screen.
MULTI – λ	The Multiple Wavelength Mode measures absorbance (ABS) or percent transmittance (%T) at up to four wavelengths, and provides computations for absorbance differences and ratios of absorbance. Simple conversions to concentrations may also be performed.
TIME COURSE	The Time Course Measurement Mode records absorbance or % transmittance at a single wavelength over a specified time period.
SYSTEM CHECKS	Provides DR/4000 Spectrophotometer diagnostics and performance validations.

4.6 Instrument Setup

Use the instrument setup menu to configure the instrument and the module to specific user requirements. From any screen that does not require numeric entry, press the **SETUP** key to access the instrument setup menu. Press the **EXIT** key to return to the original menu. Press the **(MORE)** soft key to view additional setup options.

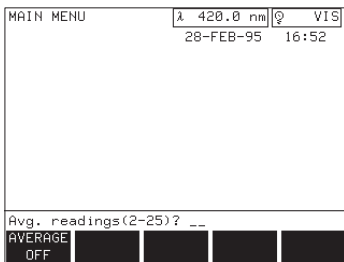


Soft Key	Function
AVG \bar{x}	Signal averaging: prompts to select the number of readings to average (from 2 to 25) or turns signal averaging off.
STORE	Determines the data storage mode. Selects manual or auto (automatic).
UV LAMP	Displays UV lamp options. Appears only on the Model DR/4000U instrument.
SAMPLE MODULE	Displays sample module configuration options. Available only when the Carousel or Sipper Module is installed.
PRINTER	Displays options for the type of printer to be used.
SERIAL I/O	Displays serial communication settings for baud rate, data bits, and parity.

Soft Key	Function
SET CLOCK	Prompts to set the date – day, month, year and the time – hours, minutes, seconds.
BEEPER OPTIONS	Displays beeper options.

4.6.1 The Signal Average Option

Press the **AVG \bar{x}** (signal average) soft key. The display prompts for the number of readings to be averaged. Enter a number from 2 to 25. Press the **ENTER** key to confirm the entry, or press **EXIT** to cancel the entry. Press the **AVERAGE OFF** soft key to turn the setting off. Signal averaging is automatically reset to OFF when a new measurement mode is selected.

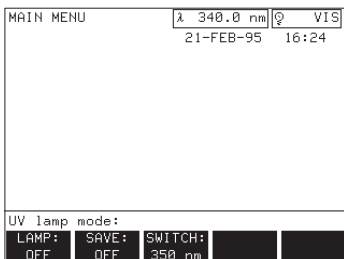


4.6.2 The Store Option

The **STORE** soft key controls data storage options and toggles between manual and auto. When set to the manual mode, data is stored only by pressing the **STORE** key on the instrument key pad. When set to automatic, data is stored automatically at the end of a measurement cycle.

4.6.3 The UV Lamp Option

Press the **UV LAMP** soft key to display the UV lamp options setting menu.

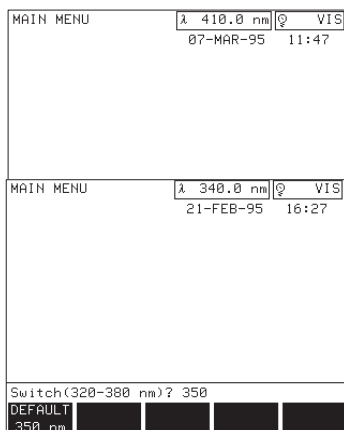


Soft Key	Function
LAMP	Toggles between the UV lamp ON and lamp OFF settings.
SAVE	Prompts for automatic lamp turn-off of 1 to 8 hours.
SWITCH	Prompts for the UV wavelength switch (320 to 380 nm).

The lifetime of the lamp is influenced by on-off operation and the length of time in use. Typical use is to turn the instrument (D2 lamp) on for the entire 8-10 hour shift, and then off until the next day. In general, avoid on/off cycles of the lamp; this shortens the lamp's life span. For maximum life, turn the lamp off only if it will remain off for at least 4-5 hours. You can also use the **SAVE** feature to turn the lamp off automatically after an operator-determined amount of time. The UV lamp settings do not affect the visible lamp operation. UV flashes in the light source box when the UV lamp is first turned on for taking measurements. When the lamp is warmed up and ready, UV stops flashing.

Press the **SAVE** soft key to display the lamp save prompt.

Use the digit keys to enter the number of hours the lamp is to remain on. Press **ENTER** to confirm the selection. If no measurements are made in the UV range within the specified time, the UV lamp will turn off automatically. Press the **SAVE OFF** soft key to turn the save feature off.



Press the **SWITCH** soft key to select a UV wavelength switch between 320 and 380 nm. Press the **ENTER** key to confirm the setting, press **EXIT** to cancel the entry, or press the **DEFAULT** soft key to set the UV lamp switch back to 350 nm. Wavelengths at or above the switch setting will use the visible lamp. Wavelengths below the switch setting will use the UV lamp.

4.6.4 The Printer Options

The **PRINTER OPTIONS** soft key provides options for selecting printer types, setting the format of printouts, and setting the page ejection mode. Press the soft keys to automatically change the selection in the soft key label.

Press the **SELECT PRINTER** soft key to change the printer selection. Each time the soft key is pressed, the printer selection changes in the prompt field of the display. The Generic mode as shown at left, removes graphics print options from printer menus. Use the Generic mode for printers that do not support graphics. All other printer selections support both text and graphics.

Press the **FORMAT** soft key to select between Block and Table formats. Block format provides a complete record of each measurement, and the information provided may be different for each measurement mode. Table format gives a summary of information in table form that is consistent in all measurement modes. The table format is easier to read but does not give all of the details of the Block format. *Figure 5* illustrates the two types of printout formats.

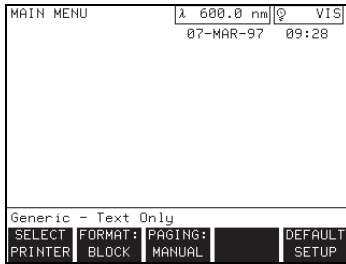


Figure 5
Printout Formats

BLOCK FORMAT

```
DR/4000U S/N: 9702U0000584 2.00
19-MAR-97 07:34:53 SINGLE WAVELENGTH
Group 0000 Sample 0001
0.10 mg/L Dil X: 1.0000
Conc X: 1.3500 BLK: 0.02 STD: 1.50 600.0 nm
0.076 ABS 83.98 %T

DR/4000U S/N: 9702U0000584 2.00
19-MAR-97 07:34:55 SINGLE WAVELENGTH
Group 0000 Sample 0002 0.72 mg/L Dil X: 1.0000
Conc X: 1.3500 BLK: 0.02 STD: 1.50
600.0 nm 0.472 ABS 33.75 %T
```

TABLE FORMAT

```
DR/4000U S/N: 9702U0000584 2.00
```

Date	Time	Group	Sample	Result	Dil X	Program
19-MAR-97	07:34	0000	0001	0.10 mg/L	1.0000	SNGL BLK STD
19-MAR-97	07:34	0000	0002	0.72 mg/L	1.0000	SNGL BLK STD
19-MAR-97	07:34	0000	0003	1.50 mg/L	1.0000	SNGL BLK STD

Press the **PAGING** soft key to select between manual and automatic paging. Select **MANUAL** when using a printer (such as the Epson Dot Matrix) that

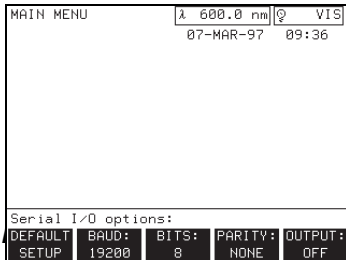
feeds paper as pages are printed and you can see the results as printed. Select AUTO when using printers (such as the HP DeskJet/LaserJet) that eject paper from the printer after the page is completely printed and you don't see the results as printed.

The **DEFAULT SETUP** soft key returns the default printer settings: text only, block format, and manual paging.

4.6.5 The Serial I/O Option

Press the **SERIAL I/O** soft key to display printer baud rate, data bits, parity and output settings. The **DEFAULT SETUP** soft key returns the default serial settings: 19200 baud, 8 bits, no parity, and output off.

The serial output can interface with a PC; however, it is also compatible with serial versions of the printers discussed in *Section 4.6.4*.

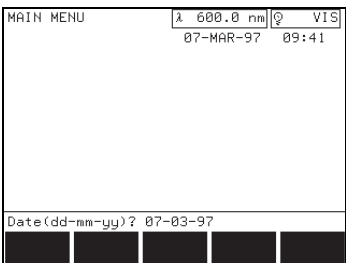


NOTE: If no device is available on the serial I/O port and the output is left on, print functions will not operate properly.

If the output option is set to OFF when the **PRINT** key is pressed, data will be sent only to the parallel port. If the output option is set to ON when the **PRINT** key is pressed, data will be sent to both the parallel port and to the serial I/O port. If not using the serial I/O port, turn the output option OFF.

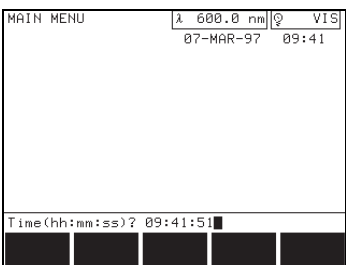
4.6.6 The Set Clock Option

Press the **SET CLOCK** soft key to change the date settings of day, month, and year (dd-mm-yy). Press the **ENTER** key to confirm the date setting and to advance to the change time option.



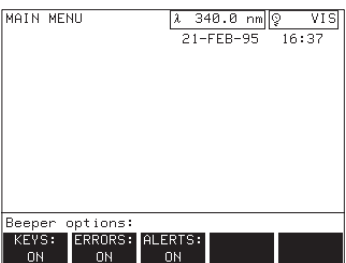
Change the time setting of hours, minutes, and seconds (hh:mm:ss), and press the **ENTER** key to confirm the new setting.

The new date and time immediately appear in the current date and time location on the screen.



4.6.7 The Beeper Option

Press the **BEEPER OPTIONS** soft key to display the beeper options menu. Pressing a soft key toggles the corresponding beeper option ON or OFF. If the keys option is on, the DR/4000 will make a short beep each time a key is pressed. If the errors option is on, the instrument will make a long beep if a keypad entry error is made. Turning the errors option off will not affect the display of error messages on the screen. If the alerts option is on, the



instrument will make a series of short beeps at the end of a measurement cycle, such as at the end of a scan or carousel measurement. Turning alerts off does not affect the timer beep sequence.

4.7 Changing Adapters in the Single-cell Module

The Single-cell Module lets the user perform one sample analysis at a time. This module requires an adapter for proper positioning of the sample cell. *Figure 1* displays the available single-cell adapters. Adapters are inserted into the module as follows (see *Figure 6*):

1. Open the module lid.
2. Loosen the thumb screw (located in the center of the module).
3. Tip the adapter slightly toward the front of the instrument and pull up.
4. To replace the adapter, loosen the thumb screw and place the adapter behind the thumb screw. Place the adapter's thumb screw indentation snugly against the screw, then set the adapter in place.
5. Tighten the thumb screw until snug, making sure the flanges on the sides of the adapter seat into the cut-out areas on each side of the module.

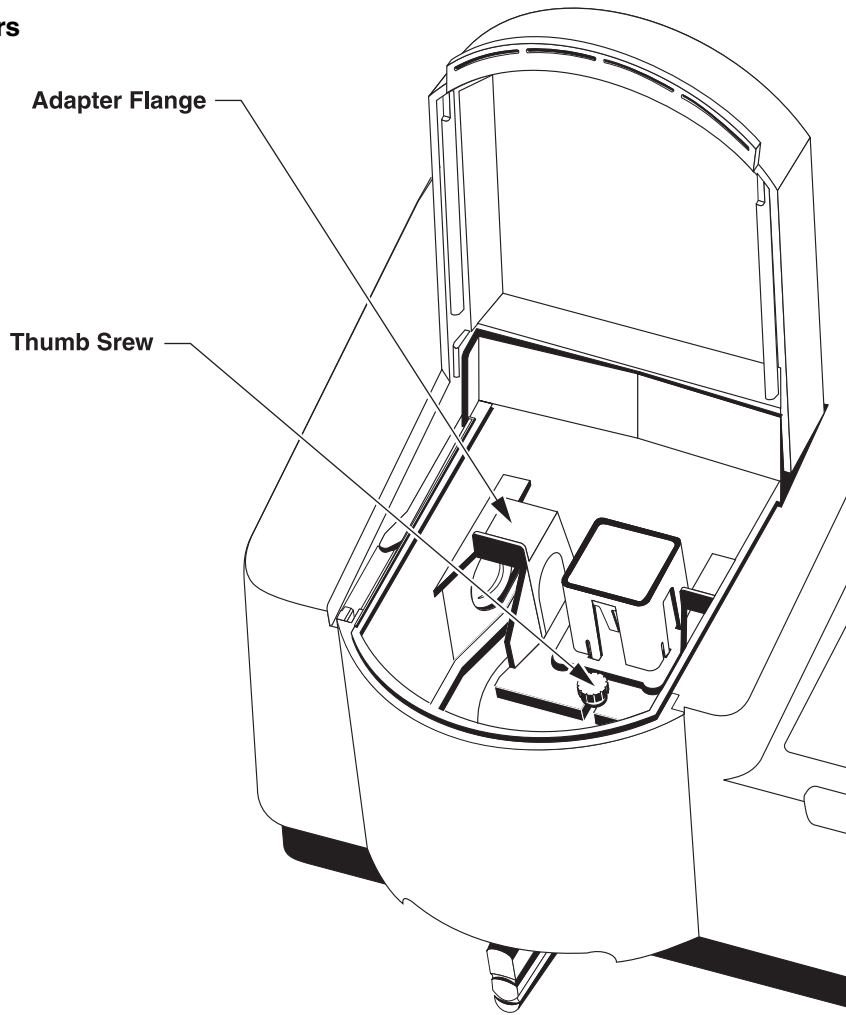
4.8 Changing Sample Modules

The DR/4000 Spectrophotometer supports a variety of sample modules (see page 97 for accessories).

Use the following procedure to change the sample module:

1. Unlock the currently installed module by turning the module lock (located directly under the module on the front of the instrument) counterclockwise until it rests horizontally (see *Figure 7*).
2. Grasp the recessed hand hold under the module and slide the module straight out (do not lift up) (see *Figure 7*).
3. Slide the new module into the module compartment, and press firmly into place.
4. Re-lock the module before use by turning the sample module lock

Figure 6
Changing Adapters



clockwise to its vertical position.

Figure 7
Unlocking and Removing the Module



4.9 Using the Carousel Module

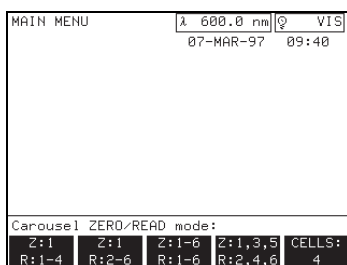
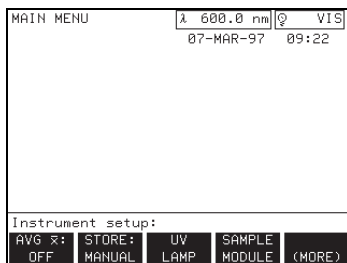
The Carousel Module provides a way to group, record, and graph several sample measurements at a time. Insert the carousel module as described in *Section 4.8*.

Place a carousel into the carousel module as follows:

1. To remove a carousel from the carousel module, grasp the handle of the carousel and pull straight up. Set the carousel aside (see *Figure 8*).
2. Grasp the handle on the carousel to be installed.
3. Place the center of the carousel on the motor spindle in the module. The reference arrow at the base of the handle should point in the direction of the flat side of the motor spindle. When properly aligned, the carousel will rest securely on the bottom of the module.

4.9.1 Instrument Setup for the Carousel Module

The DR/4000 Spectrophotometer provides several modes of operation for the Carousel Module. Each mode differs in how blank and active samples are loaded in the carousel.



Carousel modes are available in the instrument setup menu (**SETUP** key). When a Carousel Module is installed, the sample module option appears as a soft key. Carousel modes can be modified only when a Carousel Module is installed.

Modify the module setup by pressing the **SAMPLE MODULE** soft key in the instrument setup menu. The prompt line shows: **CAROUSEL ZERO/READ MODE**. The currently selected carousel mode will be underlined.

Soft Key	Function
Z: 1 R: 1-n	In the first cycle, a zero (blank sample) is placed in cell position 1 and samples are read in positions 2 through n. In subsequent cycles, a zero is not required and samples are read in positions 1 through n. This mode is useful with matched sets of 4 or 8 sample cells.
Z: 1 R: 2-n	A zero (blank sample) is required in cell position 1. Samples are read in positions 2 through n. The zero is measured once every cycle. This mode is useful with matched sets of 4 or 8 sample cells.
Z: 1-n R: 1-n	In the first cycle, a zero (blank sample) is placed in each cell position, 1 through n. In subsequent cycles, the zeroes are removed and the matching samples are read in positions 1 through n. Use this mode with pairs of matched sample cells.
Z: 1,3 R: 2,4	Zeroes (blank samples) are placed in the odd-numbered (1 and 3) cell positions. The matching samples are placed in the adjacent even-numbered (2 and 4) cells. Use this mode with pairs of matched sample cells.
CELLS	Selects the highest numbered cell to be read in any measurement cycle. Note that the "n" in each mode description above changes with each press of the CELLS soft key.

Select the carousel mode first, then select the number of active cells. Selecting a new mode automatically resets the number of active cells to four.

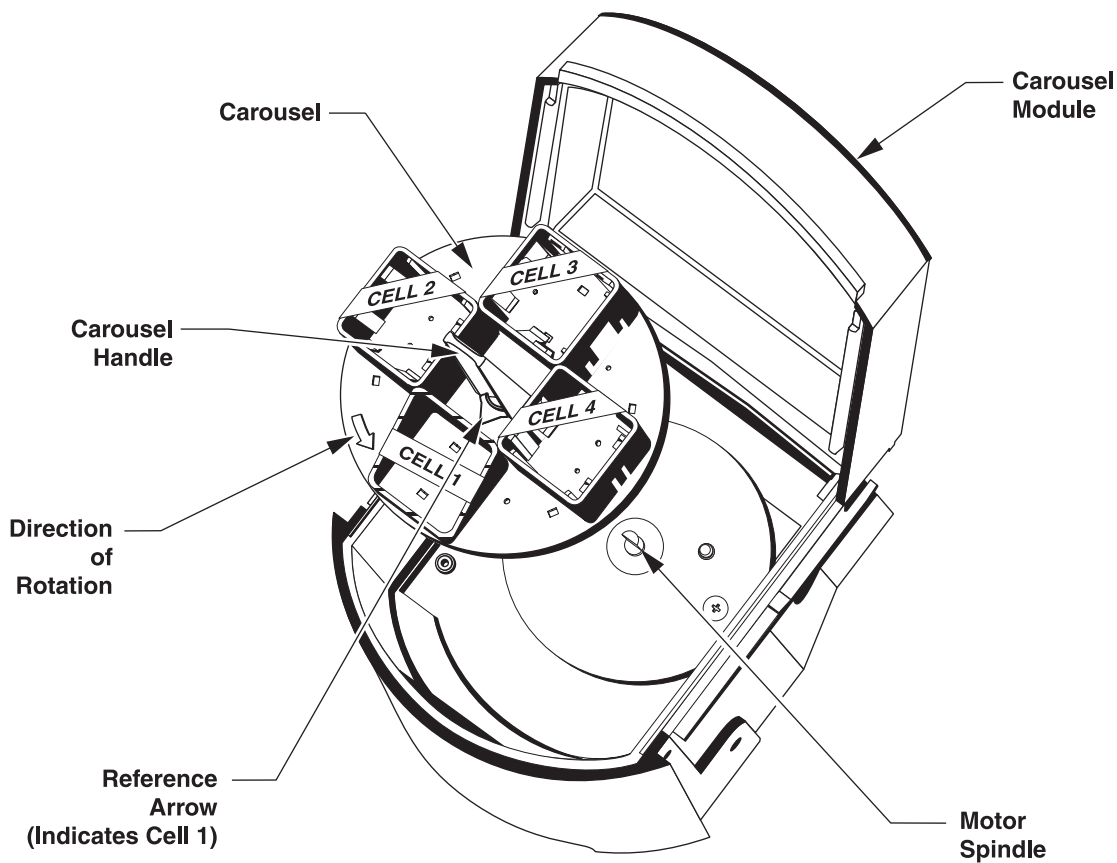
The one-inch, four-place carousel adapter (48105-00) has been improved since its initial design. The new version includes a brass insert in the bottom of the round base. This improves the fit of the adapter on the motor spindle, which improves reproducibility. If your current adapter does not have a brass fitting, contact Hach to obtain the improved version.

With the previous design, using the Z:1-n: R:1-n mode was necessary to achieve the specified reproducibility of ± 0.002 Abs. The improved carousel adapter allows this reproducibility with any of the setup modes.

A matched set of 4 and 8 DR/4000 sample cells is now available for use with the one-inch carousel adapter. These sets are especially convenient with the

"Z:1, R:1-n" and "Z:1, R:2-n" modes. After zeroing the instrument on a blank in cell position 1, read the samples in positions 2-4 or positions 1-4.

Figure 8
Carousel Module



4.9.2 Preparing a Carousel For Operation

1. Insert the Carousel Module into the DR/4000 (see *Figure 8*). Use only the one-inch cells specifically designed for the DR/4000:

Part Number	Description
26659-02	Two one-inch, matched sample cells
26659-04	Four one-inch, matched sample cells
26659-08	Eight one-inch, matched sample cells
26126-02	Two one-inch, matched, stoppered sample cells

NOTE: Precision sample cells in matched sets of 2, 4, or 8 are available for optimum reproducibility.

2. Place filled one-inch sample cells into the one-inch carousel adapter with the fill line facing the center of the carousel.

3. Insert the carousel into the module.
4. Press the **SETUP** key; the instrument setup menu is displayed.
5. Select the **SAMPLE MODULE** soft key; the carousel setup menu is displayed.
6. Select the setup option of your choice. n is the number of samples in the carousel. The default value of n is four, but n may be changed by pressing the **CELLS** soft key in the carousel setup menu. The **CELLS** soft key cycles through options for n from 2 to 6.
7. Press **EXIT** or **ENTER** to confirm the selection. The screen shows the measurement control menu. Press the **START** soft key to begin analysis.

NOTE: The Z: 1-n, R: 1-n option is not available in the measurement scan mode.

4.10 Optional Modules

Several optional accessory modules are available to enhance the accuracy of the DR/4000 Spectrophotometer (see page 97 for accessories). Refer to the manual provided with the optional module for detailed operating information.

WARNING

Do not use the Hach flow-cell modules with flammable samples or those containing hydrocarbons, solvents, concentrated acids or concentrated bases that may attack wetted parts of the cells. Conduct tests prior to use of the flow-cell modules if sample compatibility is questionable.

ADVERTENCIA

No use las células de flujo de Hach con muestras inflamables o que contengan hidrocarburos, solventes, ácidos concentrados o bases concentradas que puedan atacar las partes mojables de la célula. Experimente antes de usar las células de flujo, si existe duda sobre la compatibilidad de la muestra.

ADVERTÊNCIA

Não se deverá usar cubetas de fluxo Hach com amostras inflamáveis ou aquelas que contêm hidrocarbonetos, solventes, ácidos concentrados ou bases concentradas que podem atacar as partes molhadas das cubetas. Realize os testes antes do uso das cubetas de fluxo se é questionável a compatibilidade das amostras.

ATTENTION

Ne pas utiliser les cuves à circulation Hach avec des échantillons inflammables ou ceux contenant des hydrocarbures, solvants, acides concentrés ou bases concentrées qui peuvent attaquer les parties au contact du liquide. Effectuer des essais avant l'utilisation des cuves à circulation si la compatibilité de l'échantillon est douteuse.

WARNHINWEIS

Durchflußküvetten von Hach dürfen nicht in Verbindung mit brennbaren Proben oder Proben, die Kohlenwasserstoffe, Lösemittel, konzentrierte Säuren oder konzentrierte Basen enthalten, die benetzten Teile der Küvetten angreifen können, verwendet werden. Wenn die Verträglichkeit fraglich ist, sollten vor der Verwendung der Durchflußküvetten Tests durchgeführt werden.

4.10.1 Flow-Cell Module

The optional Flow-cell Module permits samples to be poured through a single, fixed sample cell (see *Figure 9*). Because the same optical characteristics exist for both zeroing and reading, any error that would result from optical differences between individual sample cells is eliminated. The

Flow-cell Module is available in 1-cm and 1-inch path lengths (see page 97 for accessories).

4.10.2 Sipper Module

The optional Sipper Module combines the advantages of the Flow-cell with the improved repeatability of a peristaltic pump delivery system (see Figure 9). The Sipper Module is available in 1-cm and 1-inch path lengths, and a 2 mL Micro, 1-cm path length (see page 97 for accessories).

4.10.3 Temperature Control Module

If thermal factors are critical in an analysis, this optional module will maintain the temperature of aqueous samples from 15-50 \pm 0.5 °C. Two 1-cm quartz sample cells, recommended for use with this module, are included.

Figure 9 Optional Modules

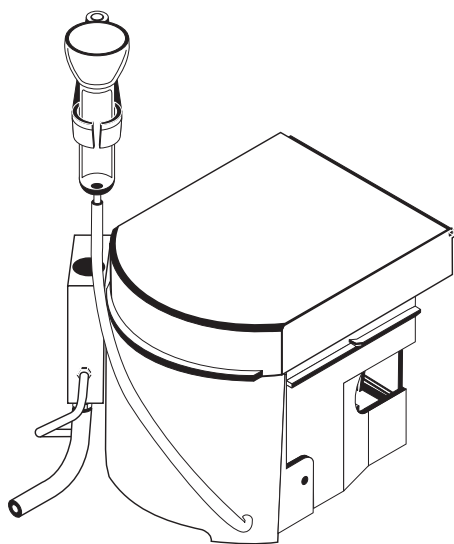
4.11 Common Measurement Control Operations

NOTE: The single wavelength mode is used as an example throughout this section.

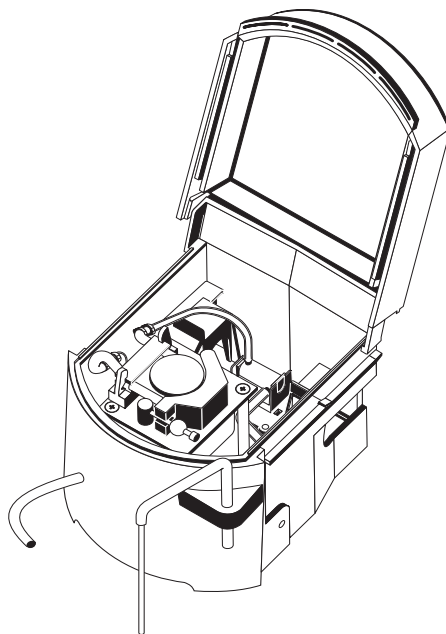
Several of the DR/4000 measurement control features are common to all modes of operation. The general purpose timer, and group and sample number settings are discussed below.

4.11.1 General Purpose Timer

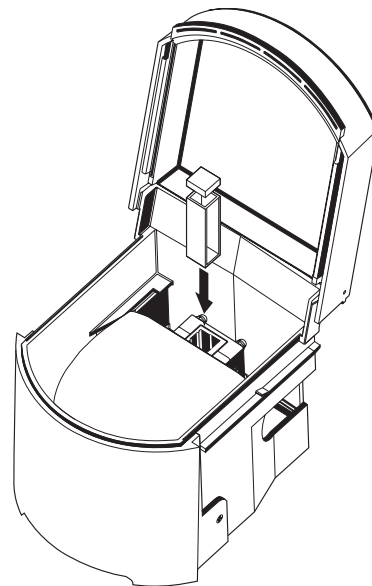
A general purpose countdown timer is provided in each measurement mode. The timer can be set and controlled while in a measurement control menu.



Flow-Cell Module
P/N 48070-04 and 48070-05

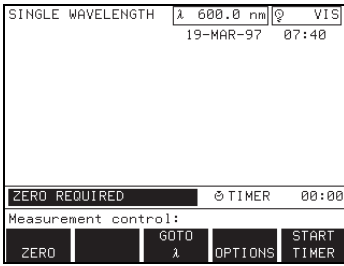


Sipper Module
P/N 48090-03 and 48090-06



Temperature Control Module
P/N 48070-08

The timer is labeled \odot TIMER and is shown in MINUTES: SECONDS format. The timer can only be set when MEASUREMENT CONTROL is displayed.



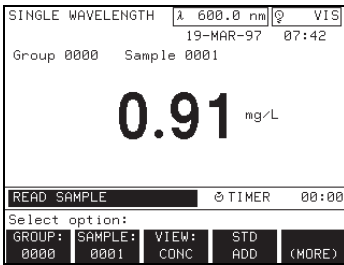
Set the timer by pressing the digit keys. The timer value will appear in the timer display. Press the **CE** key to cancel a timer entry. (There is no need to press the **ENTER** key to confirm the timer entry.)

Press the **START TIMER** soft key to start the timer countdown. **RESET TIMER** replaces **START TIMER** in the soft key label during countdown, and may be pressed at any time to stop the timer and reset it. You can not change the timer setting during the countdown.

Hach Programs may contain one or more pre-programmed timers in addition to the general purpose timer. Press the **NEXT TIMER** soft key until the general purpose timer \odot TIMER appears in the display. The timer can then be used as described above. The DR/4000 Procedures Manual supplied with the instrument instructs you in the use of pre-programmed Hach Program timers.

4.11.2 Setting Group and Sample Numbers

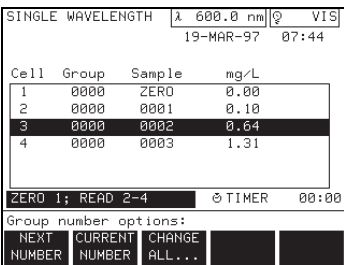
The DR/4000 provides a way to track laboratory samples by using programmable group and sample numbers. A sample number may be initialized by the operator for a particular sample. The instrument then automatically increments the sample number after each measurement is taken or stored.



The group number is used to categorize samples and may also be set by the operator; however, it remains constant and is not modified by the instrument. The group and sample numbers are stored and printed as part of every data record.

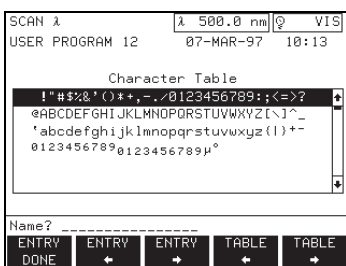
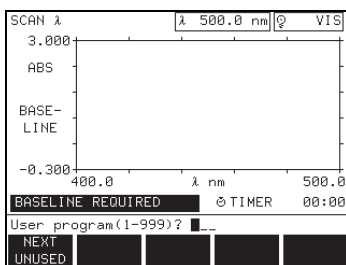
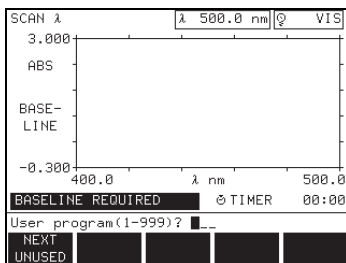
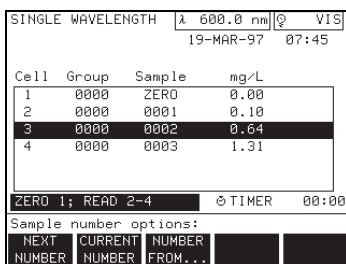
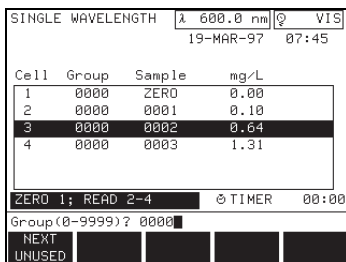
The group and sample number options are located in the options menu of each measurement mode. From the measurement control menu, press the **OPTIONS** soft key to access the options menu.

The **GROUP** and **SAMPLE** soft key labels display the current settings for the group and sample numbers. These values will be assigned to the next measurement taken or stored.



Press the **GROUP** soft key to assign a new group number. If data is present on the screen, the group number options menu is displayed. The group number options menu provides a way to program the next group number or edit the current results. If no data is present, only the next group number can be specified.

Soft Key	Function
NEXT NUMBER	Permits setting the next group number without affecting the current results on the display.
CURRENT NUMBER	Permits editing the group number of a result on the display.
CHANGE ALL...	Changes the next group number and the group number of all displayed results to the specified value (Carousel Module only).



Group numbers can range from 0 to 9999. The **NEXT UNUSED** soft key searches stored data to find the next higher unused group number, permitting new data to be uniquely identified.

Press the **SAMPLE** soft key to assign a new sample number. If data is present on the screen, the sample number options menu is displayed, permitting the operator to program the next sample number or to edit the current results. If no data is present, only the next sample number can be specified. Sample numbers can range from 1 to 9999.

Soft Key	Function
NEXT NUMBER	Permits setting the next sample number without affecting the current results on the screen.
CURRENT NUMBER	Permits editing the sample number of a result.
NUMBER FROM...	Re-numbers all displayed results and the next sample number, beginning at the specified number (Carousel Module only).

4.11.3 Saving User Programs

The DR/4000 Spectrophotometer lets you save settings for frequently-used modes of operation as user programs. Data are not saved by this method. Proceed as follows to save a user program:

1. Press the **SAVE PROGRAM** soft key under the **OPTIONS** selection in the current mode.
2. Enter a program number between 1 and 999 with the number keys, or select **NEXT UNUSED** for the next available program number and then press **ENTER**.
3. Select a name for the user program by using the up and down arrow keys to select a row of characters, and the **TABLE** left and **TABLE** right soft keys to move the cursor to the left or right along the row of characters. Press the **ENTER** key to select a character. The character will appear on the prompt line. Press the **ENTRY DONE** soft key when the name you want appears on the prompt line.

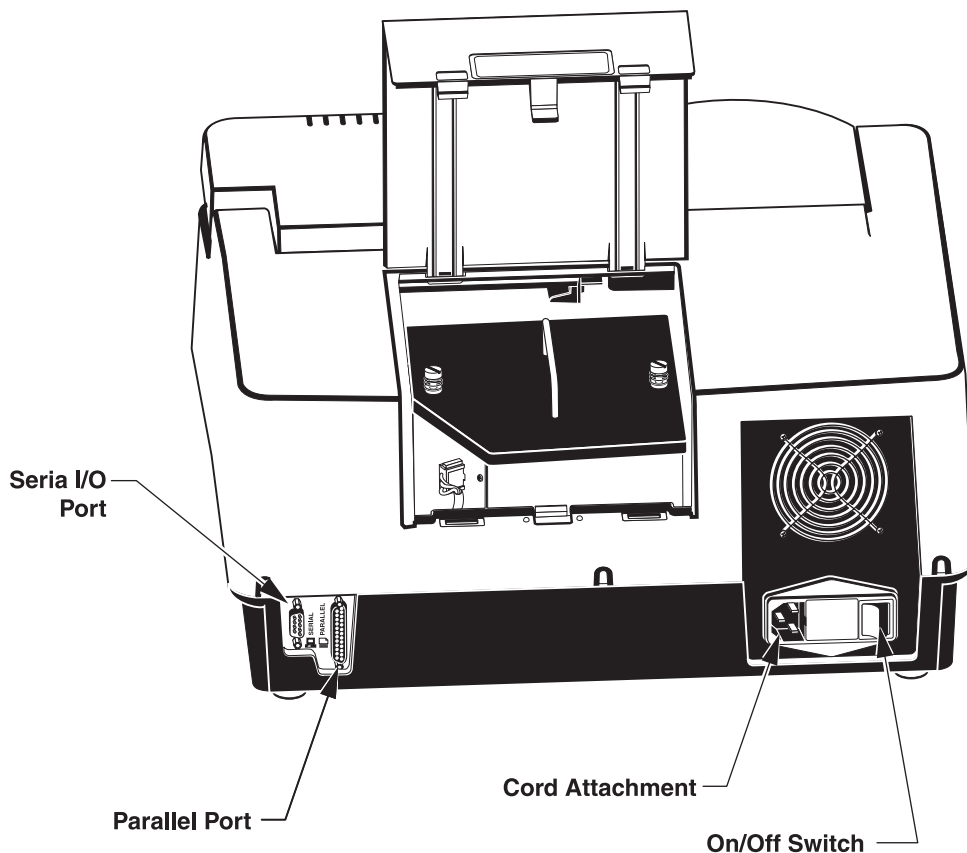
4.11.4 Recalling User Programs

Refer to Section 5.1 for instructions on recalling a user program.

4.12 RS232 Connections

All RS232 connections are made using the serial I/O port located on the back panel of the instrument (see *Figure 10*). This port utilizes an industry-standard 9-pin D connector.

Figure 10
Back Panel of DR/4000



4.12.1 Connecting to a PC

Connect the DR/4000 Spectrophotometer to a personal computer (PC) by using the computer interface cable, listed under *Optional Accessories* on page 97. The cable provides a direct connection between the DR/4000 Spectrophotometer and the 9-pin D connector used for the serial port on most personal computers. If your computer has a 25-pin D connector, use a 9-pin to 25-pin adapter (available at many computer supply stores). Refer to *Table 1* and *Table 2* if you need to wire a cable for special applications.

NOTE: Use of the specified cable or an equivalent shielded cable is mandatory for EC compliance.

For proper data transfer, the communication parameters (baud rate, data bits, and parity) of the DR/4000 and the computer must match, and the serial output option must be turned ON. Refer to Sections 4.6 and 11.2.6 for selecting DR/4000 serial I/O settings.

NOTE: Do not send graphics directly to a computer. Send all data in table form.

Once the communication link is established, press the **PRINT** key on the DR/4000 to send data to the computer.

4.12.2 Connecting to a Serial Printer

Connect the DR/4000 Spectrophotometer to a serial printer by using the printer interface cable, as listed under *Optional Accessories* on page 97. The cable provides a direct connection between the DR/4000 Spectrophotometer and the 25-pin D connector used for the serial port on most serial printers. Refer to *Table 1* and *Table 2* if you need to wire a cable for special applications.

NOTE: Use of the specified cable or an equivalent shielded cable is mandatory for EC compliance.

To print, the communication parameters (baud rate, data bits, and parity) of the DR/4000 and the printer must match, and the serial output option must be turned ON. See Sections 4.6 and 11.2.6 for selecting serial I/O settings.

Press the **PRINT** key on the DR/4000 to send data to the printer.

The tabular data format of the DR/4000 is compatible with serial printers that are at least 80 characters wide. Graphics can only be printed on printers that are directly compatible with the printer type selected in the printer setup menu (see Section 4.6.4). If your printer does not support graphics, or its graphics are not compatible with one of the available printer types, select the Generic - Text Only option.

Table 1

DR/4000 9-pin D Connector Socket		Computer 9-pin D Connector, plug	
Pin	Signal Name	Pin	Signal Name
2	RXD	3	TXD
3	TXD	2	RXD
4	DTR	no connection	
5	GND	5	GND
6	DSR	no connection	
7	RTS	8	CTS
8	CTS	7	RTS

Table 2

DR/4000 9-pin D Connector Socket		Serial Printer 25-pin D Connector, plug	
Pin	Signal Name	Pin	Signal Name
2	RXD	no connection	
3	TXD	3	RXD
4	DTR	no connection	
5	GND	7	GND
6	DSR	20	DTR
7	RTS	no connection	
8	CTS	20	DTR

4.12.3 Additional Interface Information

Depending on the interface application, it may be necessary to know the following communication characteristics:

- The DR/4000 sends one stop bit.
- The DR/4000 uses hardware handshaking.

- All lines end with a carriage return and line feed character sequence.

4.13 Parallel Port Connections

To connect a parallel printer to the instrument, use the parallel port (25-pin) on the back of the instrument (see *Figure 10*).

Select the appropriate printer from the Setup menu by pressing the **SELECT PRINTER** soft key. See Section 4.6.4 for more information.

If you are using only the parallel port, the serial I/O must be off or the parallel port will not print the information. To turn the serial I/O off, press the **SERIAL I/O** soft key in the instrument setup menu. Press the **OUTPUT** soft key until the soft key display shows OFF. If you are using both the serial and parallel port, the Serial I/O must be ON.

HACH PROGRAM		λ 420.0 nm	VIS
		02-MAY-97	14:16
Program	Parameter	Limit	
2250	Manganese, HR	20.0 mg/L	
2260	Manganese, LR	0.700 mg/L	
2300	Molybdenum, LR	3.00 mg/L	
2310	Molybdenum, HR	50.0 mg/L	
2320	Molybdenum, HR AV	50.0 mg/L	
2350	Nickel, Autocatal.	8.00 g/L	
Program to run? 2310			
A-Z SEARCH		PAGE UP	PAGE DOWN

NOTE: Press the **EXIT** key at any time to return to the Main menu.

The DR/4000 Spectrophotometer contains more than 120 programmed procedures that may be accessed through the Hach program menu. To see an alphabetical list of Hach programs with program numbers, press the **HACH PROGRAM** soft key in the main menu. The Hach program menu will be displayed. If you know the Hach program number you want, key in the number and press **ENTER**.

To choose a specific parameter by alphabetic listing, press the **A-Z SEARCH** soft key. The menu then divides the alphabet into five sections. Narrow the alphabetical search with the next two soft key entries. The display shows Hach programs beginning with the selected letter.

Use the **PAGE UP** and **PAGE DOWN** soft keys to scroll through the Hach program menu six parameters at a time. When you find the parameter you want, use the **UP** and **DOWN** arrow keys to highlight a program. Alternately, key in the program number using the numeric key pad. Press **ENTER** to display the measurement control menu of the Hach program selected.

5.1 Using the Single-Cell Module Within the Hach Program Mode

Follow the Hach Method in the DR/4000 Procedures Manual for the selected Hach Program. The wavelength setting at the top of the display is set automatically for the parameter being measured.

NOTE: Hach program 2310, Molybdenum, HR is used as an example throughout this section.

If you select the wrong program or want to change programs at any time, press **EXIT** once. (Pressing **EXIT** a second time will display the measurement control menu.) The prompt asks: EXIT TO MAIN MENU? Press the **NEW PROGRAM** soft key. The display returns to the Hach program menu. Select the new program as described above. The display shows the program's measurement control menu.

Store all valuable data before exiting the measurement control menu (see Section 10 Data Handling).

HACH PROGRAM 2310		λ 420.0 nm	VIS
Molybdenum, HR		02-MAY-97	14:17
ZERO REQUIRED		0.1 Wait	05:00
Measurement control:			
ZERO	OPTIONS	NEXT TIMER	START TIMER

Hach Program Measurement Control Menu

Soft Key	Function
ZERO	Sets the absorbance value to zero (see Section 5.1.1).
READ	Starts the sample measurement (only required for multi-wavelength programs or when Auto Store is selected).
OPTIONS	Displays the options menu for changing sample variables (see Section 5.1.3).
NEXT TIMER	Selects from multiple timers (see Section 5.1.2).
START TIMER	Starts selected timer countdown (see Section 5.1.2).

WARNING

This instrument is not intended for use with flammable samples or those containing hydrocarbons.

5.1.1 Taking Hach Program Measurements

ADVERTENCIA

Este instrumento no está destinado para uso con muestras inflamables o que contengan hidrocarburos.

ADVERTÊNCIA

Este instrumento não é feito com o fim de ser empregado com amostras inflamáveis ou aquelas que contêm hidrocarbonetos.

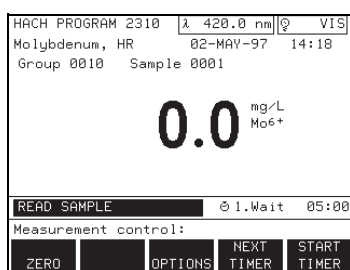
ATTENTION

Cet instrument n'est pas conçu pour une utilisation avec des échantillons inflammables ou des échantillons contenant des hydrocarbures.

WARNHINWEIS

Dieses Gerät darf nicht für Tests mit brennbaren Proben oder Proben, die Kohlenwasserstoffe enthalten, benutzt werden.

Place the blank sample cell in the cell compartment with the volume marks facing the front of the instrument. Close the module lid. The status bar shows: ZERO REQUIRED.



Press the **ZERO** soft key. The display shows: 0.0 mg/L Mo⁶⁺ and the status bar shows: READ SAMPLE.

Remove the blank sample cell from the cell compartment. Place the sample cell containing sample in the cell compartment with the volume marks facing the front of the instrument. Close the module lid. The instrument automatically reads the sample and displays the result. Repeat this step for the remaining samples. Store all valuable data before exiting the measurement control menu (see *Section 10 Data Handling*).

5.1.2 Using Programmed Timers

Some procedures require specific time periods for reagent reactions, color development, and sample manipulation (heating, mixing, etc.). These time periods are programmed into each Hach procedure. Press the **START TIMER** soft key to begin the programmed timer countdown. The time period for the Molybdenum HR program is five minutes.

After pressing the **START TIMER** soft key, press the **RESET TIMER** soft key at any time to return the timer to its original time. Press the **START TIMER** soft key again to repeat the timer countdown. When the countdown reaches zero a sequence of beeps sound.

At the end of the timer, the next Hach program timer is automatically set. Use the **NEXT TIMER** soft key to re-select a timer if required.

The general purpose timer is available in addition to the programmed timers. Press the **NEXT TIMER** soft key, until ⌚ TIMER is displayed. See *Section 1.11.1* for more information.

5.1.3 Hach Program Options

Press the **OPTIONS** soft key in the measurement control menu to display the option menu. These options let the operator change sample-related settings. Press the **(MORE)** soft key once or twice to view all of the options in the menu.

Hach Program Options Menu

HACH PROGRAM 2310	λ 420.0 nm	VIS
Molybdenum, HR	02-MAY-97	14:21
Group 0010	Sample 0001	
3.2 mg/L Mo6+		
READ SAMPLE 1.Wait 05:00		
Select option:		
GROUP:	SAMPLE:	VIEW:
0010	0001	CONC
		DIL X:
		1.0000 (MORE)

HACH PROGRAM 2310	λ 420.0 nm	VIS
Molybdenum, HR	02-MAY-97	14:22
Group 0010	Sample 0001	
3.2 mg/L Mo6+		
READ SAMPLE 1.Wait 05:00		
Select option:		
DEFAULT	UNITS:	FORM:
SETUP	mg/L	Mo6+
		STD
		ADD
		(MORE)

HACH PROGRAM 2310	λ 420.0 nm	VIS
Molybdenum, HR	02-MAY-97	14:22
Group 0010	Sample 0001	
3.2 mg/L Mo6+		
READ SAMPLE 1.Wait 05:00		
Select option:		
SAVE	BLANK:	STD:
PROGRAM	OFF	OFF
		(MORE)

Soft Key	Function
GROUP	Assigns a group number as discussed in Section 1.11.2.
SAMPLE	Assigns a sample number as discussed in Section 1.11.2.
VIEW	Displays data as concentration (CONC), absorbance (ABS), or percent transmittance (%T).
DIL X	Applies a dilution factor for a measurement.
DEFAULT SETUP	Restores default settings to program. Display returns to the measurement control menu.
UNITS	Selects from several different concentration units, depending on the procedure.
FORM	Selects choice of chemical form. Appears only if parameter has more than one common chemical form.
STD ADD	System of checking accuracy (see Section Section 4).
SAVE PROGRAM	Saves all settings in the current mode of operation. See Section 1.11.3 for details.
BLANK	Compensates for color in reagent blank (not available with all methods).
STD	Adjusts the calibration curve (not available with all methods).

The **UNITS** soft key lets the operator select from several units. The list of available units varies depending on the procedure. Repeatedly press the **UNITS** soft key to select units and to display them to the right of the data reading.

The **FORM** soft key appears only for Hach programs with more than one chemical form. The chemical form is displayed to the right of the data reading. The operator may choose to display readings in any form available by repeatedly pressing the **FORM** soft key. Conversion factors between chemical forms are programmed into the instrument, and readings change automatically when adjusting the chemical form.

The **DEFAULT SETUP** soft key returns all default settings to the selected Hach program. The display returns to the measurement control menu.

The **DIL X** soft key allows the operator to enter a dilution factor. The current result and all subsequent results will be multiplied by the dilution factor that is entered. For example, if the sample has been diluted by a factor of 2, enter 2. The dilution factor symbol appears in the upper right of the display to indicate the adjustment is being made. The default setting for this option is 1 (off).

Press **EXIT** to return to the measurement control mode.

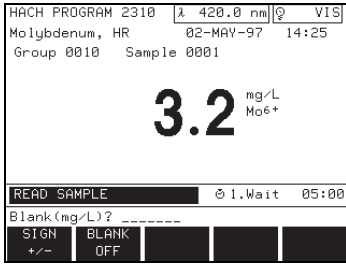
5.1.4 Reagent Blank

The reagent **BLANK** soft key lets the operator select a specific value for a reagent blank. Using a reagent blank is equivalent to adding a y-intercept value to the calibration line (i.e., concentration = (CONC X) ABS – reagent blank).

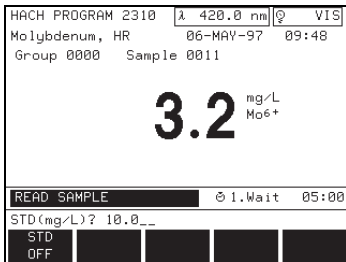
Press the **BLANK** soft key to display the reagent blank menu.

NOTE: The options menu varies according to the program. For example, the **FORM** soft key will not appear on the menu for programs with only one chemical form.

NOTE: The dilution factor can also be used to adjust for a variety of properties such as specific gravity and sample weight (i.e., digestions).



NOTE: When a reagent blank has been entered, pressing the **ZERO** soft key (in the measurement control menu) displays the negative blank correction value rather than zero.



NOTE: The calibration curve for single wavelength readings can be adjusted using the **STD** soft key.

Reagent Blank Menu

Soft Key	Function
SIGN ±	Changes sign on keyed-in value.
BLANK OFF	Turns reagent blank setting off.

The display prompts to enter a value for the reagent blank. If the instrument has already been zeroed and is currently displaying the blank value, this value will be inserted in the Blank (mg/L) box. Use the **SIGN** soft key to change the sign of the value, if necessary, then press **ENTER**. The reagent blank symbol appears in the upper right of the display to indicate the adjustment is being made. To turn the blank off, press the **BLANK OFF** soft key.

5.1.5 Standard Adjustment

Press the **STD** soft key. The screen prompts for the standard concentration value.

Standard Adjustment Menu

Soft Key	Function
STD OFF	Turns standard adjustment setting off

Place a known standard into the instrument with the volume marks facing the front of the instrument. Press the **ENTER** key to accept the default value, or key in a new value and then press **ENTER**. The new value is displayed in the **STD** soft key label and the standard adjustment symbol (**STD**) appears in the upper right of the display to indicate the adjustment is being made. To turn the standard adjust off, press the **STD** soft key, then press the **STD OFF** soft key.

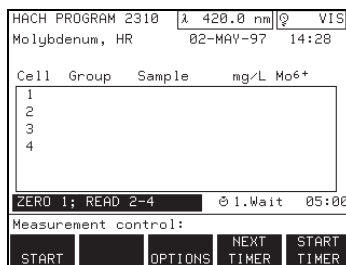
5.2 Using the Carousel Module Within the Hach Program Mode

For information on changing sample modules, loading and inserting the carousel, or instrument setup for the Carousel Module, see Section 1.9.

The Carousel Module options and measurement control menus are similar to the Single-cell Module menus described in Section 5.1. Minor differences appear in the **GROUP** and **SAMPLE** soft keys, as discussed in Section 1.11.2.

Before taking sample readings in the Carousel Module, choose the mode of operation (if different from the default setting) by following the instructions in Section 1.9.1. Next, choose options for sample readings with the **OPTIONS** soft key under the measurement control menu discussed in Section 5.1.3.

The status bar indicates which cells to load with zeroes (blank samples) and which cells will be read (active cells). To begin the first set of measurements,



press the **START** soft key. The instrument adjusts the carousel to measure the number one cell, and measures the remaining cells as programmed through the instrument setup menu (**SETUP** key). The status bar shows: ZEROING... and READING... as the carousel turns, and the instrument takes readings.

Press the **CANCEL** soft key (present only after **START** is pressed) at any time to erase all readings and start over. An alert sounds as the last reading appears on the screen.

The screen displays readings from each sample as cell number, group number, sample number, and result with units as selected with the **VIEW** soft key: concentration (CONC), absorbance (ABS), or percent Transmittance (%T).

All other measurement control functions operate in the same manner as the Single-cell Module described above.

5.3 Storing Data From a Hach Program

The setup options provide manual and automatic storage. Refer to Section 1.6.2 for instructions on setting this option. Use the following procedures to manually or automatically store data.

5.3.1 Manual Storage of Data

In the manual storage mode, simply press the **STORE** key after each reading to add the sample reading to the data log. If a carousel module is being used, all non-zero results are stored with one press of the **STORE** key.

5.3.2 Auto Storage of Data

In the automatic storage mode, a **READ** soft key is added to the measurement control menu. When **READ** is pressed, the instrument will read the sample, place the result in the data log, and then display: DATA STORED. The display result is not updated continuously when in the automatic storage mode. If a carousel module is being used, all non-zero results are stored automatically after the last active cell is read.

5.4 Customizing a Hach Program

Following the instructions in Section 1.11.3 to save the selected Hach program as a user program. All options in effect (such as units, forms, dilution factor, reagent blank, and standard adjust) are saved with the program and will be restored when the user program is recalled (for more information see section 5.1 *Recalling a User Program*).

6.1 Accuracy and Precision

Accuracy is the nearness of a test result to the true value. Precision is how closely repeated measurements agree with each other. Although good precision suggests good accuracy, precise results can be inaccurate. The following paragraphs describe how to improve the accuracy and precision of analyses by using standard additions.

One of the greatest aids is knowing what is in the sample. You don't need to know exactly what is in each sample, but be aware of substances that are likely to interfere in the analysis method you use. When using a method, it may be helpful to determine if those interferences are present.

6.1.1 Standard Additions

Standard additions is a common technique for checking interferences, bad reagents, faulty instruments, and incorrect procedures. This technique is also referred to as "spiking" and "known additions."

Perform Standard Additions by adding a small amount of a standard solution to your sample and repeating the test. Use the same reagents, equipment, and technique. You should get close to 100% recovery. If not, you have an identifiable problem.

If standard additions works for your test, a Standard Additions Method section will be in the procedure under *Accuracy Check*. Follow the detailed instructions given.

If you get about 100% recovery for each addition, everything is working right and your results are correct.

If you don't get about 100% recovery for each addition, a problem exists. You can tell if you have an interference in your sample. Repeat the standard additions using demineralized water as your sample to check the reagents, instrument, and technique. If you get about 100% recovery for each addition, you have an interference in your sample. See Section 1.4.2, *Estimating Concentration Using Standard Additions* in the DR/4000 Procedures Manual. If you didn't get good recoveries with the demineralized water, use the following checklist to find the problem:

1. Check to see that you are following the procedure exactly:
 - a) Are you using the proper reagents in the proper order?
 - b) Are you waiting the necessary time for color to develop?
 - c) Are you using the correct glassware?
 - d) Is the glassware clean?
 - e) Does the test need a specific sample temperature?
 - f) Is the sample's pH in the correct range?

Hach's written procedure should help you to answer these questions.

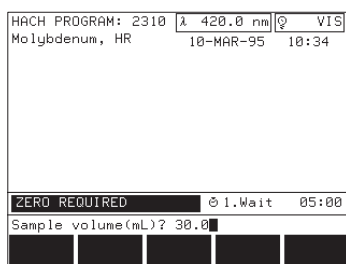
2. Check the performance of your instrument. Follow the instructions in the *Trouble Shooting/Service Checks* section of this manual.
3. Check your reagents. Repeat the standard additions using new, fresh reagents. If your results are good, the original reagents were bad.
4. If nothing else is wrong, the standard is almost certainly bad. Repeat the Standard Additions with a new standard.
5. If you still cannot identify the problem, you need some extra help. Please call our Technical Support Group at 800-227-4224 (U.S.A.) or 970-669-3050. A representative will be happy to help you.

6.2 Selecting the Standard Addition Option

Standard additions involves adding small volumes of a known standard to a specific volume of sample. This “spiked” sample is then analyzed for the additional standard. The process includes three important items: (1) standard concentration; (2) standard additions volumes; and (3) sample volume. The sample volume is not necessarily the volume analyzed in the procedure; it is the volume of sample to which the standard is added. For example, in Hach Program 2310, standard is added to 30 mL of sample, but only 10 mL of the solution is actually analyzed in the procedure. This is also true for most of the Test ‘N Tube chemistries (i.e., In Hach Program 2460, standard is added to 25 mL of sample but only 2 mL of the solution is actually analyzed). It is important to note that the volume of sample tested in the method does not change.

Hach Programs offering the standard additions option are pre-programmed with consideration for the three items listed above. These values are the same as outlined in the Accuracy Check instructions at the back of the procedure. If alternative spiking schemes are desired, the default values can be overridden. The values entered into the DR/4000, however, are the same as those used to spike the samples.

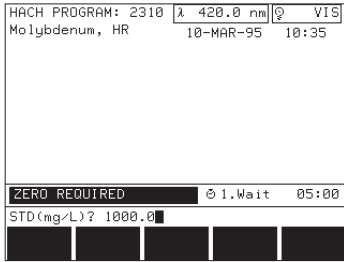
NOTE: *Standard additions uses the units and chemical form currently in effect. Make certain that subsequent entries are made in the correct units.*



Select a measurement mode from the main menu. Modes with the standard additions option include Hach programs, user programs, and single and multi-wavelength. Not all Hach Programs include the accuracy check option. Hach Program 2310 is used as an example throughout this section.

From the measurement control menu, press the **OPTIONS** soft key. If necessary, press the **(MORE)** soft key until the **STD ADD** option appears in the options menu. Press the **STD ADD** soft key to select standard additions.

The prompt line will request the sample volume to which additions will be made. When using a Hach Program, the sample volume outlined in the Accuracy Check will be presented as a default entry. This is not necessarily the sample volume used in the test. Press the **ENTER** key to accept the default value, or use the digit keys to specify an alternate sample volume, then press **ENTER** to confirm.



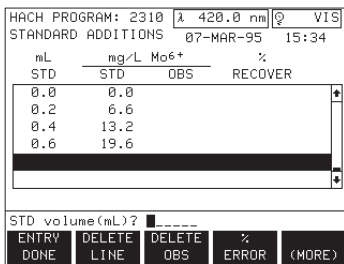
NOTE: If you have zeroed on a blank and the screen is displaying that value, the instrument will insert this value as the 0,0 value in the standard additions table. Values for the OBS and % Recover columns will appear. If you wish to change the blank value, complete the standard additions procedure, then edit the standard additions table.

The prompt line requests entry of the standard concentration. When using a Hach Program, the standard concentration outlined in the Accuracy Check will be presented as a default entry. Press **ENTER** to accept the default concentration.

Some chemicals (chlorine for example) are less stable than others, or the concentration of different lots of standard may vary when shipped from the factory. These chemicals have a certificate of concentration included in the carton. When the DR/4000 prompt line reads: STD (mg/L)?_ _ _ __, enter the concentration value shown on the certificate. Make sure the displayed units are the same as the units on the certificate, then press **ENTER** to confirm.

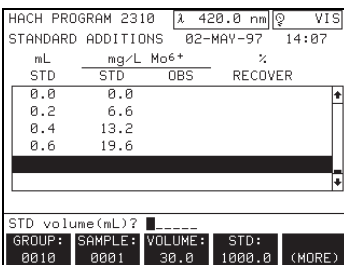
The instrument next displays the standard additions table. Use this table to specify the volumes of standard that will be added to a series of samples. As few as one, or as many as 11 additions may be specified. When using a Hach Program, a set of default standard volumes may be loaded automatically as outlined in the Accuracy Check.

Enter the spike volumes with the digit keys and press **ENTER** to confirm. Editing is accomplished by using the **UP** and **DOWN** arrow keys to select a line in the table, then using the digit keys and the **ENTER** key to enter a new value. Press the **ENTRY DONE** soft key when entry of the spike volumes is complete. The screen will switch to the measurement control screen for the standard additions.



Standard Addition Options Table

Soft Key	Function
ENTRY DONE	Signifies that standard volume entry is complete.
DELETE LINE	Removes the currently selected line from the table.
DELETE OBS	Removes the selected observed result (OBS) from the table, permitting the result to be re-read later.
% ERROR % RECOVERY	Deviations of observed results from ideal may be displayed as percent recovery or percent error. This soft key toggles between the two options.
GROUP	Permits the user to edit the group number of the standard addition result (group numbers are not assigned to the individual observed results).
SAMPLE	Permits the user to edit the sample number of the standard addition result (sample numbers are not assigned to the individual observed results).
VOLUME	Provides a way to edit the sample volume.
STD	Provides a way to edit the standard concentration.



NOTE: It is important to run both the spiked and unspiked samples through the procedure for appropriate color development.

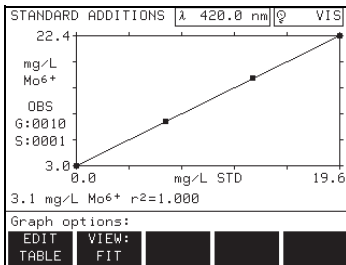
If the instrument is zeroed before the standard additions mode is entered, the existing zero will be used in the standard additions calculation. If a zero is needed, the screen will prompt: ZERO REQUIRED. Zero on sample or a reagent blank as instructed in the procedure. Be sure to follow the steps outlined in the procedure and to use the sample volume requested; using the wrong volume will produce incorrect results. This sample volume is not necessarily the same as the volume outlined in the Accuracy Check.

HACH PROGRAM: 2310				λ 420.0 nm		VIS	
STANDARD ADDITIONS				07-MAR-95		15:43	
mL	mg/L Mo6+		%				
STD	STD	OBS	RECOVER				
0.0	0.0	-0.0	100.00				
0.2	6.6						
0.4	13.2						
0.6	19.6						

READ SAMPLE 01.Wait 05:00

Measurement control:

ZERO	READ	NEXT	START
		TIMER	TIMER



NOTE: An r^2 value > 0.90 is required for a good fit.

HACH PROGRAM 2310				λ 420.0 nm		VIS	
STANDARD ADDITIONS				02-MAY-97		14:12	
mL	mg/L Mo6+		%				
STD	STD	OBS	RECOVER				
0.0	0.0	3.0	100.00				
0.2	6.6	9.6	100.28				
0.4	13.2	16.1	99.50				
0.6	19.6	22.4	99.24				

STD volume(mL)? -----

ENTRY	DELETE	DELETE	%	
DONE	LINE	OBS	ERROR	(MORE)

Once the zero is entered into the instrument, insert the original, unspiked sample and press the **READ** soft key. Some procedures require that only a portion of the unspiked sample be used; transfer the volume outlined in the procedure to an appropriate sample cell and press the **READ** soft key. When the instrument has read the original sample, the highlighted line will move down to the first standard addition. Insert the appropriate volume of the standard addition to be read and press the **READ** soft key. Repeat this process for all standard additions.

When the last standard addition has been read, the instrument will create a plot of the data showing the observed concentration of the standards on the y-axis and the concentration of standard added on the x-axis. The left side of the screen shows the group number (G:0000) and the sample number (S:0001).

The concentration of the zero standard as calculated using the results of the standard additions is shown below the graph. To the right of this value is the calculated r^2 value. The r^2 value should be close to 1.00. If the r^2 value is less than 0.90, **LINE?** will be displayed. This prompt is shown to bring the r^2 value to the analyst's attention. The soft key options are **EDIT TABLE** and **VIEW**.

Press the **VIEW** soft key to toggle the displayed graph between fit and ideal. Use this function to show how the actual recovery of the standard additions compares to the ideal (100%) recovery.

One or more of the readings can be revised if necessary. Press the **EDIT TABLE** soft key and use the arrow keys to move the highlighted line to the value to be changed. Press the **DELETE LINE** soft key to delete the entire line or press the **DELETE OBS** soft key to erase the observed concentration value read previously. Press the **ENTRY DONE** soft key to continue.

If a line is deleted, the instrument will regenerate the standard additions graph using the remaining data. If an observed concentration value is deleted, a press of the **ENTRY DONE** soft key will return the instrument to the **READ SAMPLE** screen. The analyst may now insert the standard to be re-read. The new concentration(s) will be entered and a new graph generated.

Store and/or print the data by pressing the appropriate **STORE** and/or **PRINT** data key. Recall standard additions stored data in the same manner as is used to recall any other data. If a group or sample number has been specified for the standard additions, that number may be used to specify which data to recall. See Section *Section 3* for more information.

6.2.1 Estimating Concentration Using Standard Additions

If you know you have an interference, you may still be able to estimate the concentration of the analyte in your sample. The following steps will help you to estimate the result:

1. Use the Standard Additions Method section under *Accuracy Check* in your procedure to analyze the sample.
2. When you finish, the display shows a plot of the data and a line that

estimates it. It also shows a concentration in the lower left corner. It may also say LINE? below the plot. If it doesn't say LINE? skip to step 4.

3. LINE? means the data may not plot as a line or your results show as a negative number. Check the plot on the screen carefully and answer the following questions:
 - a) Do the points seem to plot as a line? If no, you may not estimate the result. Try to use another method to analyze the sample. If yes, go to 3b.
 - b) If the concentration is a small negative number, there is no analyte in the sample. If the concentration is a large negative number, you will not be able to estimate a result. Try to use an alternative method to analyze your sample. If you answered yes to 3a and you have a positive number, go to Step 4.
4. The data plots as a line, so you can estimate the result. The concentration in the lower left corner of the display is the estimate.

Below the plot is the calculated r^2 value. This is a measure of how well the data plots as a line. If $r^2 = 1.000$, 100% of the variation in your data is due to the standard additions you made. If $r^2 = 0.900$, 90% of the variation in your data is due to the standard additions you made. The other 10% is unexplained. LINE? will show if r^2 is less than 0.900 (the unexplained variation is large and your data may not plot as a line). Carefully checking the plot will help you decide if your data really plots as a line. If it plots as a curve, you cannot estimate a result. Remember, the smaller r^2 is, the less chance your data plots as a line.

LINE? will also show if the calculated concentration is less than zero. Sometimes the measurement variation will cause a small negative reading for a zero concentration. Just report zero for the concentration. A large negative number means the data doesn't plot as a line. Use another method to analyze your sample if this occurs.

A user program lets you customize and save the settings of any mode of operation. To create a user program, refer to the appropriate section of this manual to select the desired mode of operation (sections 6-9). Adjust settings as needed and use the SAVE program option to save the settings.

In the user program mode, you may also create, edit, and recall user-entered calibrations. This lets the operator create custom calibration curves and analysis procedures.

7.1 Recalling a User Program

With the instrument on and at the main menu screen, press the **USER PROGRAM** soft key. The screen displays available user programs, user-entered calibrations, and any factory-supplied programs which are available to be copied. The user program numbers, names, and dates stored are also displayed.

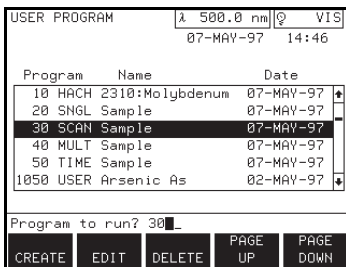
When recalling user programs, the following abbreviations appear on the screen to identify the operation mode:

<u>Abbreviation</u>	<u>Operation Mode</u>
USER	User-entered calibrations
HACH	Hach Programs
SNGL	Single Wavelength
MULT	Multiple Wavelength
SCAN	Wavelength Scan
TIME	Time Course

From the user program menu, it is possible to run an existing program, create a new program, edit a program, or delete a program. The following table gives a brief description of options discussed in the upcoming sections.

User Program Menu

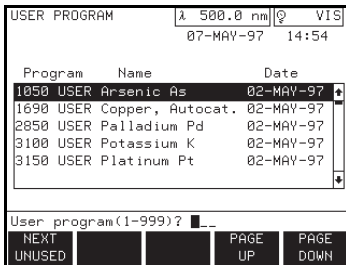
Soft Key	Function
CREATE	Allows the user to create a new user-entered calibration.
EDIT	Allows the user to make changes to an existing user-entered calibration.
DELETE	Gives the option to delete an existing user program or user-entered calibration.
PAGE UP	Moves the highlighted line up one full screen or to the top of the screen. (Available if seven or more programs are shown in the user program screen.)
PAGE DOWN	Moves the highlighted line down one full screen or to the bottom of the screen. (Available if seven or more programs are shown in the user program screen.)



Select the **USER PROGRAM** soft key from the main menu. Use the **UP** or **DOWN** arrow keys to highlight the desired user-entered program or key in the program number with the numeric keypad. Press the **ENTER** key to begin using the program selected. User programs will enter the same mode of operation from which they were saved (as indicated by the table of

abbreviations above). User-entered calibrations operate with the same measurement control menu as Hach programs (see Section *Section 2*).

7.2 User-Entered Calibrations



7.2.1 Assigning a New Program Number

Press the **CREATE** soft key. The prompt line will ask for a new program number. Enter the number using the numeric keypad and press the **ENTER** key. When a valid number is entered, the display will change and prompt the user to select the program type.

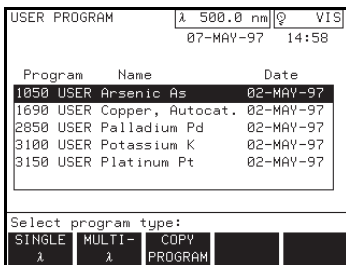
Each user-entered calibration may be assigned a unique number between 1 and 999. This number is displayed in front of the specified program as part of the user program.

Four-digit program numbers are reserved for Hach user calibration templates (see Section 7.5). The prompt line will flash **INVALID ENTRY** if the number is already in use.

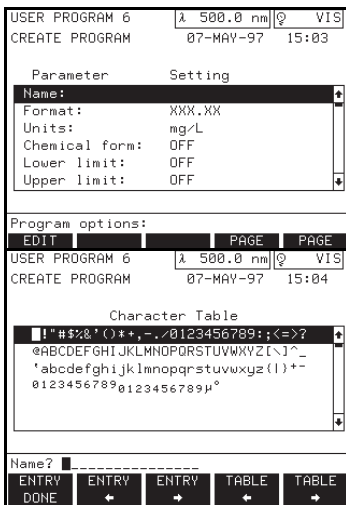
NOTE: Press the exit key at any time to return to the main menu.

To assign the next available number, press the **NEXT UNUSED** soft key and then press **ENTER**.

7.3 User-Entered, Single Wavelength Calibration



A press of the **SINGLE λ** soft key brings up the create program screen where parameter and setting information can be entered. The highlighted line (PROGRAM NAME) is active and may be edited with a press of the **EDIT NAME** soft key. When the **EDIT NAME** soft key is pressed, a character table is displayed on the screen.



The **UP** and **DOWN** arrow keys move the highlighted line up and down through the character table. The soft keys with entry arrows move the cursor on the prompt line to the right and left. The **TABLE ARROW** soft keys move the cursor in the highlighted line to the right or left. Press the keys or hold them down to scroll through the choices.

When the proper character in the table is flashing, press the **ENTER** key. The character is added to the name at the spot where the entry cursor is positioned. Press the **ENTRY DONE** soft key to return to the parameter table.

After a name is entered, the highlighted line moves down to **FORMAT**. The **FORMAT** soft key cycles through choices for decimal placement. Press the **ENTER** key to accept a decimal position and move on to the **UNITS** line.

Two soft keys are available for units selection. Scroll through the preprogrammed choices with repeated presses of the **UNITS** soft key. Continue by pressing the **ENTER** key, or create your own units by pressing the **CUSTOM UNITS** soft key. The character table is displayed and characters are selected in the same manner as editing a name. Press the **ENTRY DONE** soft key when your custom units are complete.

NOTE: The **LIMIT OFF** soft key sets the lower or upper limit back to (none).

USER PROGRAM 6		λ 500.0 nm	Q VIS
CREATE PROGRAM		07-MAY-97	15:05
Parameter	Setting		
Name:	XXXXXXXXXX		
Format:	XXX.XX		
Units:	mg/L		
Chemical form:	OFF		
Lower limit:	OFF		
Upper limit:	OFF		
Limit(mg/L)? -----			
SIGN	LIMIT	PAGE	PAGE
+/-	OFF	UP	DOWN

NOTE: Accept the displayed wavelength value by pressing the **ENTER** key.

USER PROGRAM 6		λ 500.0 nm	Q VIS
CREATE PROGRAM		07-MAY-97	15:09
Parameter	Setting		
Chemical form:	OFF		
Lower limit:	OFF		
Upper limit:	OFF		
Wavelength:	500.0 nm		
Calib. table:	OFF		
Calib. formula:	C=a+bA		
Program options:			
CREATE		PAGE	PAGE
TABLE		UP	DOWN

USER PROGRAM 6		λ 500.0 nm	Q VIS
CREATE PROGRAM		07-MAY-97	15:11
mg/L	ABS		
0.0000	0.000		
0.1000	0.010		
0.5000	0.050		
0.9000	0.090		
1.0000	0.100		
Conc(mg/L)? -----			
ENTRY	EDIT	DELETE	
DONE	ABS	LINE	

USER PROGRAM 6		λ 500.0 nm	Q VIS
CREATE PROGRAM		07-MAY-97	15:15
mg/L	ABS		
0.0000			
0.1000			
0.5000			
0.9000			
1.0000			
ZERO REQUIRED			
		⊗ TIMER	00:00
Measurement control:			
ZERO			START
			TIMER

Enter a chemical form in the same manner. Press the **EDIT FORM** soft key to enter the character table. Choose characters from the character table accepting each with the **ENTER** key. Press the **ENTRY DONE** soft key when the chemical form entry is complete. Press the **ENTER** or **DOWN** arrow key to move to the line to specify the lower limit of the test.

Enter the lower and upper limits using the digit keys then press the **ENTER** key. If a negative value is to be entered, press the **SIGN** soft key before the numbers are entered. Enter a lower limit to enable an under range warning (UNDER!) if a measurement falls below the lower limit. Enter an upper limit to enable an over range warning (OVER!) if a measurement exceeds the upper limit. The user can thus be warned of values outside the working range of the test.

Make sure the appropriate line is highlighted, then specify the wavelength by keying in the number with the numeric keypad. Accept with a press of the **ENTER** key or use the **DOWN** arrow key to move to the next line.

The user has two choices at this point in the user-entered calibration menu. A calibration table may be created (see *Option 1 below*) or the user may bypass the calibration table option and enter a Calibration formula instead (see *Option 2 below*).

Option 1: Create a calibration table by entering the concentration values, then measuring or entering corresponding absorbance values. A calibration curve is selected from the resulting graph.

Option 2: If the user has the means to determine the mathematical relationship (i.e., calibration curve) between concentration and absorbance (using linear regression or other curve-fitting software), any of three types of equations (linear, quadratic, or cubic) can be entered by inputting values for the coefficients.

If the user chooses to use the calibration table option, make sure the highlighted line is on CALIB. TABLE. Press the **CREATE TABLE** soft key to enter concentration values for this program. Key in the desired standard concentration values using the numeric key pad. Press the **ENTER** key after each value to add it to the table. If the instrument is to read the standards and enter the corresponding absorbances to the table, press the **ENTRY DONE** soft key now. Use the soft key options to read the zero and other standards and enter the corresponding absorbance.

Add the zero concentration standard to the sample compartment and press the **ZERO** soft key. Press the **READ** soft key to accept the absorbance reading for

the zero concentration. Place each standard concentration sample cell into the sample cell holder in the order listed on the screen, close the lid, and press the **READ** key. When the last standard is read, the display changes to show a graphical representation of the data. The formula used to generate the graph is shown below the graph. The A_0 value and/or the r^2 value is also displayed.

NOTE: If an error is made while entering numbers on the prompt line, press the **CE** key to clear and start over.

NOTE: C =Concentration; a , b , c , and d = coefficients; A =absorbance

The absorbance values may be directly keyed in after entering the concentration values. Press the **EDIT ABS** soft key and enter the numerical value on the prompt line (change the sign before entering numbers by pressing the **SIGN** soft key). Press the **ENTER** key to accept each entry. Press the **ENTRY DONE** soft key after all the standard values are entered into the table. Four possible mathematical relationships between Concentration and Absorbance are offered. These options are as follows:

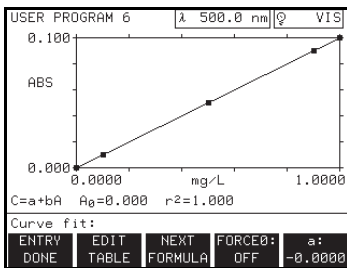
1. Piecewise Linear: $C = \text{Piecewise}(A)$; A_0 is displayed
2. Linear: $C = a + bA$; A_0 is displayed
3. Quadratic: $C = a + bA + cA^2$; A_0 is not displayed
4. Cubic: $C = a + bA + cA^2 + dA^3$; A_0 is not displayed

Although the displayed graph shows concentration on the x-axis, and absorbance on the y-axis, the equations used to calculate the concentration in the sample correspond to the inverse relationship. That is, the equations are based on concentration being the dependent (y-axis) variable and absorbance being the independent (x-axis) variable.

A_0 is the absorbance corresponding to a zero concentration, according to the current fit being used. While using a linear, quadratic, or cubic equation, and from the display that shows the graph, the soft key options are as follows.

Curve Fit Options

Soft Key	Function
ENTRY DONE	Returns the user to the Parameter/Setting display.
EDIT TABLE	Returns the user to the calibration table so concentration and/or absorbance values may be edited.
NEXT FORMULA	Toggles to the next available formula. The graph changes to display the calculated line.
FORCE 0	Forces the calibration through the origin (0 conc, 0 Abs) if ON is selected. Allows a non-zero intercept if OFF is chosen.
a, b, c, d	Repeated presses scroll through the coefficients for the displayed formula/graph.



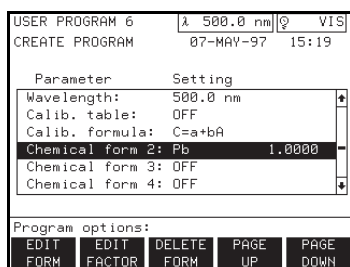
If changes to the entered data are needed, press the **EDIT TABLE** soft key to return to the concentration and absorbance values in the table. The table appears on the display and the soft key menu changes to **ENTRY DONE**, **EDIT ABS** and **DELETE LINE**. The cursor prompts for a new concentration value or an adjustment to an existing concentration value on the CONC (mg/L) ? _ _ _ _ prompt line. Use the **UP** and **DOWN** arrow keys to highlight any line of data that requires a change. Enter the concentration using the digit keys.

If the standard needs to be re-read and a new absorbance reported, highlight the line using the arrow keys, press the **EDIT ABS** soft key, then press the **CE** key and the **ENTER** key. When the **ENTRY DONE** soft key is pressed, the instrument will prompt to read the edited standards.

Insert the standards in the order listed and press the **READ** soft key. The instrument will read the standards and report an absorbance value. The information will be added to the calibration table.

Change an absorbance value directly by pressing the **EDIT ABS** soft key. The prompt line will ask for a new absorbance value. Enter the new absorbance and press the **ENTER** key to accept the new value. Press the **ENTRY DONE** soft key to exit the calibration table display.

If the calibration table option was by-passed, a calibration curve formula must be entered. It will also be necessary to enter values for the coefficients in the formula. The calibration curve formula line provides a variety of formulas. Scroll through the preprogrammed list by pressing the **NEXT FORMULA** soft key repeatedly. To manually enter a calibration curve, select the **EDIT FORMULA** soft key and enter coefficient values with the digit keys.

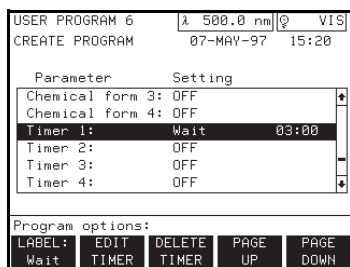


NOTE: The **EDIT FACTOR** soft key does not appear until a chemical form is entered.

If an original chemical form was entered earlier, additional forms may be entered at this time. Along with each additional chemical form entered, the user must also enter a conversion factor. The factor will define the mathematical relationship between the first chemical form and this chemical form. Move down the list to enter up to four chemical formulas.

If more than one chemical form exists for the test, enter these forms in the same manner as the first chemical form, using the character table. Press the **EDIT FACTOR** soft key to enter a factor on the numeric keypad. Press **ENTRY DONE** to complete the entry. When all additional chemical forms are completed, the highlighted line moves to Timer 1: (none). When the **ADD TIMER** soft key is pressed the following soft key options are displayed.

Timer Options



Soft Key	Function
LABEL	Gives options for instructing the user during the timer period. The options include: Wait, Shake, Invert, Swirl, Boil, Heat, and Timer. Not available unless a timer value is entered.
EDIT TIMER	Allows the user to change the numeric portion of the timer. The numeric keypad is active, press ENTER to complete the entry. Not available unless a timer value is entered.
DELETE TIMER	Changes the timer setting to (none). Not available unless a timer value is entered.
PAGE UP	Moves the highlight up to the top of the screen.
PAGE DOWN	Moves the highlight down to the bottom of the screen.

Up to four timer periods may be set for user-entered calibrations. A label is assigned to each of the timer periods set for the test. See the *Timer Options* table above for available labels. After a timer is set, it may be changed or deleted via the soft key menu.

When all entries for the user-entered calibration are complete, press the **EXIT** key. The prompt line will ask: STORE CHANGES? with **YES** and **NO** as soft key options. Press the **YES** soft key to exit and store changes; press the **NO** soft key to exit without storing changes to the calibration.

7.4 User-Entered Multi-Wavelength Calibration

Beginning at the main menu, press the **USER PROGRAM** and **CREATE** soft keys. Assign a number as described in Section 7.2.1, then select the **MULTI-λ** soft key.

USER PROGRAM 10	λ 500.0 nm	VIS
CREATE PROGRAM	07-MAY-97	15:23
Parameter	Setting	
Upper limit:	OFF	
Formula:	A=K ₁ A ₁ +K ₂ A ₂	
Wavelength 1:	500.0 nm 1.0000	
Wavelength 2:	500.0 nm 1.0000	
Wavelength 3:	OFF	
Wavelength 4:	OFF	
Program options:		
NEXT	PAGE UP	PAGE DOWN
FORMULA		

The main difference between multi-wavelength and single wavelength calibrations is the way the absorbance value (A) is determined. In the single wavelength mode, a single measurement at one wavelength determines the value of A. In the multi-wavelength mode, an equation involving individual absorbance readings at two or more wavelengths determines a net absorbance value (A). Examples of equations are:

$$A=K_1A_1 + K_2A_2; \text{ and } A=K_1A_1/ K_2A_2.$$

Finally, the net absorbance value A, is plugged into one of four possible absorbance/concentration relationships. These relationships (formulas) are the same as the single wavelength formulas shown on page 50.

Two to four wavelengths may be specified for multiple wavelength programs. The number of wavelengths is determined by the selected absorbance formula.

Cycle through the formula choices by pressing the **NEXT FORMULA** soft key. The same number of wavelengths and coefficients must be entered as are seen in the formula. A default wavelength value is entered to each active wavelength line and may be changed to customize the multiple wavelength program. Scroll to the different wavelength entries by pressing the arrow keys. The components of the multiple wavelength program are entered in the same manner as the single wavelength program.

7.5 Copying a User-Entered Calibration

USER PROGRAM	λ 500.0 nm	VIS
	07-MAY-97	15:25
Program	Name	Date
1050	USER Arsenic As	02-MAY-97
1690	USER Copper, Autocat.	02-MAY-97
2850	USER Palladium Pd	02-MAY-97
3100	USER Potassium K	02-MAY-97
3150	USER Platinum Pt	02-MAY-97
Program to run?	1050	
CREATE	EDIT	DELETE

Use the **COPY PROGRAM** soft key option to use an existing program as a template for a new user-entered program. From the main menu, press the **USER PROGRAM** soft key. From the user program menu, press the **CREATE** soft key. Enter a number for the user-entered program with the numeric keypad. Press the **COPY PROGRAM** soft key and choose a factory- or user-entered program to copy. Enter the program number on the prompt line then press the **ENTER** key or scroll to the program to copy with the arrow keys. You can only copy programs that have the USER label. If you try to copy other programs the USER error message will appear. Press the **ENTER** key. All parameter and setting information is copied to the create program screen.

Using the available soft key menu, change the settings in the same manner as entering a new program.

7.6 Editing an Existing User-Entered Calibration

NOTE: You cannot edit programs with numbers greater than 1000. If you try to edit other programs the **USER** error message will appear. Instead, copy the program and edit thereafter.

Press the **EDIT** soft key from the user program menu to select an existing user calibration to change. The cursor prompts for a program number on the prompt line. Key in the desired program number using the numeric keypad or scroll up and down through the list using the arrow keys. Press the **EDIT** soft key then the **ENTER** key to move into the user program: edit program mode. You can only edit programs that have the **USER** label. If you try to edit other programs the **USER** error message will appear.

Use the arrow keys to move the highlighted line through the list. Edit an entry using the available soft key options. When all changes have been made, press the **EXIT** key. The prompt line will ask: **STORE CHANGES?** with **YES** and **NO** as soft key options. Press the **YES** soft key to exit and store changes or the **NO** soft key to exit without storing changes to the program.

7.7 Deleting a User Program

NOTE: The user may not delete four-digit factory-entered programs.

Delete an existing user program by pressing the **DELETE** soft key from the user program menu. The cursor prompts for a program number on the **PROGRAM TO DELETE? _ _** prompt line. Key in the desired one- to three-digit program number using the numeric key pad and press the **ENTER** key.

The prompt line will verify the deletion with the question: **DELETE PROGRAM X?** (the X corresponds to any specified program). Press the **YES** soft key to delete the program or the **NO** soft key to return to the user program menu screen.

Press the **EXIT** key to leave the user program menu and return to the main menu.

The Single Wavelength Mode provides a way to measure samples at a single wavelength. Select the **SINGLE** λ soft key in the main menu to display the single wavelength mode. SINGLE WAVELENGTH will appear in the top left corner of the display. The reading appears in the center of the display with the group and sample numbers.

8.1 Using the Single-Cell Module Within the Single Wavelength Mode

Single λ Measurement Control Menu

SINGLE WAVELENGTH		λ 500.0 nm	VIS
31-MAR-97		14:33	
ZERO REQUIRED		TIMER 00:00	
Measurement control:			
ZERO	GOTO	START	
	λ	OPTIONS	TIMER

Soft Key	Function
ZERO	Measures the blank sample.
READ	When displayed, starts the sample measurement. If not displayed, readings are updated continuously.
GOTO λ	Prompts to select a wavelength.
OPTIONS	Displays the options menu for changing sample-related variables (see Section 8.2).
START TIMER	Starts timer countdown (see Section 1.11.1).

NOTE: Press **EXIT** at any time in the measurement control menu to return to the Main Menu. The prompt asks: **EXIT TO MAIN MENU?**, and if the current data has not been stored, a warning flashes: **NOT STORED**. Store the data if necessary, then select the **YES** soft key to display the main menu.

NOTE: If an error is made while entering numbers on the prompt line, press the **CE** key to clear and start over.

WARNING

This instrument is not intended for use with flammable samples or those containing hydrocarbons.

Before taking sample measurements, press the **GOTO** λ soft key to select a specific wavelength for sample readings. Enter a value with the digit keys and press **ENTER**. The wavelength selection bar displays the new wavelength.

8.1.1 Taking Single Wavelength Measurements

ADVERTENCIA

Este instrumento no está destinado para uso con muestras inflamables o que contengan hidrocarburos.

ADVERTÊNCIA

Este instrumento não é feito com o fim de ser empregado com amostras inflamáveis ou aquelas que contêm hidrocarbonetos.

ATTENTION

Cet instrument n'est pas conçu pour une utilisation avec des échantillons inflammables ou des échantillons contenant des hydrocarbures.

WARNHINWEIS

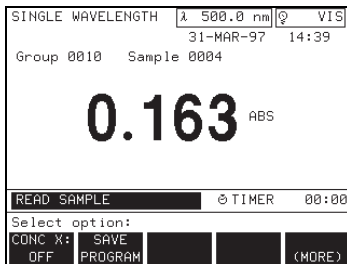
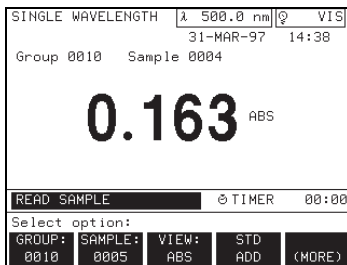
Dieses Gerät darf nicht für Tests mit brennbaren Proben oder Proben, die Kohlenwasserstoffe enthalten, benutzt werden.

To begin taking measurements, place a sample cell containing the blank in the cell compartment with the fill marks facing the front of the instrument. Close the module lid. The status bar shows: ZERO REQUIRED.

Press the **ZERO** soft key. The display shows zero and the status bar shows: READ SAMPLE. Remove the blank sample cell from the cell compartment. Place the sample cell containing sample in the cell compartment with the fill marks facing the front of the instrument. Close the module lid. The instrument automatically reads the sample and displays the result on the screen. Continue replacing sample cells and taking readings for the remaining samples.

8.2 Single Wavelength Options

Press the **OPTIONS** soft key in the measurement control menu to display the options menu. These options let the operator change sample-related settings.



Single λ Options Menu

Soft Key	Feature
GROUP	Assigns a group number as discussed in Section 1.11.2.
SAMPLE	Assigns a sample number as discussed in Section 1.11.2.
VIEW	Displays data in absorbance (ABS), percent transmittance (%T), or concentration.
STD ADD	Adjusts for standard addition measurements. See Section Section 4.
CONC X	Prompts for concentration factor.
SAVE PROGRAM	Saves all settings in the current mode of operation See Section 1.11.3 for details.

Press the **CONC X** soft key to display the concentration factor (CONC X) options menu. See Section 8.2.1, below.

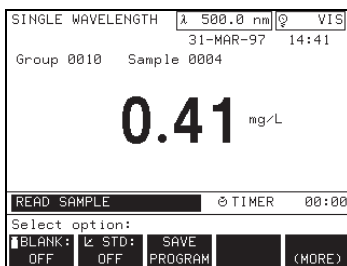
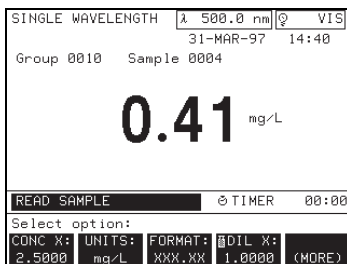
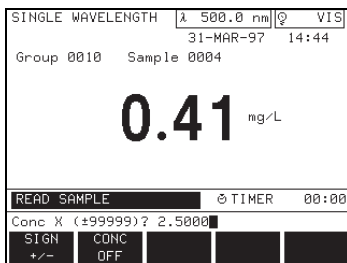
8.2.1 Concentration Factor

The **CONC X** soft key provides a way to select a specific concentration factor for converting absorbance readings to concentration. The concentration factor is the slope of the line in the equation:

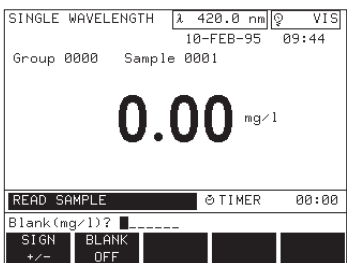
$$\text{Concentration} = (\text{CONC X}) \times \text{ABS}$$

NOTE: If an error is made while entering numbers on the prompt line, press the **CE** key to clear and start over.

Press the **CONC X** soft key to display the concentration factor (Conc X) options menu. Enter a concentration factor with the **DIGIT** keys and change the units at this time, if necessary.



NOTE: The dilution factor can also be used to adjust for a variety of properties such as specific gravity and sample weight.



CONC X Options

Soft Key	Function
SIGN ±	Changes sign of value on prompt line.
CONC OFF	Turns concentration factor off and returns to the options menu.

Press the **ENTER** key to confirm the selection and return to the options menu. The change will be displayed in the **CONC X** soft key label, and the units are displayed to the right of the data.

To remove the concentration selection, press the **CONC X** soft key and then press the **CONC OFF** soft key. The **CONC X** soft key label displays: CONC X: OFF.

After a concentration factor has been set, additional options become available in the options menu.

Additional CONC X Options

Soft Key	Function
CONC X	Concentration factor: prompts for concentration value.
UNITS	Selects from a variety of units.
FORMAT	Changes decimal point setting in data display.
DIL X	Adds a dilution factor to a measurement.
BLANK	Compensates for color in reagent blank.
↵ STD	Adjusts the calibration curve.
SAVE PROGRAM	Saves all settings in the current mode of operation. See Section 1.11.3 for details.

The **UNITS** soft key lets the operator select from a list of several concentration units. Repeatedly press the **UNITS** soft key to view the available units.

Press the **FORMAT** soft key repeatedly to specify the maximum number of decimal places for the data display. The decimal moves one position to the left each time the key is pressed.

8.2.1.1 Dilution Factor

The **DIL X** soft key allows the operator to enter a dilution factor. 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 (off).

8.2.1.2 Reagent Blank

The reagent **BLANK** soft key lets the operator select a specific value for a reagent blank. Using a reagent blank is equivalent to adding a y-intercept value to the calibration line (i.e., concentration = (CONC X) ABS – reagent blank).

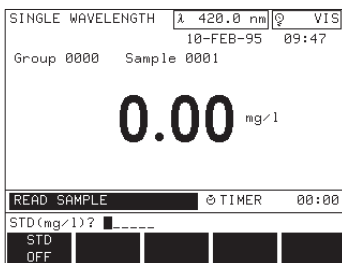
Press the **BLANK** soft key to display the reagent blank menu.

Reagent Blank Menu

Soft Key	Function
SIGN ±	Changes sign on keyed-in value.
BLANK OFF	Turns reagent blank setting off.

The display prompts to enter a value for the reagent blank. Use the **SIGN** soft key to change the sign of the value, if necessary, then press **ENTER**.

NOTE: When a reagent blank has been entered, pressing the **ZERO** soft key (in the measurement control menu) gives the negative blank correction value rather than zero.



NOTE: The calibration curve for single wavelength readings can be adjusted using the **STD** soft key.

8.2.2 Standard Adjustment

Press the **STD** soft key. The screen prompts for the standard concentration value.

Standard Adjustment Menu

Soft Key	Function
STD OFF	Turns standard adjustment setting off

Place a known standard into the instrument with the fill marks facing the front of the instrument. Press the **ENTER** key to accept the default value, or key in a new value and then press **ENTER**. The new value is displayed in the **STD** soft key label and the standard adjustment symbol (λ) appears in the upper right of the display to indicate that an adjustment has been made. Press the **STD** soft key again to turn the standard adjustment off or to recall the previous standard adjustment entry.

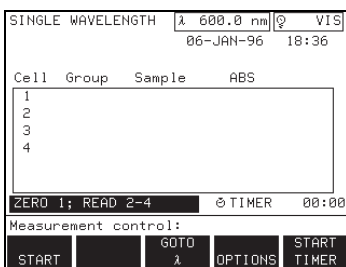
8.3 Using the Carousel Module Within the Single Wavelength Mode

For information on changing sample modules, loading and inserting the carousel, or instrument setup for the Carousel Module read Section 1.9.

The Carousel Module options and measurement control menus are similar to the Single-cell Module menus described in Section 8.1. Minor differences appear in the **GROUP** and **SAMPLE** soft keys, as discussed in Section 1.11.2.

Before taking sample readings in the carousel module, choose the mode of operation (if different from the default setting) by following the instructions in Section 1.9.1. Then choose options for sample readings with the **OPTIONS** soft key (see Section 8.2).

Load and insert the carousel. The status bar indicates which cells to load with blank samples and which cells will be active cells.



To begin the first set of measurements, press the **START** soft key. The status bar displays the instrument operation: **READING 1...**, **READING 2...**, etc. while the carousel turns and the instrument takes readings as programmed through the instrument setup menu (**SETUP** key). The instrument lists each reading on the screen as it is taken. An alert sounds as the last reading appears on the screen present only if the **START** soft key is pressed.

Press the **CANCEL** soft key any time before the alert to start over and to erase all readings from the current set of measurements.

The carousel mode can be changed at this time as described in Section 1.9.1. Press the **START** soft key to continue taking measurements.

8.4 Storing Data in the Single Wavelength Mode

The setup options provide manual and automatic storage. Refer to Section 1.6.2 and Section *Section 3* for instructions on setting this option. Use the following procedures to manually or automatically store data.

8.4.1 Manual Storage of Data

In the manual storage mode, simply press the **STORE** key after each reading to add the sample to the data log. If a carousel module is being used, all non-zero results are stored with one press of the **STORE** key.

8.4.2 Auto Storage of Data

In the automatic storage mode, a **READ** soft key is added to the measurement control menu. When **READ** is pressed, the instrument will read the sample, place the result in the data log, and then display: DATA STORED. The display result is not updated continuously when in the automatic storage mode. If a carousel module is being used, all non-zero results are stored automatically after the last active cell is read.

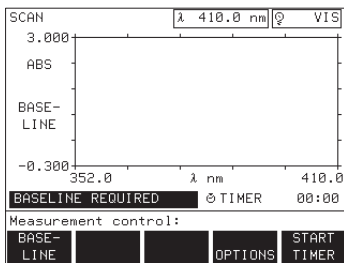
The Wavelength (λ) Scan mode shows how light is absorbed by a solution over a range of wavelengths. The operator can display the collected data in graph or table form and in units of percent transmittance (%T) or absorbance (ABS).

Select the **SCAN** λ soft key from the main menu to display the Scan mode. SCAN will appear in the top left corner of the display. The central feature of the Scan mode display is its graph. The operator can change graph variables (ABS and %T) and set the x- and y-axes by adjusting the soft key settings in the options menu (**OPTIONS** soft key).

9.1 Using the Single-cell Module

9.1.1 Wavelength Scan Measurement Control

The status bar in the scan mode measurement control menu displays: **BASELINE REQUIRED**. Before taking a baseline reading, however, press the **OPTIONS** soft key to set up sample-related options, particularly the λ min, λ max, and λ step options (see Section 9.1.2 below).



Measurement Control Menu

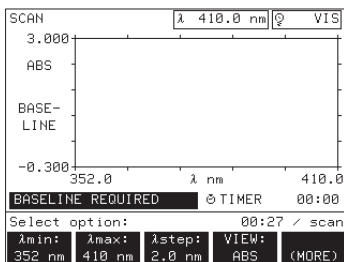
Soft Key	Function
BASELINE	Scan that defines the base reading for measurements.
OPTIONS	Contains options to change graph scale and units.
START TIMER	Starts timer countdown (see Section 1.11.1).

NOTE: Press **EXIT** at any time in the measurement control menu to return to the main menu. The prompt asks: **EXIT TO MAIN MENU?**, and if the current data has not been stored, a warning flashes: **NOT STORED**. Store the data if necessary, then select the **YES** soft key to display the main menu.

After the sample-related options have been set up, press the **BASELINE** soft key on the measurement control menu to scan a sample (usually a blank). This will determine the baseline or zero reading before scanning and graphing sample measurements.

9.1.2 Wavelength Scan Options

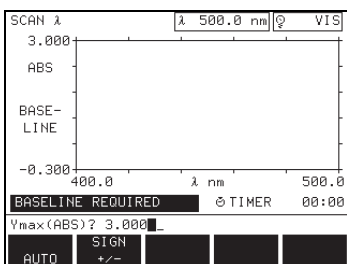
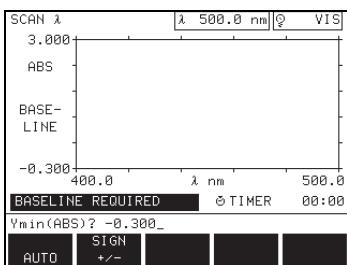
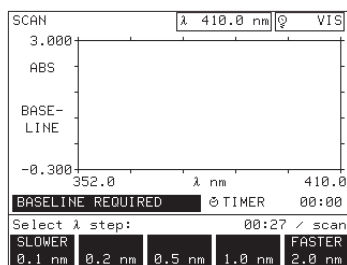
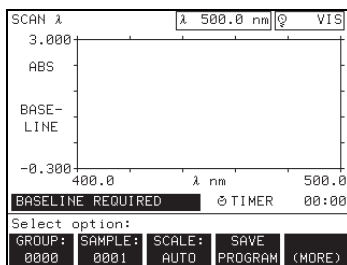
Press the **OPTIONS** soft key under the measurement control menu to set up basic graph criteria before scanning samples. Press the **OPTIONS** soft key to display the options menu. Press the **(MORE)** soft key to view additional options.



Wavelength Scan Options Menu

Soft Key	Function
λ min	Sets lowest value of scanning wavelength. Changing requires new baseline.
λ max	Sets highest value of scanning wavelength. Changing requires new baseline.
λ step	Sets interval between recorded data points. Changing requires new baseline.
VIEW	Displays data in ABS or %T. Adjustable at any time except during scans.
GROUP	Prompts to change group number. See Section 1.11.2
SAMPLE	Prompts to change sample number. See Section 1.11.2

Wavelength Scan Options Menu (Continued)



Soft Key	Function
SCALE	Prompts to adjust Ymin and Ymax settings for MANUAL mode or sets to AUTO mode.
SAVE PROGRAM	Saves all settings in the current mode under a selected identification number. See Section 1.11.3.

To adjust the minimum and maximum scanning wavelengths, use the λ **MIN** and λ **MAX** soft keys. The screen will prompt for the corresponding value. Press **ENTER** to confirm the setting and to return to the options menu. The changes will be displayed along the x-axis of the graph. Key in a value with the numbered keys and press the **SIGN** soft key to change the sign of the value, if necessary. Press **ENTER** to confirm the setting. Changing these options requires the operator to scan a new baseline.

Press the λ **STEP** soft key to choose a scan resolution, depending on the data point interval.

Scans recording data with high resolution scan slower than those recording data with low resolution. The time a scan will take, in minutes and seconds, is displayed above the soft keys. Changing the λ step option requires the operator to scan a new baseline.

When the **SCALE** option is set to AUTO the instrument automatically adjusts the y-axis when a scan goes beyond the default range of the graph, so that the operator can observe the entire scan; however, the **SCALE** soft key lets the operator adjust the minimum and maximum y-axis settings on the display graph. Changing one of the settings affects both settings; both settings register either MANUAL or automatic (AUTO) in the **SCALE** soft key label.

Ymin and Ymax Settings

Soft Key	Function
AUTO	Returns default y-axis setting.
SIGN \pm	Changes sign on a value.

Set the **SCALE** soft key label to AUTO by pressing the **(MORE)** soft key to reveal the **SCALE** soft key, press it, and then press the **AUTO** soft key to set this feature.

Set the **SCALE** feature to MANUAL by changing the Ymin and Ymax settings after pressing the **SCALE** soft key. This adjusts the scan graph scale to show scan values within a limited range.

WARNING

This instrument is not intended for use with flammable samples or those containing hydrocarbons.

9.1.3 Taking Wavelength Scan Measurements

ADVERTENCIA

Este instrumento no está destinado para uso con muestras inflamables o que contengan hidrocarburos.

ADVERTÊNCIA

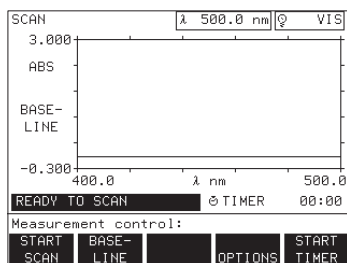
Este instrumento não é feito com o fim de ser empregado com amostras inflamáveis ou aquelas que contêm hidrocarbonetos.

ATTENTION

Cet instrument n'est pas conçu pour une utilisation avec des échantillons inflammables ou des échantillons contenant des hydrocarbures.

WARNHINWEIS

Dieses Gerät darf nicht für Tests mit brennbaren Proben oder Proben, die Kohlenwasserstoffe enthalten, benutzt werden.

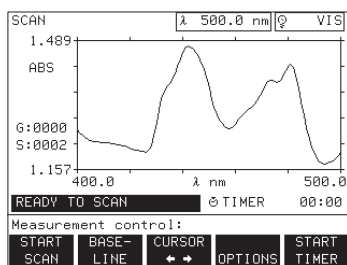


The status bar in the scan mode reads: **BASELINE REQUIRED** before sample scans begin. Place a blank (or the appropriate baseline sample) in the sample chamber with the fill marks facing the front of the instrument. Press the **BASELINE** soft key. The status bar reads: **BASELINE...**, while the graph and the wavelength status box reflect the sample scan.

The **BASELINE** soft key becomes **STOP SCAN** to provide a way to start a scan over. An alert sounds at the end of each scan. After the baseline scan, the measurement control menu adds the **START SCAN** soft key.

Scanning Measurement Control Menu

Soft Key	Function
START SCAN	Appears after a baseline is taken. Scans the sample and produces a graph of units vs. wavelength.
BASELINE	Scan that defines the base reading for measurements.
CURSOR	Displays the graph options menu. Allows user to select a specific point on the graph by placing a cursor on the graph or by searching a table. Appears after a scan is taken.
OPTIONS	Contains options to change graph scale and units.
START TIMER	Starts preset timer.



After scanning the baseline, the highlighted status bar, shows: **READY TO SCAN**. Samples can now be scanned. Place a sample cell in the sample chamber with the fill marks facing the front of the instrument, and press the **START SCAN** soft key.

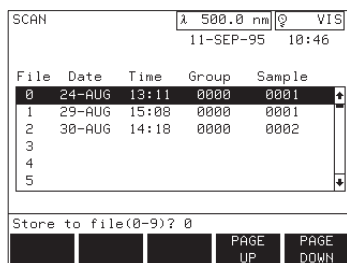
While the instrument scans a sample, the status bar reads: **SCANNING...** The scan is drawn on the graph, and the wavelength status box reflects the current wavelength. After the sample scan, the measurement control menu adds the **CURSOR** soft key.

The display gives the current group (G:) and sample number (S:) to the left of the graph while the instrument scans each sample.

Replace the scanned sample with the next sample and press the **START SCAN** soft key. Repeat this step for each sample.

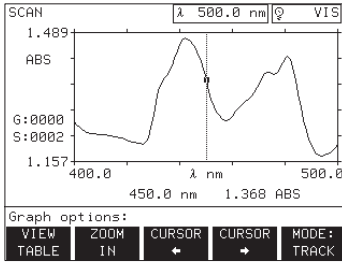
If storing scanned data is required, press the **STORE** key and select a file number from 0 to 9. Press **ENTER** to confirm the selection; the scan will be stored in the specified file and the display will return to the measurement control menu.

A separate area of memory stores scans. Scan storage does not affect the data capacity of other measurement modes.



9.1.4 Wavelength Scan Analysis Options

Press the **CURSOR** soft key to display the graph options menu. This menu lets the operator select specific points on the graph or table, including peak and valley points.



NOTE: Press **EXIT** at any time to return to the measurement control menu.

Graph Options Menu

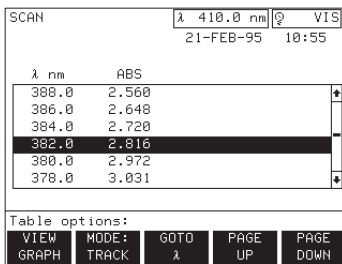
Soft Key	Function
VIEW TABLE	Shows scan data in table form.
ZOOM IN	Provides closer look at selected point on graph.
ZOOM OUT	Returns graph to normal view (appears after pressing ZOOM IN).
CURSOR KEYS	Moves the cursor left and right along the scan.
MODE	Selects peak, valley, or tracking cursor modes.

Press the **ZOOM IN** soft key to view data around the cursor in detail. The **ZOOM IN** soft key may be pressed repeatedly to obtain successively more detailed views. Pressing the **ZOOM OUT** soft key returns the graph to its original view.

Use the **CURSOR** soft keys to move the cursor to the left or right. The data point corresponding to the cursor position is displayed beneath the graph. Press and hold down a **CURSOR** soft key to move in larger increments.

The type of cursor movement is determined by the mode option. Press the **MODE** soft key to cycle between TRACK, PEAK, and VALLEY. In track mode, the cursor moves across each data point in the scan. In the peak and valley modes, the cursor stops only on peak and valley points, respectively.

The **VIEW TABLE** soft key displays the table options menu. This menu lets the operator view scan data in table form.



Wavelength Scan Table Options Menu

Soft Key	Function
VIEW GRAPH	Returns display to graph view.
MODE	Lists all data points, or lists only the peak or valley data points.
GOTO λ	Permits the operator to select a specific wavelength from the table.
PAGE UP and PAGE DOWN	Scrolls through the data table six data points at a time.

Press the **VIEW GRAPH** soft key to return to the graph view, or press **EXIT** to return to the measurement control menu.

NOTE: The **MODE** option in the table options menu tracks the mode option in the graph options menu.

The selected mode option determines the type of table displayed. Press the **MODE** soft key to cycle between TRACK, PEAK, and VALLEY. In the track mode, the table displays all data points in the scan with peaks and valleys tagged in the right-most column. In the peak and valley modes, the table displays only the peak and valley points, respectively.

NOTE: The highlighted position in the table tracks the cursor position in the graph.

Locating a particular point in the table can be accomplished in one of three ways:

1. Use the **PAGE UP** and **PAGE DOWN** soft keys to move one screen (six points) at a time.

2. Use the **UP** and **DOWN** arrow keys on the keypad to move one point at a time.
3. Use the **GOTO** λ soft key to jump to a specific data point.

9.2 Using the Carousel Module In Wavelength Scan Mode

For information on changing sample modules, loading and inserting the carousel, or instrument setup for the Carousel Module, read Section 1.9.

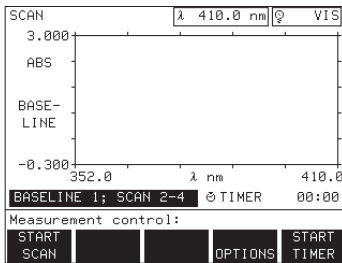
The Carousel Module options and measurement control menus are similar to the Single-cell Module menus described in Section 9.1. Minor differences appear in the **GROUP** and **SAMPLE** soft keys, as discussed in Section 1.11.2.

NOTE: In scan mode, references to “zero” are synonymous with “baseline.”

Before taking sample readings in the Carousel Module, choose the mode of operation (if different from the default setting) by following the instructions in Section 1.9.1. Then choose options for scan readings with the **OPTIONS** soft key under the measurement control menu.

NOTE: The four-cell carousel will be used in the following examples.

Load and insert the carousel. The status bar indicates which cell to load with blank samples and which cells will be active samples.



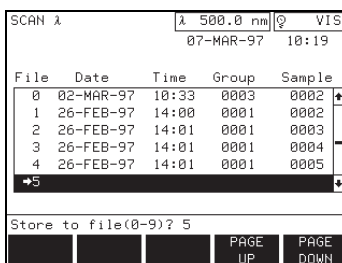
Press the **START SCAN** soft key. The status bar shows instrument operation by displaying **BASELINE 1...**, **SCANNING 2...**, etc., as programmed through the instrument setup menu (**SETUP** key). Press the **STOP SCAN** soft key at any time to show a graph of scanned data. An alert sounds when the last scan is completed.

9.3 Storing Scanned Data

9.3.1 Manual Storage of Scans

The setup options provide **MANUAL** or **AUTO** storage (see Section 3 for setting this option). To store scan data in the manual storage mode, follow this procedure:

1. If using a carousel, use the **UP** and **DOWN** arrow keys on the keypad to select the cell data to be stored (the cell number is displayed to the left of the graph). If using the Single-cell Module begin at step 2.
2. Press the **STORE** key.
3. Select a file number from 0 to 9. Press **ENTER** to confirm the selection; the scan will be stored in the specified file and the display will return to the measurement control screen.
4. Repeat steps 1 through 3 for each carousel cell position to be stored.



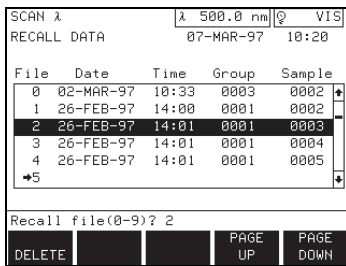
9.3.2 Auto Storage of Scans

In the Auto storage mode, the arrow to the left of the stored data table indicates the location of the next file to receive data.

The arrow advances one file number after each automatic store, wrapping around to file number 0 after storing in file number 9. No warning is given when auto store overwrites existing files. To manually position the arrow, proceed as follows:

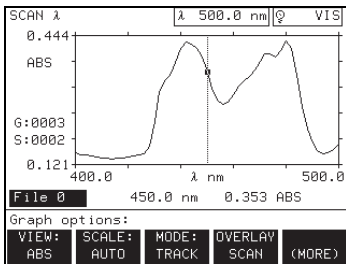
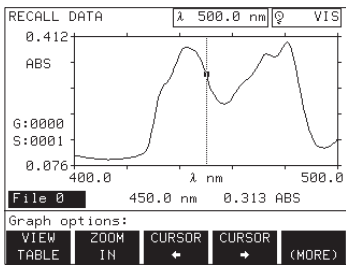
1. Press the **RECALL** key.
2. Use the arrow keys to move the highlight bar to the position you want the arrow to appear next.
3. Press the **DELETE** soft key. The arrow will then point to the highlighted number, and the next data cell to be stored will occupy that file.

9.4 Recalling Scanned Data



To access stored scans from the scan mode measurement control menu, press the **RECALL** data key. To access stored scans from the main menu, press the **RECALL** data key, then press the **SCAN** soft key.

Select a file number to recall (0-9) using the digit keys or the **UP** and **DOWN** arrow keys, and press **ENTER**. A graph of the recalled scan is displayed.

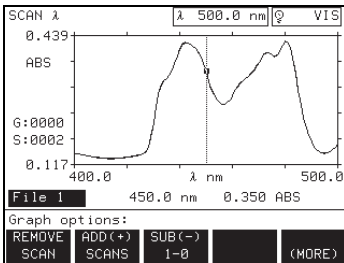


Wavelength Scan Graph Options Menu

Soft Key	Function
VIEW TABLE	Shows scan data in table form.
ZOOM IN	Provides a closer look at selected point on the graph.
ZOOM OUT	Returns graph to normal view (appears after pressing ZOOM IN).
CURSOR KEYS	Moves the cursor left or right along the scan.
VIEW	Displays data as ABS or %T.
SCALE	Permits selection of a fixed or automatic y-axis selection.
MODE	Selects peak, valley, or tracking mode.
OVERLAY SCAN	Allows any number of stored scans to be graphed together.
REMOVE SCAN	Removes the currently selected scan from the screen. Only shown if scans are overlaid.
ADD (+) SCANS	Adds the two scans shown on the screen. Only available if two scans are overlaid.
SUB (-) SCANS	Subtracts the two scans on the screen. Only available if two scans are overlaid.

The **VIEW TABLE** soft key displays the table options menu. This menu displays scan data in table form. See the *Wavelength Scan Table Options Menu* on page 64 for more information.

Press the **ZOOM IN** soft key to view data around the cursor in detail. **ZOOM IN** may be pressed repeatedly to obtain successively more detailed views. Press the **ZOOM OUT** soft key to return the graph to its original view.

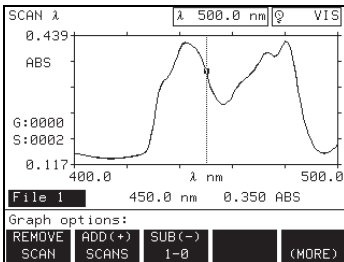


Use the **CURSOR** soft keys to move the cursor to the left or right. The data point corresponding to the cursor position is displayed beneath the graph. Press and hold down a **CURSOR** soft key to move the cursor in larger increments. Press the **UP** and **DOWN** arrow keys to move the cursor between scans. The status bar shows the file number of the scan selected.

The type of cursor movement is determined by the mode option. Press the **MODE** soft key to cycle between TRACK, PEAK, and VALLEY. In track mode, the cursor moves across each data point in the scan. In the peak and valley modes, the cursor stops only on peak and valley points, respectively.

Press the **SCALE** soft key to specify the y-axis minimum value, or to set the feature to AUTO. If you enter a value for Ymin or Ymax, the Scale feature will automatically change to MANUAL. Pressing the **AUTO** soft key in either entry restores automatic scaling to the y-axis.

Press the **OVERLAY SCAN** soft key to select another scan to display on the same screen with the current scan. Select the file number of the new scan and press **ENTER**. Only scans that have the same wavelength range and step can be displayed using the overlay option. This process can be repeated until all matching scans are displayed.



Use the **UP** and **DOWN** arrow keys to move the cursor between scans. The selected file number is shown in the display status bar. Use the **CURSOR** soft keys to move the cursor along the selected scan.

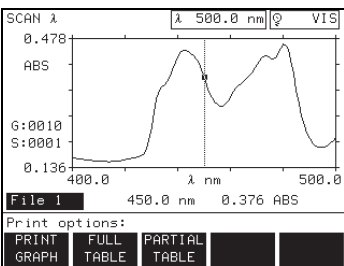
To remove a scan from the overlay display, use the **UP** and **DOWN** arrow keys to select the scan you want to remove. Press the **REMOVE SCAN** soft key.

NOTE: Press the **EXIT** or **RECALL** keys to recall a new set of scans. Press the **EXIT** key to return to the measurement control menu.

With two scans overlaid on the screen, the **ADD (+)** and **SUB (-)** scan options appear in the graph options menu, permitting addition and subtraction of the two scans respectively. When subtracting two scans, select the order of subtraction by pressing the appropriate soft key (such as **FILE 1-0** or **FILE 0-1**).

A single scan, the result of addition or subtraction, is shown on the screen. Press the **ADD (+) OFF** or the **SUB (-) OFF** soft keys, respectively, to restore the original scans.

9.5 Printing Scanned Data



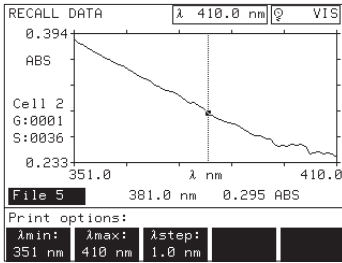
From the measurement control menu or while recalling data, press the **PRINT** key to initiate scan data printing. A print options menu is displayed.

Data Printing Options

Soft Key	Function
PRINT GRAPH	Prints a copy of the scan graph. Available only if the graph option in the serial I/O setup menu is set to ON (see Section 1.6).
FULL TABLE	Prints all of the selected scan data in table form.

Data Printing Options (Continued)

Soft Key	Function
PARTIAL TABLE	Prints only a portion of the selected scan data.



Press the **PARTIAL TABLE** soft key to print a selected portion of a scan. Use the λ **MIN** and λ **MAX** options to enter the wavelength range to print. Use the λ **STEP** option to select the wavelength resolution. Press **PRINT** or **ENTER** to print the data.

9.6 Deleting Scanned Data

To delete scan data, you must first recall it. To access stored scans from the scan mode measurement control menu, press the **RECALL** key. To access stored scans from the main menu, press the **RECALL** key, then press the **SCAN** soft key.

Select a file number to recall (0-9) using the digit keys or the **UP** and **DOWN** arrow keys. Press the **DELETE** soft key and answer the prompts that are displayed on the screen.

10.1 Storing Data

The DR/4000 Spectrophotometer has a 200-sample data log that stores data from all measurement modes except scan and time course modes (see Section 7.3 for storing scan results or Section 12.3 for storing time course results).

The instrument provides manual or automatic storage options. In the manual storage mode, press the **STORE** data key to place the results currently displayed on the screen into the data log. The displayed results are added to the end of the data log and the DATA STORED message is displayed briefly above the soft keys. When the data log becomes full, the oldest data, at the beginning of the log, are discarded to make room for the new results.

The instrument does not place samples labeled as ZERO in the data log and does not make duplicate entries; pressing **STORE** only places new or modified results in the data log.

If automatic store is selected in the setup menu, a **READ** soft key will be displayed in the control menu. When **READ** is pressed, the instrument will read samples, put the results in the data log and display: DATA STORED. It is not necessary to press the **STORE** key to place information in the data log.

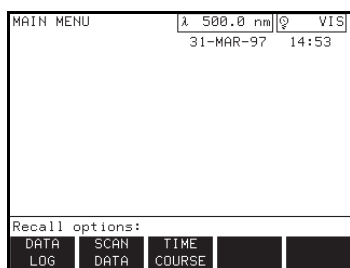
10.2 Recalling Data

Data placed in the data log can be recalled, printed, and deleted. Special features are provided for summarizing selected samples in printed reports.

10.2.1 Recalling Stored Data

1. Display the data log by one of the following methods (refer to Section 9.4 for recalling scan results or Section 12.4 for recalling time course results):

- From any measurement mode, press the **RECALL** data key to access stored data.
- From the main menu, press the **RECALL** data key, then press the **DATA LOG** soft key.



The data summary table and recall options menu, as shown below, will be displayed. Initially, the entire contents of the data log is contained in the displayed table. As indicated by the document icon to the left of each sample, all samples in the data log will be printed when the **PRINT** key is pressed. Use the summary options to select and display sets of data, and use the tag options to specify samples for inclusion in printed reports.

RECALL DATA		λ 420.0 nm	VIS
		07-MAR-95	15:52
Date	Time	Summary - ALL	
09-FEB	10:26	-0.000 ABS	100.03 %T
23-FEB	16:18	-0.01 mg/L	NH ₂ Cl N
06-MAR	14:28	0.117 ABS	76.33 %T
06-MAR	14:28	0.177 ABS	66.56 %T
06-MAR	14:28	0.302 ABS	49.89 %T
06-MAR	16:56	-0.0 mg/L	Mo6*
Recall options:			
SUMMARY	TAG	VIEW	PAGE
OPTIONS	OPTIONS	DETAILS	UP
			PAGE
			DOWN

Recall Options

Soft Key	Function
SUMMARY OPTIONS	Provides access to the data summary menu.
TAG OPTIONS	Accesses the data tag options to mark data for printing.
VIEW DETAILS	Toggles the display to view the detailed information of the selected data point.
PAGE UP	Moves the display up one full screen.
PAGE DOWN	Moves the display down one full screen.

Press the **SUMMARY OPTIONS** soft key to display the following soft key menu choices.

RECALL DATA		λ 420.0 nm	VIS
		07-MAR-95	15:53
Date	Time	Summary - ALL	
09-FEB	10:26	-0.000 ABS	100.03 %T
23-FEB	16:18	-0.01 mg/L	NH ₂ Cl N
06-MAR	14:28	0.117 ABS	76.33 %T
06-MAR	14:28	0.177 ABS	66.56 %T
06-MAR	14:28	0.302 ABS	49.89 %T
06-MAR	16:56	-0.0 mg/L	Mo6*
Summary options:			
SHOW	DATE:	GROUP:	SAMPLE:
ALL	ALL	ALL	ALL
			PROG:
			ALL

Summary Options

Soft Key	Function
SHOW ALL	Clears all summary options and displays all stored data.
DATE	Permits summarizing data in the table by a specified date.
GROUP	Summarizes data in the table by a specified group.
SAMPLE	Summarizes data in the table by a specified sample number.
PROG	Permits data summary by a specified program number.

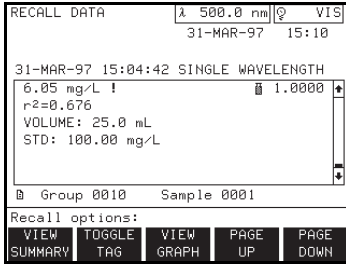
RECALL DATA		λ 500.0 nm	VIS
		31-MAR-97	14:54
Date	Time	Summary - ALL	
31-MAR	14:36	0.027 ABS	
31-MAR	14:36	-0.000 ABS	
31-MAR	14:37	0.163 ABS	
31-MAR	14:46	0.21 mg/L	
31-MAR	14:46	1.17 mg/L	
31-MAR	14:46	2.43 mg/L	
Tag options:			
CLEAR	TOGGLE	PAGE	PAGE
ALL	TAG	DELETE	UP
			DOWN

The **DATE**, **GROUP**, **SAMPLE** and **PROG** options are additive. It is possible for example, to list only data points of a particular program number, taken on a particular day. In the recall options menu, press the **TAG OPTIONS** soft key to further specify data to be printed. Refer to the following table for information on setting or clearing document tags.

Printer Tag Options

Soft Key	Function
CLEAR ALL/ SET ALL	Removes or adds tags to all data in memory for deleting, printing, or downloading to a computer. SET ALL is the default setting. No data will be deleted or sent to the printer until some or all data are tagged. The soft key label reflects the action to be taken.
TOGGLE TAG	Toggles the tag setting for the selected data point.
PAGE UP	Moves the display up one full screen.
PAGE DOWN	Moves the display down one full screen.

RECALL DATA		λ 500.0 nm	VIS
		31-MAR-97	15:08
31-MAR-97 14:46:46 SINGLE WAVELENGTH			
2.43 mg/L		1.0000	
Conc X: 2.5000			
500.0 nm		0.972 ABS	10.67 %T
Group 0010 Sample 0007			
Recall options:			
VIEW	TOGGLE	PAGE	PAGE
SUMMARY	TAG	UP	DOWN

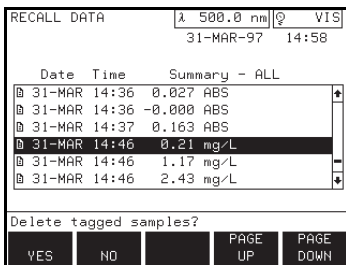


10.3 Printing Data

NOTE: Press the **EXIT** key to leave the Data Recall menu. The instrument returns to the operating menu in use when the Data Recall menu was accessed.

NOTE: The wavelength status box shows the current position of the monochromator, not necessarily the wavelength at which the data was collected.

10.4 Deleting Data



NOTE: Press the **EXIT** key to leave the Data Recall menu. The instrument returns to the operating menu in use when the Data Recall menu was accessed.

From the recall options menu, a press of the **VIEW DETAILS** soft key accesses detailed information about the specified data point. Press the **VIEW SUMMARY** soft key to return to the summary table.

The DR/4000 Spectrophotometer allows you to print all stored data or any set of stored data as follows:

1. Recall stored data to be printed by pressing the **RECALL** key as described in Section 10.2.
2. Select the data set and samples that you want to print, as described in Section 10.2.
3. Press the **PRINT** key to send tagged information to the printer. The prompt line indicates that information is being sent to the printer. Terminate printing at any time by pressing the **CANCEL** soft key.

The DR/4000 Spectrophotometer allows you to delete all stored data or any set of stored data as follows:

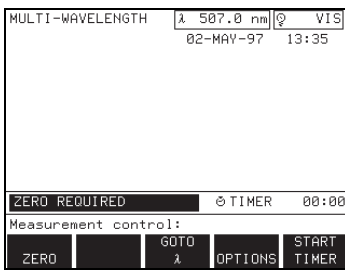
1. Recall stored data by pressing the **RECALL** key and follow the instructions in Section 10.2 to select the set of data to be deleted.
2. Tag the data of interest as described in Section 10.2.
3. Press the **DELETE** soft key. The display shows: DELETE TAGGED SAMPLES?
4. Press the **YES** or **NO** soft key. The instrument will delete the tagged samples and return to the recall options menu.

The multiple wavelength mode of the DR/4000 Spectrophotometer provides a way to take measurements requiring the sum, difference, or ratios of absorbances at up to four wavelengths. Press the **MORE** soft key in the main menu and then press the **MULTI—λ** soft key to display the multiple wavelength mode.

MULTI—WAVELENGTH appears as the mode in the top left corner of the display. The reading appears in the center of the display with the group and sample numbers.

11.1 Using the Single-Cell Module Within the Multiple Wavelength Mode

Multi-λ Measurement Control Menu



Soft Key	Function
ZERO	Zeroes the instrument at each of the specified wavelengths.
READ	Begins multi-wavelength measurements (appears after zero reading is taken).
GOTO λ	Prompts operator to select specific wavelengths.
OPTIONS	Displays the options menu for changing sample-related variables (see Section 11.1.2).
START TIMER	Starts timer countdown (see Section 1.11.1).

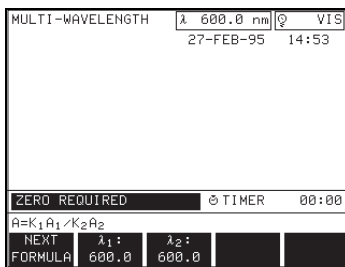
NOTE: Press **EXIT** at any time in the measurement control menu to return to the main menu. The prompt asks: **EXIT TO MAIN MENU?**, and if the current data has not been stored, a warning flashes: **NOT STORED**. Store the data if necessary, then select the **YES** soft key to view the main menu.

When the instrument is set to read ABS or %T, the absorbance or percent transmittance at each wavelength is displayed.

11.1.1 Selecting Multiple Wavelengths

Press the **GOTO λ** soft key to select the wavelengths for multiple wavelength readings.

GOTO λ Menu



Soft Key	Function
NEXT FORMULA	Cycles through the available absorbance equations and determines the number of wavelengths required.
λ ₁ , λ ₂ , λ ₃ , and λ ₄	Prompts for wavelength settings.

The following formulas are available by pressing the **NEXT FORMULA** soft key:

$$A = K_1A_1 + K_2A_2$$

$$A = K_1A_1 + K_2A_2 + K_3A_3$$

$$A = K_1A_1 + K_2A_2 + K_3A_3 + K_4A_4$$

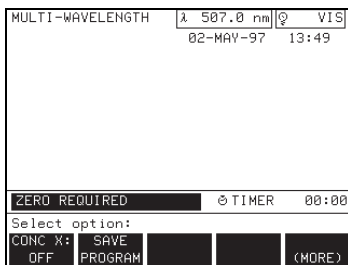
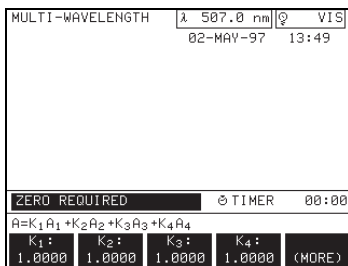
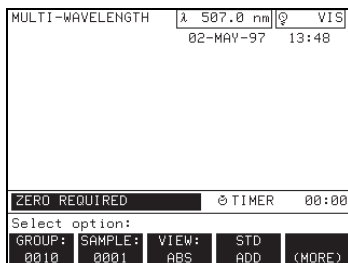
$$A = K_1A_1 / K_2A_2$$

$$A = (K_1A_1 + K_2A_2) / K_3A_3$$

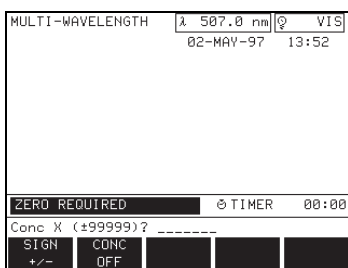
$$A = (K_1A_1 + K_2A_2) / (K_3A_3 + K_4A_4)$$

In the absorbance formulas, A₁ refers to the absorbance at wavelength 1, A₂ refers to the absorbance at wavelength 2, etc. K₁ refers to the coefficient at wavelength 1, K₂ refers to the coefficient at wavelength 2, etc. Coefficients are

NOTE: If an error is made while entering numbers on the prompt line, press the **CE** key to clear and start over.



NOTE: If an error is made while entering numbers on the prompt line, press the **CE** key to clear and start over.



entered later in the options menu (see Section 11.1.2). Coefficients can be set negative where subtraction is required.

Use the λ soft keys to display prompts for each of the wavelength settings. Enter the desired wavelength values with the digit keys. Only the number of wavelengths corresponding to the selected absorbance formula will be displayed on the soft keys. Press **ENTER** to confirm the selections and return to the measurement control menu.

11.1.2 Multiple Wavelength Options

Press the **OPTIONS** soft key in the measurement control menu to display the options menu. These options let the operator change sample-related settings.

Multi- λ Options Menu

Soft Key	Function
GROUP	Assigns a group number as described in Section 1.11.2.
SAMPLE	Assigns a sample number as described in Section 1.11.2.
VIEW	Displays data in concentration (CONC), absorbance (ABS), or percent transmittance (%T).
STD ADD	System of checking accuracy (see Section Section 4).
K ₁ , K ₂ , K ₃ , K ₄	Sets coefficient related to a specific wavelength.
CONC X	Prompts for a concentration factor.
SAVE PROGRAM	Saves all settings in the current mode of operation. See Section 1.11.3.

11.1.3 Concentration Factor

The **CONC X** soft key provides a way to select a specific concentration factor for converting absorbance readings to concentration. The concentration factor is the slope of the line in the equation:

$$\text{Concentration} = (\text{CONC X}) \times \text{ABS}$$

Press the **CONC X** soft key to display the concentration factor (Conc X) options menu. Enter a concentration factor with the **DIGIT** keys and change the units at this time, if necessary.

CONC X Options

Soft Key	Function
SIGN ±	Changes sign of value on prompt line.
CONC OFF	Turns concentration factor off and returns to the options menu.

Use the **SIGN** soft key to change the sign of the value entered on the prompt line.

Press the **ENTER** key to confirm the selection and return to the options menu. The change will be displayed in the **CONC X** soft key label, and the units are displayed to the right of the data.

To remove the concentration selection, press the **CONC X** soft key and then press the **CONC OFF** soft key. The **CONC X** soft key label displays: CONC X: OFF.

After a concentration factor has been set, additional options become available in the options menu.

Additional CONC X Options

Soft Key	Function
CONC X	Concentration factor: prompts for concentration value.
UNITS	Selects from a variety of units.
FORMAT	Changes decimal point setting in data display.
DIL X	Adds a dilution factor to a measurement.
BLANK	Compensates for color in reagent blank.
↵ STD	Adjusts the calibration curve.
SAVE PROGRAM	Saves all settings in the current mode of operation. See Section 1.11.3 for details.

The **UNITS** soft key lets the operator select from a list of several concentration units. Repeatedly press the **UNITS** soft key to view the available units.

Press the **FORMAT** soft key repeatedly to specify the maximum number of decimal places for the data display. The decimal moves one position to the left each time the key is pressed.

11.1.3.1 Dilution Factor

The **DIL X** soft key allows the operator to enter a dilution factor. 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 (off).

11.1.3.2 Reagent Blank

The reagent **BLANK** soft key lets the operator select a specific value for a reagent blank. Using a reagent blank is equivalent to adding a y-intercept value to the calibration line (i.e., concentration = (CONC X) ABS – reagent blank).

Press the **BLANK** soft key to display the reagent blank menu.

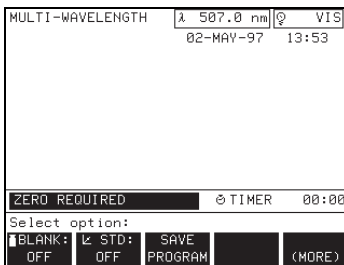
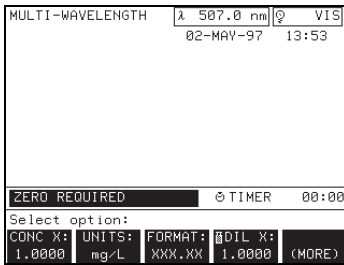
Reagent Blank Menu

Soft Key	Function
SIGN ±	Changes sign on keyed-in value.
BLANK OFF	Turns reagent blank setting off.

The display prompts to enter a value for the reagent blank. Use the **SIGN** soft key to change the sign of the value, if necessary, then press **ENTER**.

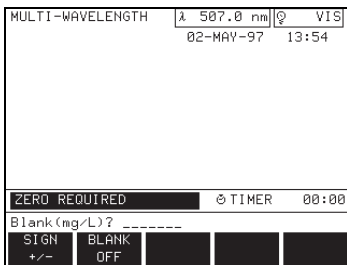
11.1.4 Standard Adjustment

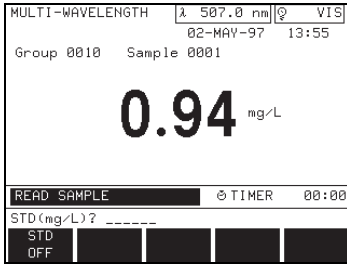
Press the **↵ STD** soft key. The screen prompts for the standard concentration value.



NOTE: The dilution factor can also be used to adjust for a variety of properties such as specific gravity and sample weight.

NOTE: When a reagent blank has been entered, pressing the **ZERO** soft key (in the measurement control menu) gives the negative blank correction value rather than zero.





WARNING

This instrument is not intended for use with flammable samples or those containing hydrocarbons.

Standard Adjustment Menu

Soft Key	Function
STD OFF	Turns standard adjustment setting off

Place a known standard into the instrument with the fill marks facing the front of the instrument. Press the **ENTER** key to accept the default value, or key in a new value and then press **ENTER**. The new value is displayed in the **STD** soft key label and the standard adjustment symbol (⌵) appears in the upper right of the display to indicate that an adjustment has been made. To turn the standard adjust off, press the ⌵ **STD** soft key, then press the **STD OFF** soft key.

11.1.5 ⚠ Taking Multiple Wavelength Measurements

ADVERTENCIA

Este instrumento no está destinado para uso con muestras inflamables o que contengan hidrocarburos.

ADVERTÊNCIA

Este instrumento não é feito com o fim de ser empregado com amostras inflamáveis ou aquelas que contêm hidrocarbonetos.

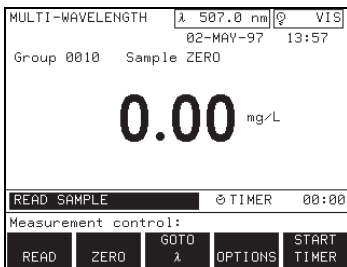
ATTENTION

Cet instrument n'est pas conçu pour une utilisation avec des échantillons inflammables ou des échantillons contenant des hydrocarbures.

WARNHINWEIS

Dieses Gerät darf nicht für Tests mit brennbaren Proben oder Proben, die Kohlenwasserstoffe enthalten, benutzt werden.

Before taking sample measurements, select sample-reading options using the **VIEW** and **GOTO λ** soft keys.



To begin taking measurements, place a blank sample cell in the cell compartment with the fill marks facing the front of the instrument. Close the module lid. The status bar shows: ZERO REQUIRED.

Press the **ZERO** soft key. The zero is displayed and the status bar shows: READ SAMPLE. The wavelength selection box displays the wavelengths as each reading is taken.

Remove the blank sample cell from the cell compartment. Place the sample cell containing sample in the cell compartment with the fill marks facing the front of the instrument. Close the module lid.

Press the **READ** soft key. The status bar shows: READING..., then READ SAMPLE. Press the **UP** arrow key if you need to re-zero with the blank. Otherwise, continue replacing sample cells and taking readings for the remaining samples.

NOTE: The instrument stores a maximum of 200 sets of data points in memory. Press the **RECALL** key to view stored data or press the **PRINT** key to send the on-screen data to the printer.

If storing sample data is required, press the **STORE** key after each displayed reading (see Section *Section 3*).

If a timer value has been set, press the **START TIMER** soft key to begin the timer countdown. Read Section *1.11.1* for information on setting timers.

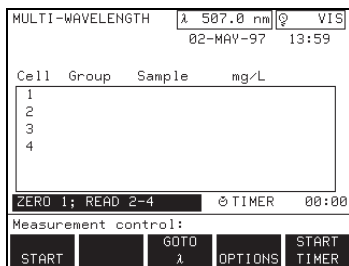
11.1.6 Using the Carousel Module Within the Multiple Wavelength Mode

For information on changing sample modules, loading and inserting the carousel, or instrument setup for the Carousel Module, read Section *1.9*.

The Carousel Module options and measurement control menus are similar to the Single-cell Module menus described in Section *11.1*. Minor differences appear in the **GROUP** and **SAMPLE** soft keys, as discussed in Section *1.11.2*.

Before taking sample readings in the Carousel Module, choose the mode of operation (if different from the default setting) by following the instructions in Section *1.9.1*. Then choose options for sample readings with the **OPTIONS** soft key under the measurement control menu (see Section *11.1.2*).

Load and insert the carousel. The status bar indicates which cells will be read as zeros and which cells will be read as active samples.



To begin the first set of measurements, press the **START** soft key. The instrument adjusts the carousel to zero the number one cell, and read the remaining cells as programmed through the instrument setup menu (**SETUP** key). The status bar displays the instrument operation: **READING 1...**, **READING 2...**, etc. as the carousel turns and the instrument takes readings. The instrument lists each reading in the data display as it is taken. An alert sounds as the last reading appears on the screen.

Press the **CANCEL** soft key any time before the alert to start over and to erase all readings from the current set of measurements.

If necessary, the carousel mode can be changed at this time as described in Section *1.9*. Press the **START** soft key to continue taking measurements.

11.2 Storing Data in Multiple Wavelength Mode

The setup options provide manual and automatic storage. Refer to Section *1.6.2* and Section *Section 3* for instructions on setting this option. Use the following procedures to manually or automatically store data.

11.2.1 Manual Storage of Data

In the manual storage mode, simply press the **STORE** key after each reading to add the sample to the data log. If a carousel module is being used, all non-zero results are stored with one press of the **STORE** key.

11.2.2 Auto Storage of Data

In the automatic storage mode, a **READ** soft key is added to the measurement control menu. When **READ** is pressed, the instrument will read the sample, place the result in the data log, and then display: DATA STORED. The display result is not updated continuously when in the automatic storage mode. If a carousel module is being used, all non-zero results are stored automatically after the last active cell is read.

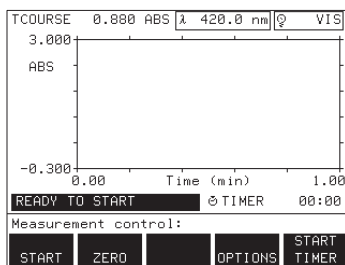
The time course measurement mode provides a way to evaluate reactions by taking readings at one wavelength over time. For example, the operator can determine how quickly color develops in a sample, how stable it is, and how soon it decays.

Select the **TIME COURSE** soft key from the second level of the main menu options. The time course mode appears as TCOURSE in the top left of the screen. Wavelength and light source indicators appear in the top right of the screen.

12.1 Using the Single-Cell Module Within the Time Course Mode

12.1.1 Time Course Measurement Control

The **START** soft key in the following menu appears after pressing the **ZERO** soft key for a baseline reading. Be sure to set the options before taking measurements (see Section 12.1.2).



NOTE: Press **EXIT** at any time in the measurement control menu to return to the main menu. The prompt asks: **EXIT TO MAIN MENU?**, and if the current data has not been stored, a warning flashes: **NOT STORED. Store the data if necessary, then select the YES soft key to display the main menu.**

Measurement Control Menu

Soft Key	Function
START	Starts sample scan (appears after zero reading is taken).
ZERO	Gives a zero value to a sample reading.
OPTIONS	Displays the options menu for changing sample-related variables (see Section 12.1.2).
START TIMER	Starts timer countdown (see Section 1.11.1).

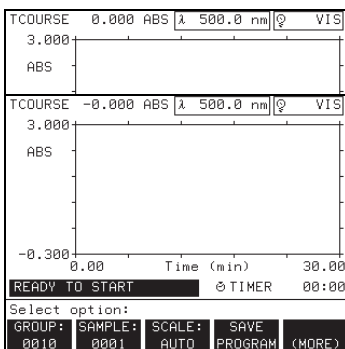
The central portion of the screen contains a graph of absorbance (ABS) vs. time (minutes). The absorbance variable may be changed in the options menu.

Adjust total time, rate, and wavelength settings using the options menu before taking readings. Press the **OPTIONS** soft key to display the options menu.

The **START** and **ZERO** soft key operations are discussed in Section 12.1.3.

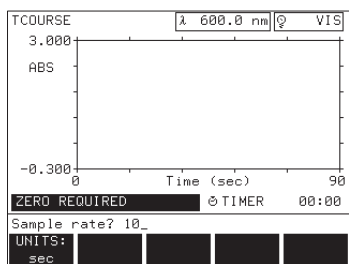
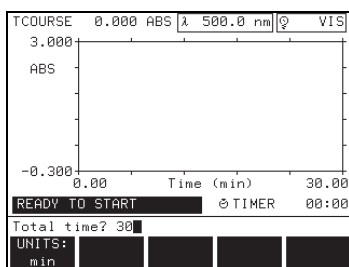
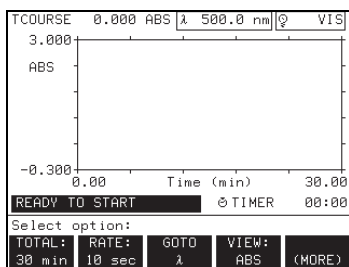
12.1.2 Time Course Options

Before taking measurements, press the **OPTIONS** soft key to select sample-reading options. The display shows the options menu.



Options Menu

Soft Key	Function
TOTAL	Prompts to select the total time (sec, min, hr) over which readings will be taken.
RATE	Prompts to select rate of each reading (sec, min, hr).
GOTO λ	Prompts operator to select specific wavelength.
VIEW	Displays data in ABS or %T.
GROUP	Changes group number (see Section 1.11.2).



NOTE: When the total time is set, the rate is automatically set to a value that will collect the maximum amount of data in the specified total time.

Options Menu (Continued)

SAMPLE	Changes sample number (see Section 1.11.2).
SCALE	Adjusts the y-axis scale (available after measurements are taken).
SAVE PROGRAM	Saves all settings in the current mode under a selected identification number. See Section 1.11.3.
CONC X	Prompts for a concentration factor.

The **TOTAL** soft key sets the total time over which the instrument will take readings. Key in the time with the digit keys. Then select the units for the time period in seconds, minutes, or hours by pressing the **UNITS** soft key. The units selected for the total time become the units for the x-axis of the graph and all subsequent reports. Press **ENTER** to confirm the selection and to return to the options menu.

The **RATE** soft key sets the rate at which readings are taken within the time period. Key in a rate with the digit keys. Then select the units for the rate in seconds, minutes, or hours by pressing the **UNITS** soft key. Press **ENTER** to confirm the selection and to return to the options menu. The minimum value for the rate is determined by the current value for the total time and the maximum of 490 points available for a time-course measurement. For example, if a total time of 48 hours is selected, the fastest (minimum) rate is determined by:

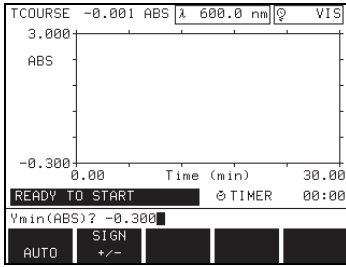
$$\text{rate} = \frac{48 \text{ hours}}{490 \text{ points}} = 0.098 \text{ hours per point (or 6 minutes)}$$

The instrument will give an out-of-range error if a rate smaller than this is entered.

Press the **GOTO λ** soft key to select a specific wavelength for sample readings. Enter a value with the numbered keys and press **ENTER**. The wavelength status bar displays the change.

Press the **VIEW** soft key to set the data display reading to ABS or %T. The data display changes each time the soft key is pressed.

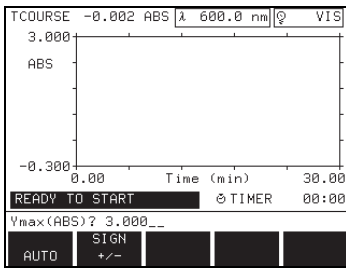
When the **SCALE** option is set to AUTO the instrument automatically adjusts the y-axis when a measurement goes beyond the default range of the graph, so that the operator can observe the entire scan. The **SCALE** soft key lets the operator adjust the minimum and maximum y-axis settings on the display graph.



Ymin and Ymax Settings

Soft Key	Function
AUTO	Returns default y-axis setting.
SIGN ±	Changes sign on a value.

Set the **SCALE** soft key label to AUTO by pressing the **(MORE)** soft key to reveal the **SCALE** soft key, press it, and then press the AUTO soft key to set this feature.

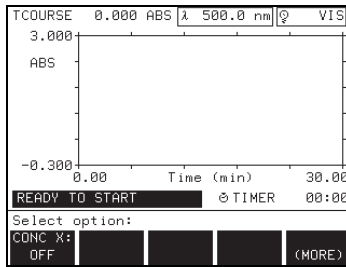


Set the **SCALE** feature to MANUAL by changing the Ymin and Ymax settings after pressing the **SCALE** soft key. This adjusts the scan graph scale to show scan values within a limited range.

12.1.2.1 Concentration Factor

The **CONC X** soft key provides a way to select a specific concentration factor for converting absorbance readings to concentration. The concentration factor is the slope of the line in the equation:

$$\text{Concentration} = (\text{CONC X}) \times \text{ABS}$$

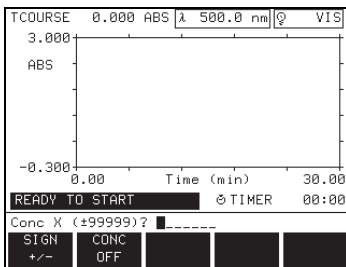


NOTE: If an error is made while entering numbers on the prompt line, press the **CE** key to clear and start over.

Press the **CONC X** soft key to display the concentration factor (Conc X) options menu. Enter a concentration factor with the **DIGIT** keys and change the units at this time, if necessary.

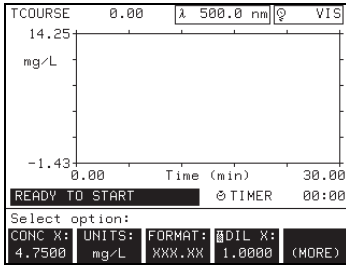
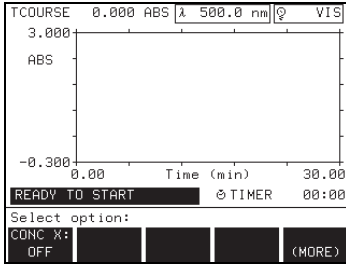
CONC X Options

Soft Key	Function
SIGN ±	Changes sign of value on prompt line.
CONC OFF	Turns concentration factor off and returns to the options menu.



Use the **SIGN** soft key to change the sign of the value entered on the prompt line.

Press the **ENTER** key to confirm the selection and return to the options menu. The change will be displayed in the **CONC X** soft key label, and the units are displayed to the right of the data.



To remove the concentration selection, press the **CONC X** soft key and then press the **CONC OFF** soft key. The **CONC X** soft key label displays: CONC X: OFF.

After a concentration factor has been set, additional options become available in the options menu.

Additional CONC X Options

Soft Key	Function
CONC X	Concentration factor: prompts for concentration value.
UNITS	Selects from a variety of units.
FORMAT	Changes decimal point setting in data display.
DIL X	Adds a dilution factor to a measurement.

The **UNITS** soft key lets the operator select from a list of several concentration units. Repeatedly press the **UNITS** soft key to view the available units.

Press the **FORMAT** soft key repeatedly to specify the maximum number of decimal places for the data display. The decimal moves one position to the left each time the key is pressed.

The **DIL X** soft key allows the operator to enter a dilution factor. 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 (off).

NOTE: The dilution factor can also be used to adjust for a variety of properties such as specific gravity and sample weight.

WARNING

This instrument is not intended for use with flammable samples or those containing hydrocarbons.

12.1.3 Taking Time Course Measurements

ADVERTENCIA

Este instrumento no está destinado para uso con muestras inflamables o que contengan hidrocarburos.

ADVERTÊNCIA

Este instrumento não é feito com o fim de ser empregado com amostras inflamáveis ou aquelas que contêm hidrocarbonetos.

ATTENTION

Cet instrument n'est pas conçu pour une utilisation avec des échantillons inflammables ou des échantillons contenant des hydrocarbures.

WARNHINWEIS

Dieses Gerät darf nicht für Tests mit brennbaren Proben oder Proben, die Kohlenwasserstoffe enthalten, benutzt werden.

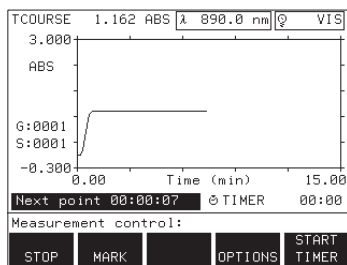
Before taking readings, adjust the total time, rate, and wavelength settings using the options menu. Press the **OPTIONS** soft key to display the options menu (above).

NOTE: Clean all sample cells with a lint-free, oil-free cloth before placing in the sample compartment.

To begin taking sample readings, place the blank sample cell in the cell compartment with the fill marks facing the front of the instrument. Close the module lid. The status bar shows: ZERO REQUIRED. Press the **ZERO** soft key. The status bar shows: ZEROING... and then: READY TO START. A **START** soft key is then added to the menu. Next to the mode title, real-time absorbance is recorded during readings.

Place the sample into the sample compartment with the fill marks facing the front of the instrument. Close the module lid. Press the **START** soft key to begin the time period. The status bar shows: NEXT POINT 00:00:00 (time and rate settings will be reflected in the display). Readings are taken at each interval when the status bar displays zero.

If additions to samples are necessary during the time period, open the lid only after the countdown begins. Make sure the module lid is closed while the reading is being taken (status bar displays: NEXT POINT 00:00:00).



Measurement Menu

Soft Key	Function
STOP	Stops reading, graphs existing data, and adjusts time coordinates.
MARK	Places a marker on the graph line.
OPTIONS	Displays same options menu as <i>Options Menu</i> .
START TIMER	Starts preset timer countdown.

The group (G:) and sample (S:) numbers are displayed to the left of the graph.

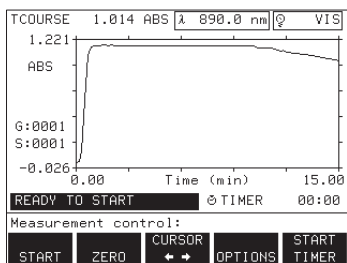
The **MARK** soft key lets the operator place a mark on any point on the line while readings are taken to mark sample additions or reactions.

Press the **STOP** soft key at any time during the time period to terminate the readings and to display the current data in graph form. The displayed graph reflects the change in time and adjusts the y-axis to accommodate the data.

If the time period is allowed to run out, an alert sounds and a graph line is drawn on the graph at the end of the time period. The screen displays the graph version of the measurement control menu. See Section 12.1.4 for details.

12.1.4 Time Course Graph Options

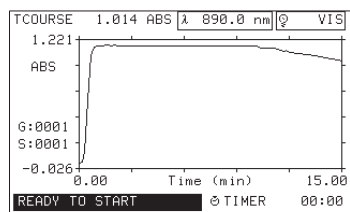
The soft keys in the graph version of the measurement control menu are similar to those listed in Section 12.1.1, except for the addition of the **CURSOR** soft key. Press the **CURSOR** soft key to display the graph options menu. The y-axis adjusts to accommodate the data.



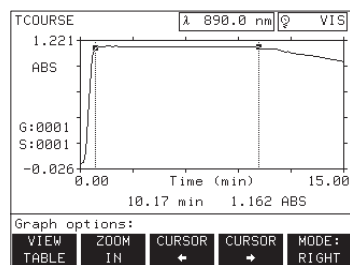
Graph Version of Measurement Control Menu

Soft Key	Function
START	Start the time period.
ZERO	Gives zero reading to sample.

Graph Version of Measurement Control Menu



Press the **CURSOR** soft key at any time to return to the measurement control menu.



Soft Key	Function
CURSOR	Displays the graph options menu for detailed view of specific areas within the graph.
OPTIONS	For adjusting sample-related options.
START TIMER	Starts preset timer.

Press the **CURSOR** soft key to display the graph options menu. The graph is displayed with two cursor points. The graph options menu provides a way to select specific points on the graph or from a table. These points can be used to determine the best time to take a reading at a specific wavelength.

Graph Options Menu

Soft Key	Function
VIEW TABLE	Displays table options menu and table, listing ABS or %T vs. time.
ZOOM IN	Shows detail of an area between two points on the graph
ZOOM OUT	Returns graph to normal view (appears after pressing ZOOM IN).
CURSOR left	Moves the selected cursor along the graph line.
CURSOR right	Moves the selected cursor along the graph line.
MODE	Selects the left or right cursor or determines the slope of the line between the cursors.

Select **SLOPE** to display the slope of the best-fit line of the data between the two cursors. The data, including the correlation coefficient (r^2), is displayed below the graph.

Press the **ZOOM IN** soft key to see the area between the cursors in detail. Press the **VIEW TABLE** soft key to display the table options menu.

Adjust the placement of each cursor by first pressing the **MODE** soft key. **LEFT** selects the left cursor and **RIGHT** selects the right cursor. After selecting the mode, the **CURSOR LEFT** and **RIGHT** soft keys move the selected cursor to the right or left. Place the cursors so that the range of interest lies between the cursors.

Time (min)	ABS
3.17	0.999
3.33	0.999
3.50	0.992
3.67	0.991
3.83	0.991
4.00	0.989

12.1.5 Time Course Table Options

The **VIEW TABLE** soft key displays the table options menu. The table options menu provides a way to select a specific data point from a table. The highlighted data point on the table indicates the cursor placement from the **MODE** soft key setting (left or right).

Table Options Menu

Soft Key	Function
VIEW GRAPH	Returns display to graph view and graph options menu.
GOTO TIME	Prompts operator to select specific time.

Table Options Menu

Soft Key	Function
PAGE DOWN and PAGE UP	Scrolls through the data table six data points at a time.

NOTE: Press **EXIT** at any time to return to the measurement control menu.

NOTE: The highlighted position in the table tracks the cursor position in the graph.

Locate data in the table by using the **PAGE UP** and **PAGE DOWN** soft keys and the arrow keys on the keypad. Another method is to use the **GOTO TIME** soft key and key in the time of interest.

12.2 Time Course Operation Using the Carousel Module

For information on changing sample modules, loading and inserting the carousel, or instrument setup for the Carousel Module, see Section 1.9.

The carousel module options and measurement control menus are similar to the Single-cell Module menus described in Section 12.1. Minor differences appear in the **GROUP** and **SAMPLE** soft keys, as discussed in Section 1.11.2.

Load and insert the carousel. The status bar indicates which cells will be read as zeros and which cells will be read as active cells.

To begin the first set of measurements, press the **START** soft key. The instrument adjusts the carousel to zero the number one cell, and reads the remaining cells as programmed through the instrument setup menu (**SETUP** key). The status bar displays the instrument operation: **READING1...**, **READING 2...**, etc., as the carousel turns and the instrument takes readings. The instrument updates the graph of the selected cell as readings are taken.

Use the **UP** and **DOWN** arrow keys on the keypad to view the data for any cell position.

If additions to samples are necessary during the time period, open the lid only after the countdown begins. Make sample adjustments and return the carousel to the module. Make sure the lid is closed while the reading is being taken (the status bar shows: **NEXT POINT 00:00:00**).

NOTE: The dilution factor applies to all samples in the carousel.

The timer may be set at any time by keying in a time with the digit keys. Press the **START TIMER** soft key to begin the timer countdown. See Section 1.11.1 for more information on setting timers.

Press the **STOP** soft key at any time during the time period to terminate the readings and display the current data in graph form. The displayed graph reflects the change in time and adjusts the y-axis to accommodate the data.

If the time period is allowed to run, an alert sounds and a graph line is drawn at the end of the time period. The y-axis adjusts to accommodate the data and the measurement control menu changes to the graph version of the menu.

12.3 Storing Time Course Data

12.3.1 Manual Storage of Time Course Data

The setup options provide MANUAL or AUTO storage (see Section 3 for setting this option). To store time course data in the manual storage mode, follow this procedure:

If using a carousel, use the **UP** and **DOWN** arrow keys on the keypad to select the cell data to be stored (the cell number is displayed to the left of the graph). If using the Single-cell Module begin at step 2.

The screenshot shows the TCOURSE menu with the following data table:

File	Date	Time	Group	Sample
4	08-APR-97	12:06	0000	0005
5	08-APR-97	12:06	0000	0006
6	21-APR-97	11:03	0000	0001
7	21-APR-97	11:03	0000	0001
8				
9				

Below the table, the prompt "Store to file(0-9)? 8" is displayed. At the bottom of the screen, there are two soft keys: "PAGE UP" and "PAGE DOWN".

1. Press the **STORE** key.
2. Select a file number from 0 to 9. Press **ENTER** to confirm the selection; the scan will be stored in the specified file and the display will return to the measurement control screen.
3. Repeat steps 1 through 3 for each carousel cell position to be stored.

12.3.2 Auto Storage of Time Course Data

In the auto storage mode, the arrow to the left of the stored data table indicates the location of the next file to receive data.

The arrow advances one file number after each automatic store, wrapping around to file number 0 after storing in file number 9. No warning is given when auto store overwrites existing files. To manually position the arrow, proceed as follows:

1. Press the **RECALL** key.
2. Use the arrow keys to move the highlight bar to the position you want the arrow to appear next.
3. Press the **DELETE** soft key. The arrow will then point to the highlighted number, and the next data cell to be stored will occupy that file.

12.4 Recalling Time Course Data

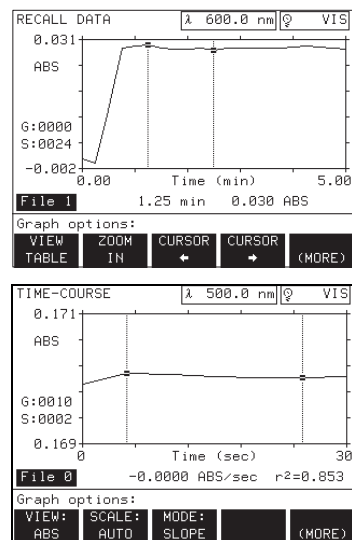
File	Date	Time	Group	Sample
4	08-APR-97	12:06	0000	0005
5	08-APR-97	12:06	0000	0006
6	21-APR-97	11:03	0000	0001
7	21-APR-97	11:03	0000	0001
8				
9				

Recall file(0-9)? 7

DELETE PAGE UP PAGE DOWN

To access stored scans from the scan mode measurement control menu, press the **RECALL** data key. To access stored scans from the main menu, press the **RECALL** data key, then press the **TIME COURSE** soft key.

Select a file number to recall (0-9) using the digit keys or the **UP** and **DOWN** arrow keys, and press **ENTER**. A graph of the recalled scan is displayed.



Time Course Graph Options Menu

Soft Key	Function
VIEW TABLE	Shows time course data in table form.
ZOOM IN	Shows detail of an area between two points on the graph.
ZOOM OUT	Returns graph to normal view (appears after pressing ZOOM IN).
CURSOR KEYS	Moves the selected cursor left or right along the graph.
VIEW	Displays data as ABS or %T.
SCALE	Permits selection of a fixed or automatic y-axis selection.
MODE	Selects the left or right cursor or determines the slope of the line between the cursors.

The **VIEW TABLE** soft key displays the table options menu. This menu displays time course data in table form. See the *Options Menu* on page 79 for more information.

Adjust the placement of each cursor by first pressing the **MODE** soft key. **LEFT** selects the left cursor and **RIGHT** selects the right cursor. After selecting the mode, the **CURSOR LEFT** and **RIGHT** soft keys move the selected cursor to the right or left. Place the cursors so that the range of interest lies between the cursors.

Select **SLOPE** to display the slope of the best-fit line of the data between the two cursors. The data, including the correlation coefficient (r^2), is displayed below the graph.

Press the **ZOOM IN** soft key to view data between the cursors in detail. **ZOOM IN** may be pressed repeatedly to obtain successively more detailed views. Press the **ZOOM OUT** soft key to returns the graph to its original view.

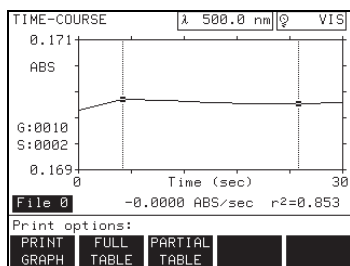
Use the **CURSOR** soft keys to move the cursor to the left or right. The data point corresponding to the cursor position is displayed beneath the graph. Press and hold down a **CURSOR** soft key to move the cursor in larger increments.

Press the **VIEW TABLE** soft key to display the table options menu.

Press the **SCALE** soft key to adjust the ymin and ymax settings. See page 81 for details.

NOTE: The wavelength noted in the Wavelength status bar indicates the current monochromator setting, it does not necessarily represent the time course wavelength.

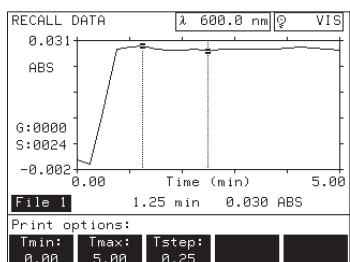
12.5 Printing Time Course Data



From the measurement control menu or while recalling data, press the **PRINT** key to initiate time course data printing. A print options menu is displayed.

Data Printing Options

Soft Key	Function
FULL TABLE	Prints all of the selected time course data in table form.
PARTIAL TABLE	Prints only a portion of the selected time course data.
PRINT GRAPH	Prints a copy of the graph. Available only if the graph option in the serial I/O setup menu is set to ON (see Section 1.6).



Press the **PARTIAL TABLE** soft key to print a selected portion of the data. Use the **TMIN** and **TMAX** options to enter the time range to print, and use the **TSTEP** option to select the time interval. Press **PRINT** or **ENTER** to print the data.

12.6 Deleting Time Course Data

To delete Time Course data, you must first recall the data. To access stored scans from the scan mode measurement control menu, press the **RECALL** key. To access stored scans from the main menu, press the **RECALL** key, then press the **TIME COURSE** soft key.

Select a file number to recall (0-9) using the digit keys or the **UP** and **DOWN** arrow keys. Press the **DELETE** soft key and answer the prompts that are displayed on the screen.



MAINTENANCE

WARNING

Some of the tasks in this section of the manual have safety issues associated with them. Because the potential for injury to individuals and equipment exists when these safety issues are not addressed, Hach Company strongly recommends that qualified personnel conduct the installation, and that all installation personnel review the associated instructions carefully.

ADVERTENCIA

Algunas de las tareas comprendidas en esta sección del manual pueden ocasionar daños a las personas y al material si no observan la medidas de seguridad. Hach Company recomienda encarecidamente que el material sea instalado por un personal cualificado y que el personal encargado de la instalación lea atentamente estas instrucciones.

ADVERTÊNCIA

A execução de algumas tarefas previstas nesta secção do manual pode causar ferimentos às pessoas ou estragos no equipamento se não forem observadas precauções de segurança. A Hach Company recomenda vivamente que o equipamento seja instalado por pessoal qualificado e que todas as pessoas afectadas à sua instalação leiam atentamente estas instruções.

ATTENTION

Certaines tâches dans ce chapitre du mode d'emploi peuvent causer des blessures aux personnes et endommager le matériel si les consignes de sécurité ne sont pas suivies. Hach Company recommande vivement que l'installation soit faite par du personnel qualifié et que toutes les personnes effectuant l'installation lisent attentivement ces instructions.

WARNUNG

Einige der in diesem Abschnitt der Betriebsanleitung beschriebenen Arbeiten können bei Nichtbeachtung der Sicherheitsvorschriften zu Verletzungen von Personen oder Schäden am Gerät führen. Es wird dringend empfohlen, die Installation ausschließlich von qualifiziertem Personal durchführen zu lassen; mit der Installation befaßte Personen sollten diese Anweisungen aufmerksam lesen.

13.1 Cleaning Requirements

13.1.1 Spectrophotometer

Keep the DR/4000 Spectrophotometer work area clear of papers and debris. Occasionally check the vent underneath the instrument and the fan in the back of the instrument for obstructions.

If the fan or the vent become blocked, the lamps may overheat, causing the LAMPS OVERHEATED error message to appear on the screen. Clear the blocked airways immediately and press the **START** soft key to restart the instrument.

Keep the instrument surface clean at all times and promptly wipe up spills on and around the instrument. If the case becomes dirty, wipe it clean with a soft cloth, water, and mild soap.

Keep the inside of the modules clean and dry. Lenses are located on both sides of the module. Remove the module and wipe lenses with a soft, lint-free and oil-free cloth to clean.

DO NOT use organic solvents such as acetone to clean the lenses, case, or module parts.

13.1.2 Sample Cells

Clean sample cells with detergent and water. Rinse the cells several times with tap water, and then rinse thoroughly with deionized water. Rinse sample cells containing organic solvents (chloroform, benzene, toluene, etc.) with acetone before the detergent wash, and again as a final rinse before drying.

Wash polystyrene disposable sample cells with soap and water and rinse thoroughly with tap water.

13.1.3 Single-Cell and Carousel Modules

If a module becomes dirty, wipe it clean with soap and water and a soft cloth. Remove sample cell adapters or the carousel unit before cleaning the inside of the module. Dry the module thoroughly.

DO NOT immerse modules.

Clean sample cell adapters and carousels with soap and water. Wash adaptor lenses with mild soap and water and a cotton swab if necessary. Rinse thoroughly with cold tap water and let dry.

DO NOT use organic solvents such as acetone to clean modules, adapters, or carousels.

CAUTION

Do not use the Flow-Cell Module in tests that use organic solvents such as toluene, chloroform, trichloroethane or cyclohexanone. These solvents are not compatible with the plastic components of the Flow-Cell Module, and may damage the instrument and expose the operator to harmful chemicals.

13.1.4 Flow-Cell and Sipper Modules

CUIDADO

No utilice el Módulo de Celda de Flujo Continuo en pruebas que usan solventes orgánicos tales como tolueno, cloroformo, tricloroetano o ciclohexanona. Estos solventes no son compatibles con los componentes plásticos del Módulo de Celda de Flujo Continuo, y podrían dañar el instrumento, exponiendo al analista a sustancias peligrosas.

ATENÇÃO

Não use o Módulo da cubeta de fluxo em teste que use solventes orgânicos tais como tolueno, cloroformio, tricloroetano, ou ciclohexanone. Esses solventes não são compatíveis com os componentes plásticos da cubeta, e pode danificar o instrumento e expor o operador a produtos químicos perigosos.

PRUDENCE

Ne pas utiliser le module de cuve à circulation dans les techniques d'analyses qui utilisent des solvants organiques tels que le toluène, le chloroforme, le trichloroéthane ou la cyclohexanone. Ces solvants ne sont pas compatibles avec les composants en plastique de la cuve à circulation et peuvent endommager l'appareil en exposant l'opérateur à des produits chimiques dangereux.

WARNHINWEIS

Das Durchflußmodul darf nicht bei Tests verwendet werden, in denen organische Lösemittel wie Toluol, Chloroform, Trichlorethan oder Cyclohexanon benutzt werden. Diese Lösemittel sind möglicherweise mit den Kunststoffkomponenten des Durchflußmoduls nicht kompatibel und können Schäden am Gerät sowie Gesundheitsrisiken für den Laboranten verursachen.

Check the modules occasionally for accumulation of film on the windows. If the windows appear dirty or hazy, soak them in a detergent bath and then rinse thoroughly with deionized water. The Flow-cell and Sipper Modules can be disassembled for cleaning if necessary. Follow cleaning instructions in the *DR/4000 Optional Module Manual* provided with the module.

DO NOT use organic solvents such as acetone to clean any part of the Flow-cell and Sipper Modules.

13.2 Lamp Replacement

WARNING

Disconnect power to the instrument before opening the lamp compartment. Power must remain off while changing the lamp.

13.2.1 Tungsten (VIS) Lamp Replacement

ADVERTENCIA

Desconecte el instrumento de la corriente antes de abrir el compartimiento de la lámpara. La energía debe mantenerse apagada durante el reemplazo de la lámpara.

ADVERTÊNCIA

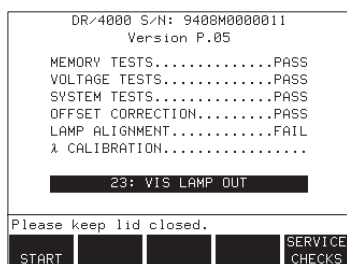
Desligue a energia elétrica do instrumento antes de abrir o compartimento da lâmpada. Durante a troca da lâmpada, não deverá ter energia elétrica no aparelho.

ATTENTION

Débrancher l'alimentation électrique de l'appareil avant d'ouvrir le compartiment de la lampe. L'alimentation doit rester coupée pendant le remplacement de la lampe.

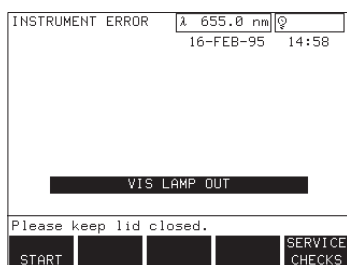
WARNHINWEIS

Vor Öffnen des Lampenfachs muß der Netzstecker gezogen werden. Während des Wechselns der Lampe bleibt die Stromversorgung unterbrochen.



If the visible (tungsten) lamp fails, operation can not continue until the lamp is replaced. Turn off the power switch and unplug the instrument before proceeding with lamp replacement instructions.

If the visible lamp fails during the power-up test, the display shows: LAMP ALIGNMENT.....FAIL and error message: 23: VIS LAMP OUT. The instrument will not operate until the lamp is replaced.



If the visible lamp fails during operation, the display shows: INSTRUMENT ERROR in the top left corner and error message: VIS LAMP OUT. The instrument will not operate until the lamp is replaced.

Tools required:

- Hach Tungsten Lamp Replacement Kit
- Number 2 Phillips screwdriver
- Large flat screwdriver (optional)

CAUTION

When removing the lamp housing, eye protection is required.

The lamps and lamp housing components are hot and can cause severe burns. Let the lamp housing compartment cool for at least 30 minutes before touching the internal components.

CUIDADO

Se requiere usar protección de los ojos al quitar la armazón de la lámpara. Las lámparas y los componentes de la armazón están calientes, y pueden causar serias quemaduras. Permita que el compartimiento de la lámpara se enfríe por lo menos 30 minutos antes de tocar los componentes que contiene.

ATENÇÃO

Quando remover o suporte da lâmpada, use proteção para os olhos. A lâmpada e suporte ficam quentes e podem causar severas queimaduras. Deixe esfriar o suporte pelo menos por 30 minutos antes de tocar nos componentes internos.

PRUDENCE

Le port des lunettes de protection est obligatoire avant de retirer le couvercle du boîtier de lampe. Les surfaces exposées peuvent causer des brûlures graves. Laisser la lampe refroidir pendant au moins 30 minutes avant de toucher les composants internes.

VORSICHT

Beim Ausbau des Lampengehäuses ist ein Augenschutz zu tragen. Kontakt kann zu schweren Verbrennungen führen. Bevor die inneren Komponenten berührt werden können, muß die Lampe 30 Minuten abkühlen.

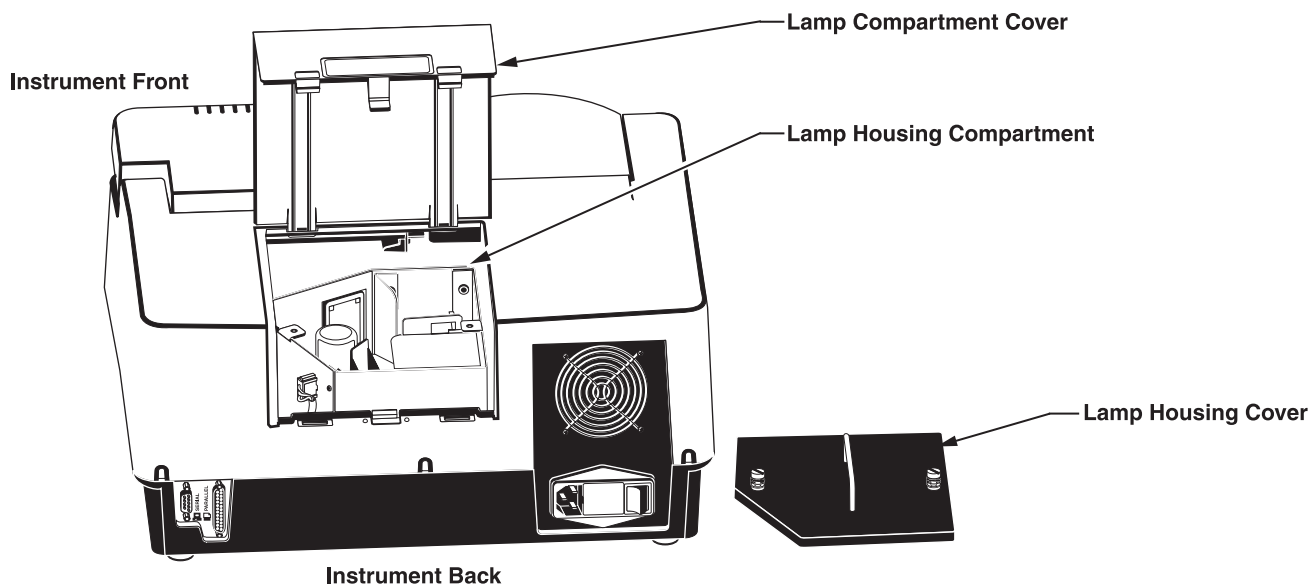
Follow the instructions below to replace the tungsten lamp. Refer to *Figure 11* and *Figure 12* when needed.

1. Read all caution and warning statements in this section of the manual, on the plastic lamp compartment cover, and on the metal lamp housing.
2. Disconnect power to the instrument. Turn the instrument so the back of it faces you.

NOTE: Wear cotton gloves when reaching into the lamp housing to avoid damaging the instrument's optics.

3. Remove the lamp compartment cover (see *Figure 11*).

Figure 11
Removing the Lamp Compartment Cover



4. Loosen the screw on the lamp housing cover and remove the cover. Use a large flat screwdriver to loosen the lamp housing screws if they are too tight to loosen by hand. Do not try to remove the screws from the cover.

NOTE: Do not touch the new lamp. Oils and dirt on the lamp will shorten the lamp life.

5. Squeeze the retaining clip on the lamp lead plug and pull out the plug (see *Figure 12*).

6. Unscrew the lamp bracket assembly from the lamp housing with a Phillips screwdriver.

7. Remove and dispose of the lamp and bracket assembly.

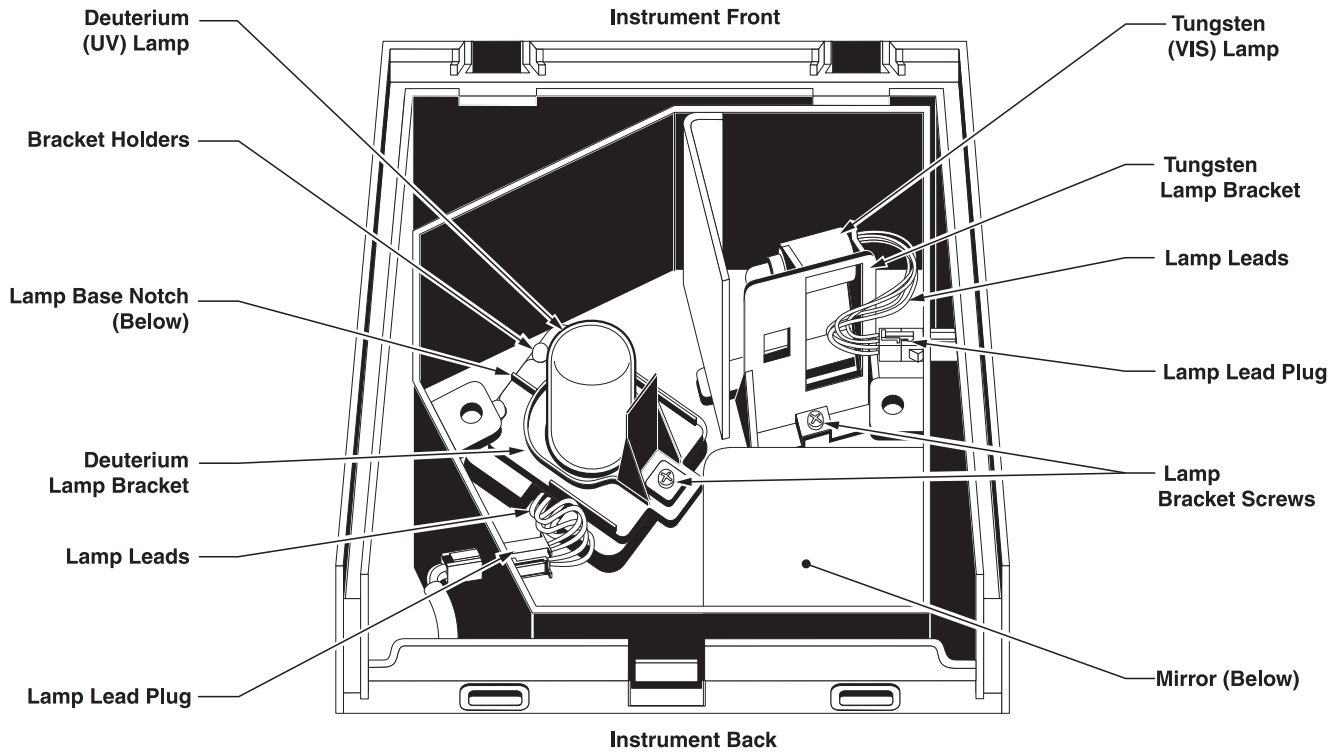
8. Place the new lamp and bracket assembly in the guides on the bottom of the lamp housing. Tighten the bracket screw to the housing.

9. Plug in the new lamp leads so the retaining clip snaps into place. **Make sure the wires curve along the right wall of the housing and are not blocking the light path.**

10. Replace the lamp housing cover and finger tighten the screws.

MAIN MENU		λ 600.0 nm	VIS
		17-JAN-96	22:06
SYSTEM CHECKS		λ 600.0 nm	VIS
		02-JUN-97	14:52
DR-4000U S/N: 9705U0000123			
Version 2.00			
Select option:			
LAMP	λ	NOISE	STRAY
HISTORY	CHECK	CHECK	LIGHT (MORE)

Figure 12
Lamp Housing Components



11. Replace the lamp compartment cover.

12. Reset the lamp history to monitor lamp use as described below.

a) Power the instrument and press the **MORE** soft key in the main menu.

b) Press the **SYSTEM CHECKS** soft key.

The display shows SYSTEM CHECKS in the upper left corner.

c) Press the **LAMP HISTORY** soft key.

The display shows the lamp history mode.

d) Select the **RESET VIS** soft key. The prompt asks: RESET VIS HISTORY?

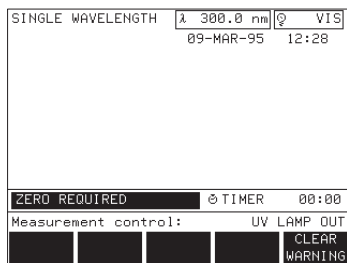
Press the **YES** soft key. The VIS settings revert to zero. The “on-time”

LAMP HISTORY	λ 600.0 nm	VIS
	16-FEB-95	16:54
VIS on-time	0.0 hr	
VIS cycles	0	
UV on-time	5.9 hr	
UV cycles	4	
UV triggers	7	
Select option:		
RESET	RESET	
VIS	UV	

setting records the new lamp's use in hours, and the "cycles" setting keeps track of the number of times the lamp is turned on.

WARNING

Disconnect power to the instrument before opening the lamp compartment. Power must remain off while changing the lamp.



WARNING

The deuterium lamp emits sufficient energy to cause eye injury. Never power the instrument with the lamp compartment open.

CAUTION

When removing the lamp housing eye protection is required. The lamps and lamp housing components are hot and can cause severe burns. Let the lamp housing compartment cool for at least 30 minutes before touching the internal components.



13.2.2 Deuterium (UV) Lamp Replacement

ADVERTENCIA

Desconecte el instrumento de la corriente antes de abrir el compartimiento de la lámpara. La energía debe mantenerse apagada durante el reemplazo de la lámpara.

ADVERTÊNCIA

Desligue a energia elétrica do instrumento antes de abrir o compartimento da lâmpada. Durante a troca da lâmpada, não deverá ter energia elétrica no aparelho.

ATTENTION

Débrancher l'alimentation électrique de l'appareil avant d'ouvrir le compartiment de la lampe. L'alimentation doit rester coupée pendant le remplacement de la lampe.

WARNHINWEIS

Vor Öffnen des Lampenfachs muß der Netzstecker gezogen werden. Während des Wechsels der Lampe bleibt die Stromversorgung unterbrochen.

The power-up test does not detect a UV lamp failure. If the UV lamp fails during operation, the user may press the **CLEAR WARNING** soft key to continue operation within the visible wavelength range. The UV lamp must be changed to operate the instrument within the ultraviolet range.

ADVERTENCIA

La lámpara de deuterio emite energía suficiente para dañar la vista. Nunca encienda el instrumento cuando esté abierto el compartimiento de la lámpara.

ADVERTÊNCIA

A lâmpada de deuterio emite energia suficiente para danificar os olhos. Nunca energize o aparelho com o compartimento da lâmpada aberto.

ATTENTION

La lampe deutérium émet une énergie suffisante pour provoquer des blessures aux yeux. Ne jamais mettre l'appareil sous tension avec le compartiment de lampe ouvert.

WARNHINWEIS

Die von der Deuterium-Lampe erzeugte Energie kann zu Augenverletzungen führen. Das Instrument darf bei geöffnetem Lampenfach auf keinen Fall angeschaltet werden.

CUIDADO

Se requiere usar protección de los ojos al quitar la armazón de la lámpara. Las lámparas y los componentes de la armazón están calientes, y pueden causar serias quemaduras. Permita que el compartimiento de la lámpara se enfríe por lo menos 30 minutos antes de tocar los componentes que contiene.

ATENÇÃO

Quando remover o suporte da lâmpada, use proteção para os olhos. A lâmpada e suporte ficam quentes e podem causar severas queimaduras. Deixe esfriar o suporte pelo menos por 30 minutos antes de tocar nos componentes internos.

PRUDENCE

Le port des lunettes de protection est obligatoire avant de retirer le couvercle du boîtier de lampe. Les surfaces exposées peuvent causer des brûlures graves. Laisser la lampe refroidir pendant au moins 30 minutes avant de toucher les composants internes.

VORSICHT

Beim Ausbau des Lampengehäuses ist ein Augenschutz zu tragen. Kontakt kann zu schweren Verbrennungen führen. Bevor die inneren Komponenten berührt werden können, muß die Lampe 30 Minuten abkühlen.

Tools required:

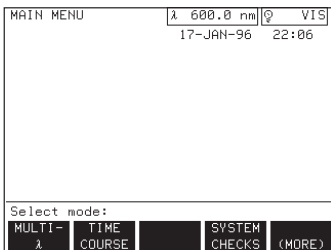
- Hach Deuterium Lamp Replacement Kit
- Number 2 Phillips screwdriver
- Large flat screwdriver (optional)

To change the UV lamp follow the instructions below. Refer to *Figure 11* and *Figure 12* when needed.

NOTE: Wear cotton gloves when reaching into the lamp housing to avoid damaging the instrument's optics.

NOTE: Do not touch the new lamp without wearing cotton gloves. Oils and dirt on the lamp will shorten the lamp life.

1. Read all caution and warning statements in this section of the manual, on the plastic lamp compartment cover, and on the metal lamp housing.
2. Disconnect power to the instrument. Turn the instrument so the back faces you.
3. Remove the lamp compartment cover.
4. Loosen the screw on the lamp housing cover and remove the cover. Use a large flat screwdriver to loosen the lamp housing screws if they are too tight to loosen by hand (*Figure 11*).
5. Squeeze the retaining clip on the lamp lead plug and pull out the plug.
6. Unscrew the lamp bracket from the lamp housing with a Phillips screwdriver. Pull the bracket out to release it from the bracket holders. Remove and dispose of the bracket.
7. Carefully pull the lamp and the lamp leads up and out of the lamp housing. Leave the plastic spacer (under the lamp) in place. Dispose of the lamp.
8. Align the new lamp so the leads run along the left compartment wall and the notch on the lamp base is one quarter turn clockwise from the large notch in the lamp housing. Set the lamp securely onto the silver lamp alignment pins.
9. Plug in the new lamp leads so the retaining clip snaps into place. The wires should emerge from the large notch in the lamp housing and run along the left compartment wall. Keep the leads clear of the lamp.
10. Set the bracket into the bracket holder and tighten the bracket screw to the housing.



SYSTEM CHECKS	λ 600.0 nm	VIS
	02-JUN-97	14:52
DR/4000U S/N: 9705U0000123		
Version 2.00		
Select option:		
LAMP HISTORY	NOISE CHECK	STRAY LIGHT (MORE)

LAMP HISTORY	λ 600.0 nm	VIS
	16-FEB-95	16:54
VIS on-time	0.0 hr	
VIS cycles	0	
UV on-time	5.9 hr	
UV cycles	4	
UV triggers	7	
Select option:		
RESET VIS	RESET UV	

11. Replace the lamp housing cover and finger tighten the screws.

12. Replace the lamp compartment cover.

13. Reset the lamp history to monitor lamp use as described below.

- Power the instrument and press the **MORE** soft key in the main menu.
- Press the **SYSTEM CHECKS** soft key. The display shows the systems checks menu.
- Press the **LAMP HISTORY** soft key. The display shows the LAMP HISTORY in the upper left corner.
- Select the **RESET UV** soft key. The prompt asks: RESET UV HISTORY? Press the **YES** soft key. The UV settings revert to zero. The on-time setting records the new lamp's use in hours; the cycles setting keeps track of the number of times the lamp is turned on; and the triggers setting keeps track of the lamp's attempted ignitions.

13.3 Fuse Replacement

WARNING

Turn off the instrument's power and remove the power cord from the instrument before removing the fuses. Failure to do so can result in electrical shock.

ADVERTENCIA

Apague el instrumento y quite el cable de suministro eléctrico del instrumento antes de sacar los fusibles. Si se omite esta precaución, puede sufrir un choque eléctrico.

ADVERTÊNCIA

Desligue a energia elétrica e remova o cordão de energia do equipamento antes de remover os fusíveis. Deixando de fazê-lo, você está sujeito a choques elétricos.

ATTENTION

Couper l'alimentation électrique de l'appareil et retirer le cordon d'alimentation avant de retirer les fusibles. L'inobservation de ces consignes crée un risque de choc électrique.

WARNHINWEIS

Vor dem Wechseln der Sicherungen muß die Stromzufuhr zum Gerät unterbrochen und der Netzstecker gezogen werden. Geschieht dies nicht, kann es zu einem Stromschlag kommen.

WARNING

For continued protection against fire hazard, replace only with the same type and rating of fuse.

ADVERTENCIA

Para protección permanente contra el peligro de incendio, reemplace el fusible solamente con otro del mismo tipo y la misma capacidad.

ADVERTÊNCIA

Para proteção continua contra perigo de incêndio, troque o fusível pelo mesmo tipo e valor.

ATTENTION

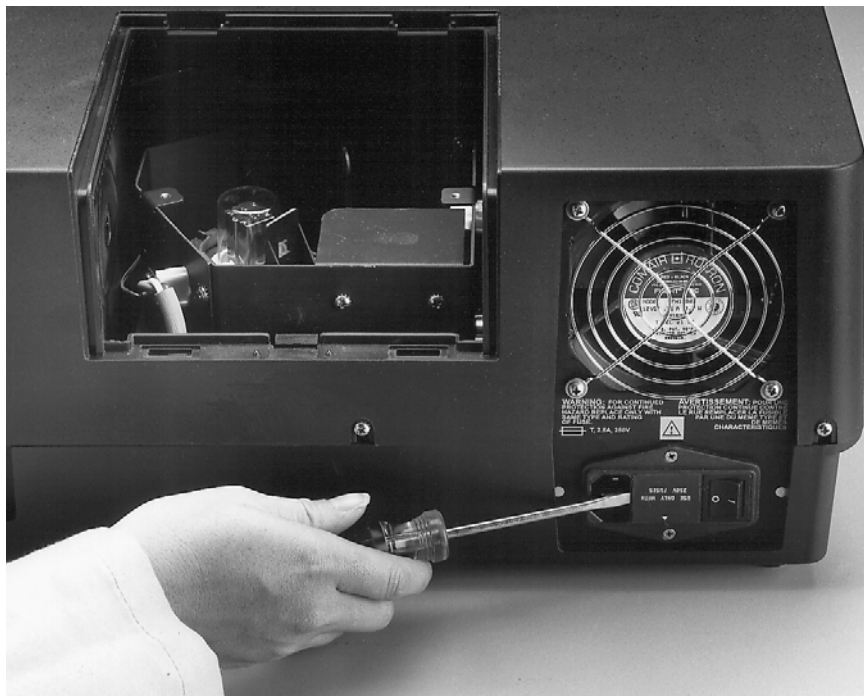
Pour une protection continue contre le feu, remplacer le fusible par un du même type et de mêmes caractéristiques.

WARNUNG

Zur Wahrung des Brandschutzes dürfen die Sicherungen nur gegen Sicherungen

des gleichen Typs und der gleichen Auslegung ausgetauscht werden.

Figure 13
Removing the Fuse Box



Follow the instructions below to change the DR/4000 Spectrophotometer fuses.

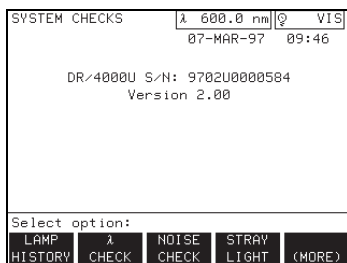
1. Unplug the instrument and remove the power cord from the back of the instrument.
2. Insert a flat screwdriver into the slot on the left edge of the fuse box and gently pry the box out.
3. Pull the fuses out of the fuse holders and replace them with new 250 volt fuses.
4. Snap the fuse box into place with the arrow pointing down.

14.1 Troubleshooting the DR/4000 Spectrophotometer

Table 3 Troubleshooting

Symptom	Cause	Remedy
Screen not readable	Screen contrast out of adjustment	Turn the contrast knob to the right of the screen until screen is clear.
Wavelength inaccurate	Power-up occurred with sample in sample cell	Remove the sample cell, and turn the instrument off and then on to recalibrate.
Power-up screen fails λ Calibration. Error message: BEAM BLOCKED?	Light beam blocked	Remove sample from sample cell and push the START soft key.
Power-up screen fails: OFF SET CORRECTION	Module lid open	Close module lid and press the START soft key.
Error message: MODULE REQUIRED	Module not inserted or connected properly	Insert module and secure with module lock.
Error message: LAMPS OVERHEATED	Not enough air flow to lamp compartment	Clear fan (back of instrument) and vents (under the instrument) of papers, dust, and debris. Then press the START soft key.
Power-up screen fails: LAMP ALIGNMENT and/or LAMP OUT warning appears.	Tungsten (VIS) lamp has burned out	Lamp replacement is necessary. Follow instructions in Section 10.2.
Warning: UV LAMP OUT	Deuterium (UV) lamp has burned out	Clear by pressing the CLEAR WARNING soft key and continue operation in visible light range. UV Lamp must be replaced to take readings below the UV crossover setting. Follow instructions in Section 10.2.2 to change UV lamp.
Trouble printing graphs	Communication parameters not set properly, graphics not turned on	See Section 1.12.2.

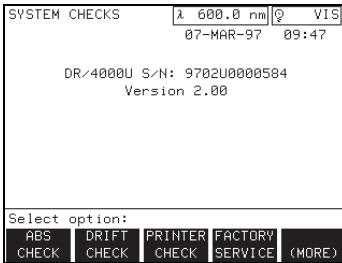
If the instrument does not respond after applying the above remedies, call the Hach Service Center for your area (see the information provided on page 100).



The DR/4000 Spectrophotometer lets the operator check the performance of the instrument. The instrument contains the software for checking photometric accuracy, photometric noise, stray light, and wavelength accuracy but does not include all of the chemistry or hardware necessary. Chemistry and hardware for the tests must be purchased separately.

Press the **MORE** soft key in the main menu and then press the **SYSTEM CHECKS** soft key to display the system checks menu.

System Checks Menu



Soft Key	Function
LAMP HISTORY	Reset lamp history after lamp replacement. See section 10.2.
λ CHECK	Checks wavelength accuracy.
NOISE CHECK	Checks photometric noise.
STRAY LIGHT	Checks stray light.
ABS CHECK	Checks photometric accuracy.
DRIFT CHECK	Checks instrument accuracy by monitoring drift. Takes on hour to complete.
PRINTER CHECK	Checks the legibility of the characters in the specified language.
FACTORY SERVICE	Prompts for service code from an authorized DR/4000 service person.

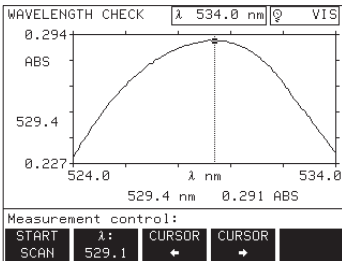
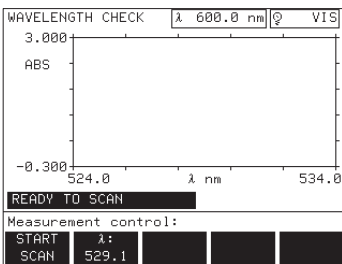
14.2.1 Wavelength Accuracy Check

No additional accessories are required to perform the wavelength accuracy check. To begin, press the **λ CHECK** soft key to measure wavelength accuracy at the following wavelengths: 529.1 nm and 808.0 nm (DR/4000U and DR/4000V), and 656.1 nm and 486.0 nm (DR/4000U only). The display shows the WAVELENGTH CHECK mode. The 656.1 option provides both an accuracy check and a bandwidth check. The 529.1, 808.0, and 486.0 options provide only a wavelength accuracy check.

Make sure the sample compartment is empty while conducting the wavelength check or the results will be inaccurate.

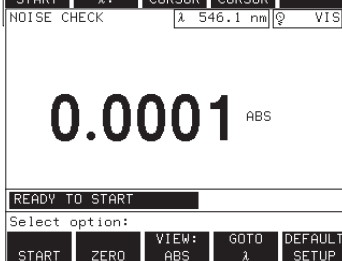
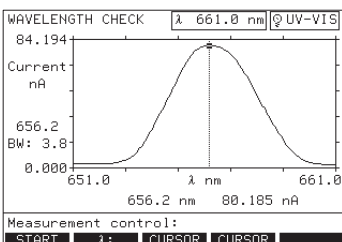
Press the **λ** soft key to cycle to the wavelength you want to check.

If checking wavelengths 529.1 or 808.0 nm, the status bar displays **BASELINE...** while a baseline measurement is taken and then **SCANNING...** as a line is drawn on the graph. The result should be a peak that is ± 1 nm from the selected wavelength as shown in the scans at left.



If checking at 656.1 nm, the status bar displays **SCANNING...** as a line is drawn on the graph. The result should be a peak at 656.1 nm and a bandwidth less than 5nm, as shown in the scan at left.

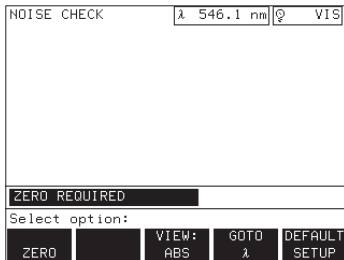
If checking at 486.0 nm, the status bar shows: **SCANNING...** as a line is drawn on the graph. The result should be a peak at 486.0 ± 1 nm.



14.2.2 Photometric Noise Check

The noise check option measures photometric noise of the instrument. Press the **NOISE CHECK** soft key (in the service menu) to display the noise check menu.

Filters for the noise check are available as NIST SRM2031 equivalent or NIST SRM 930d equivalent.

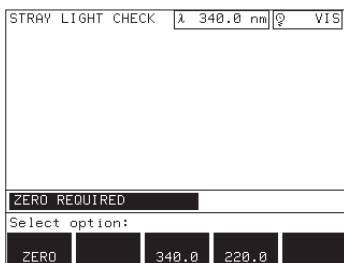


Noise Check Menu

Soft Key	Function
START	Starts the noise check measurement (appears after baseline is taken).
ZERO	Measures a baseline reading.
VIEW	Displays readout as absorbance or detector current.
GOTO λ	Prompts for specific wavelength setting.
DEFAULT SETUP	Returns noise check settings to the default wavelength of 546.1 nm.

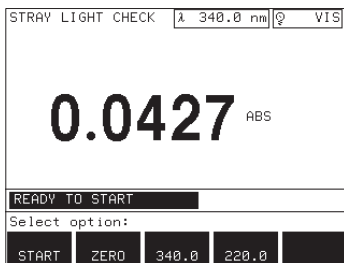
14.2.3 Stray Light Check

The stray light check measures stray light within the instrument at 340.0 nm (DR/4000U and DR/4000V) and 220.0 nm (DR/4000U only). Press the **STRAY LIGHT** soft key (in the service menu) to display the stray light menu.



Stray light Check Menu

Soft Key	Function
START	Starts stray light check.
ZERO	Measures baseline reading.
340.0	UV/VIS and VIS only stray light check at 340 nm.
220.0	UV/VIS stray light check at 220.0 nm.



Filters required for performing the stray light check include Sodium Nitrite (NaNO_2) in 50 g/L aqueous solution, and Potassium Iodide (KI) in 10 g/L aqueous solution (NIST SRM2032 equivalent). Filters should be prepared in 1-cm, UV-transmitting (Quartz) sample cells.

14.2.4 Absorbance Check

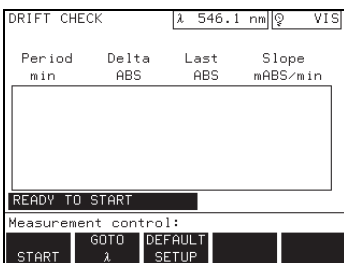
Filters for the absorbance check are available as NIST SRM2031 equivalent and NIST SRM 930d equivalent.

14.2.5 Drift Check

The drift check can be used to verify instrument accuracy by determining the amount of drift over four, 15-minute tests at 546.1 nm; however, any wavelength can be used. **This check takes one hour to complete.**

Proceed as follows to conduct the drift check:

1. Press the **DRIFT CHECK** soft key under the System Checks menu. The drift check menu will appear.
 - If you want the test to be run at a wavelength other than 546.1, press the GOTO λ soft key and change the wavelength.
 - If you want the test to be run at 546.1 and the wavelength is set differently,



press the **DEFAULT SETUP** soft key to reset the wavelength to 546.1.

DRIFT CHECK		λ 546.1 nm	VIS
Period min	Delta ABS	Last ABS	Slope mABS/min
-0.0000 ABS 59:24			
Measurement control:			
CANCEL			

2. Press the **START** soft key. The timer will count down, and the instrument will report any change in absorbance every 15 minutes.

DRIFT CHECK		λ 546.1 nm	VIS
Period min	Delta ABS	Last ABS	Slope mABS/min
15	0.0000	0.0001	0.0021
15	0.0000	0.0001	0.0009
15	-0.0000	0.0001	-0.0023
15	0.0000	0.0001	0.0029
60	-0.0001	0.0001	-0.0010
READY TO START			
Measurement control:			
START	GOTO λ	DEFAULT SETUP	

3. At the end of the test (approximately one hour) the instrument will display a summary of the four 15 minute tests.

PRINTER CHECK		λ 600.0 nm	VIS
07-MAR-97 09:52			
!"#\$%&'()*+,-./0123456789:;<=>?@ABCDE FGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz !nopqrstuvwxyz{ }~+0123456789@1234567 89µ°			
Print options:			
START			

14.2.6 Printer Check

Press the **PRINTER CHECK** soft key (in the system checks menu) to display the PRINTER CHECK. This mode displays all of the characters for the language chosen for printing. Press the **START** soft key to print the displayed characters.

If the characters do not print legibly, adjust the printer setup by selecting the **PRINTER CHECK** soft key under the **SETUP** key.



GENERAL INFORMATION

At Hach Company, customer service is an important part of every product we make. With that in mind, we have compiled the following information for your convenience.

REPLACEMENT PARTS

Description	Cat. No.
Adapter, 1-inch cell	48190-00
Adapter, 1-cm square.....	48584-00
Adapter, AccuVac	48187-00
Adapter, 16-mm Test Tube, for COD & Test 'N Tube	48189-00
Adapter, 1- inch cell, 4-position carousel.....	48105-00
Adapter, 1-cm cell, 6-position carousel.....	48115-00
Documentation Package, DR/4000, includes:	48000-88
DR/4000 Instrument Manual.....	48316-18
Procedures Manual.....	48000-22
Binder.....	48000-33
Dust Cover, DR/4000	48125-00
Fuse for 115V operation, 250V 2.5A, UL/CSA approved	46983-00
Fuse for 230V operation, 250V 2.5A, IEC type, VDE approved.....	49526-00
Lamp Replacement Kit, Deuterium.....	49513-00
Lamp Replacement Kit, Tungsten	49516-00
Module Assembly, Single Cell	48070-01
Module Assembly, Carousel.....	48070-02
Power Cord, 18/3 SVT 7.5-inch, 10A-125 VAC for North America 115 VAC use.....	18010-00
Power Cord, 8 ft, with continental European plug 230 VAC Use	46836-00
Sample Cell, 25 x 54 mm, 10-mL, w/cap.....	21228-00
Sample Cell, matched pair, 1-inch, glass.....	26659-02
Sample Cell, quartz, 1-cm, pair	48228-00

OPTIONAL ACCESSORIES

Description	Cat. No
Adapter, 5-cm cell, each	48186-00
Adapter, 10-cm cell, each	48118-00
Adapter, microcell, 1-cm	48588-00
Adapter with 1-inch quartz flow cell.....	49514-00
Adapter with 1-cm quartz flow cell.....	49539-00
Adapter, 5-place COD carousel.....	48274-00
Adapter with quartz micro sipper cell	48402-00
Cable, Computer, DB-9 to DB-9	48129-00
Cable, Printer, DB-9 to DB-25	49503-00
HachLink* data capture software	49665-00
Insert, 1-cm Microcell	48587-00
Module Kit, Flow-cell, 1-inch	48070-04
Module Kit, Flow-cell, 1-cm	48070-05
Module Kit, Sipper, 1-inch	48090-03
Module Kit, Sipper, 1-cm	48090-06
Module Kit, 2 mL Micro Sipper, 1-cm.....	48090-07
Module Kit, Temperature Control, 1-cm	48070-08
Optional Module Manual, Flow-cell and Sipper	49540-89
Printer, Portable, Citizen Model PN60 (graphic)	26687-00
Printer, 115 V, Epson Model LQ-570+ (graphic).....	48236-00
Ribbon, Ink, Cassette, for Citizen Printer, iDP562-RSL-UL	25934-00
Ribbon, for Epson Printer LQ-570+	26507-00
Sample Cell, 1-cm, glass, matched pair	20951-00
Sample Cell, 1-cm, quartz, (usable range: 170 to 2700 nm	26244-10
Sample Cell, microcell, 1-cm, 1.5 mL disposable, 100/pkg.....	26295-00

* HachLink is a trademark of Hach Company.

REPLACEMENT PARTS AND ACCESSORIES, continued

OPTIONAL ACCESSORIES, continued

Description	Cat. No.
Sample Cell, 1-inch, glass, with stoppers, matched pair	26126-02
Sample Cell, 1-inch, precision glass, matched pair	26659-02
Sample Cell, 1-inch, precision glass, matched set of 4	26659-04
Sample Cell, 1-inch, precision glass, matched set of 8	26659-08
Sample Cells, disposable, 1-inch polystyrene, with cap, 12/pkg	24102-12
Sample Cell, 5-cm, glass, (usable range: 334 to 2500 nm), each	26292-50
Sample Cell, 5-cm, quartz, (usable range: 170 to 2700 nm), each	26244-50
Sample Cell, 10-cm, glass, (usable range: 334 to 2500 nm), each	26292-01
Sample Cell, 10-cm, quartz, (usable range: 170 to 2700 nm), each	26244-01
Service Manual	48000-04
Sipper Module Tubing Replacement Kit	49521-00
Sipper Module Tubing Replacement Kit, inlet and waste	48249-00
Software Upgrade Package	49544-00
Temperature Control Module	48070-08

Section 16 How to Order

U.S.A. Customers

By Telephone:

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

By Fax:

(970) 669-2932

By Mail:

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

Information Required

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

International Customers

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

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

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

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

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

Section 17 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 18 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.

The sc100 Controller is warranted for two years from the date of shipment.

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.

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FAX: (970) 669-2932

FOR TECHNICAL ASSISTANCE, PRICE INFORMATION AND ORDERING:
In the U.S.A. - **Call toll-free 800-227-4224**
Outside the U.S.A. - **Contact the HACH office or distributor serving you.**
On the Worldwide Web - **www.hach.com; E-mail - techhelp@hach.com**
