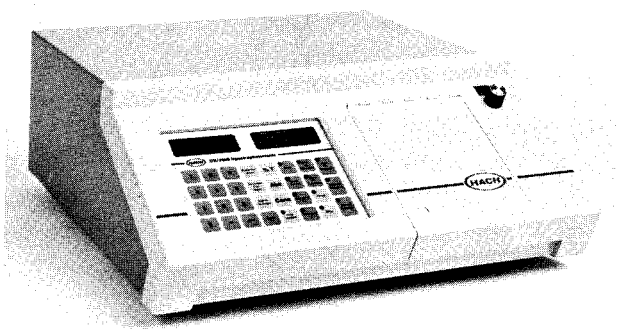
DR/3000 SPECTROPHOTOMETER
INSTRUMENT MANUAL



6-4-93-2ED REV. 2, 3/94

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SAFETY PRECAUTIONS

NOTICE

Before attempting to unpack, set up or operate this instrument, please read Sections 1 - 3 of this 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 Warnings, Cautions and Notes

Warnings, cautions and notes used in this manual have the following significance:

WARNING

Failure to observe this information can result in personal injury or loss of life.

CAUTION

Failure to observe this information can result in damage to equipment.

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.

CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

Because this instrument operates on and generates radio frequency energy, interference to radio and television reception may occur. If such interference does occur, the operator should take the necessary steps to correct the interference. The following techniques of reducing interference problems are applied easily.

1. Turn the instrument off to verify it is the interference source.
2. If the spectrophotometer is plugged into the same outlet as the device with which it is interfering, try another outlet.
3. Move the spectrophotometer away from the receiver.
4. Reposition the receiving antenna.
5. Reposition the spectrophotometer with respect to the receiving antenna.
6. Try combinations of the above.

SPECIFICATIONS

GENERAL SPECIFICATIONS

OPERATING MODES	Stored Program, Manual Program, Best Fit Program
MEASUREMENT MODES	Absorbance, Percent Transmittance, Concentration
OPERATING TEMPERATURE RANGE	10° to 40°C (50° to 104°F)
OPERATING HUMIDITY RANGE	5% to 90% RH
STORAGE TEMPERATURE RANGE	–17° to 60°C (1° to 140°F)
WARM–UP PERIOD	15 minutes

MONOCHROMATOR SPECIFICATIONS

WAVELENGTH	Range: 340–1000 nm Accuracy: ± 1 nm Repeatability: ± 0.2 nm Resolution: 0.1 nm Bandwidth: 9 nm (nominal)
STRAY LIGHT	Less than 0.1% transmittance
GRATING	1200 grooves/mm
LAMP	Tungsten Halogen (1500 hour rating)
DETECTOR	Blue enhanced silicon photovoltaic

PHOTOMETRIC SPECIFICATIONS (@548 nm)

REPRODUCIBILITY	±0.005 at 1A ±0.009 at 2A ±0.013 at 3A
LINEARITY	±0.002A (0–1A) ±0.004A (0–2A) ±0.010A (0–3A)
REPEATABILITY	±0.001A at 1A ±0.002A at 2A ±0.004A at 3A
NOISE LEVEL (Sig. Avg. 10)	±0.0001 at 1A ±0.0005 at 2A ±0.002 at 3A
DRIFT (25°C/15 min)	±0.001A at 0A

ELECTRICAL SPECIFICATIONS

POWER REQUIREMENTS	100/120/220/240 ± 10% Vac, 50/60 Hz, 75 VA
RECORDER OUTPUT	Factory set at 0–1V. 0–10 mV or 0–100 mV selectable with jumper plug

MECHANICAL SPECIFICATIONS

DIMENSIONS	18.4 cm high x 43.8 cm wide x 47.6 cm deep (7.25" x 17.25" x 18.75")
WEIGHT	12.9 kg (28.5 Lbs)

SECTION 1 INSTRUMENT DESCRIPTION

1.1 Spectrophotometer

The Hach DR/3000 Spectrophotometer (*Figure 1*) is a microprocessor–operated laboratory instrument. Preprogrammed with calibrations for most water management test requirements, it provides direct, digital readouts in absorbance, percent transmittance or concentration. When the desired program code is entered, prompting lights direct the operator through the test by giving the appropriate wavelength and indicating control key sequences. Manual programs and best–fit programs can be entered for calibrations not stored in the Read Only Memory (ROM) device. Updated ROMs will be made available for customer installation as new tests and reagents are developed.

The DR/3000, a single–beam spectrophotometer, uses a double–pass grating monochromator capable of wavelengths from 325 to 1000 nanometers (nm).

The instrument uses 1–inch sample cells, and a matched pair is supplied. An adapter also is provided to accept a standard 1–centimeter (1–cm) square cuvette and Hach COD vials (16 mm).

The analog recorder output is set for 0–1 V when the instrument leaves the factory. It can be changed to 0–10 mV or 0–100 mV by changing the position of a jumper plug on the microcomputer circuit board.

A voltage selector card allows the spectrophotometer to be adapted for any of four operating voltages. By installing the small voltage selector card with the appropriate orientation, the instrument can be set up for 100, 120,220 or 240 Vac, 50/60 Hz power.

An interface circuit board for input–output peripheral equipment capabilities is available as an optional feature to allow the spectrophotometer to be operated in a system configuration. *See Section 2* for the input and output characteristics.

1.2 Pour–Thru Cell Assemblies

One–inch and 1–cm Pour–Thru Sample Cells are offered as optional accessories because of their advantages in measuring small concentrations and in replicate testing. By reducing error due to optical variation between sample cells or from inexact placement of cells in the instrument, the pour–thru cells improve accuracy and repeatability. Considerable time is saved with pour–thru cells because the same cell is used for both the blank and the test solution. Because of its plastic construction, the pour–thru cell can not be used in tests requiring the use of organic solvents such as toluene, chloroform, trichloroethane or cyclohexanone. Provisions are made for mounting the pour–thru cell on the right side of the spectrophotometer case. The assemblies are made up of the pour–thru cell, the base assembly, the funnel with funnel holder and interconnecting tubing. *See Figure 2.* All materials are resistant to corrosion.

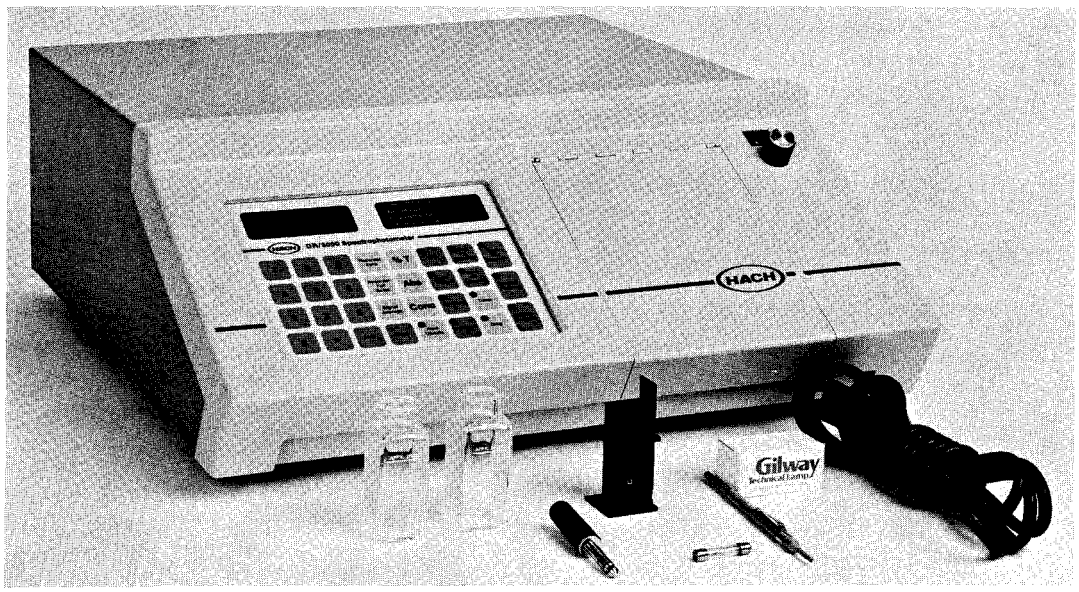


FIGURE 1 **DR/3000 SPECTROPHOTOMETER**

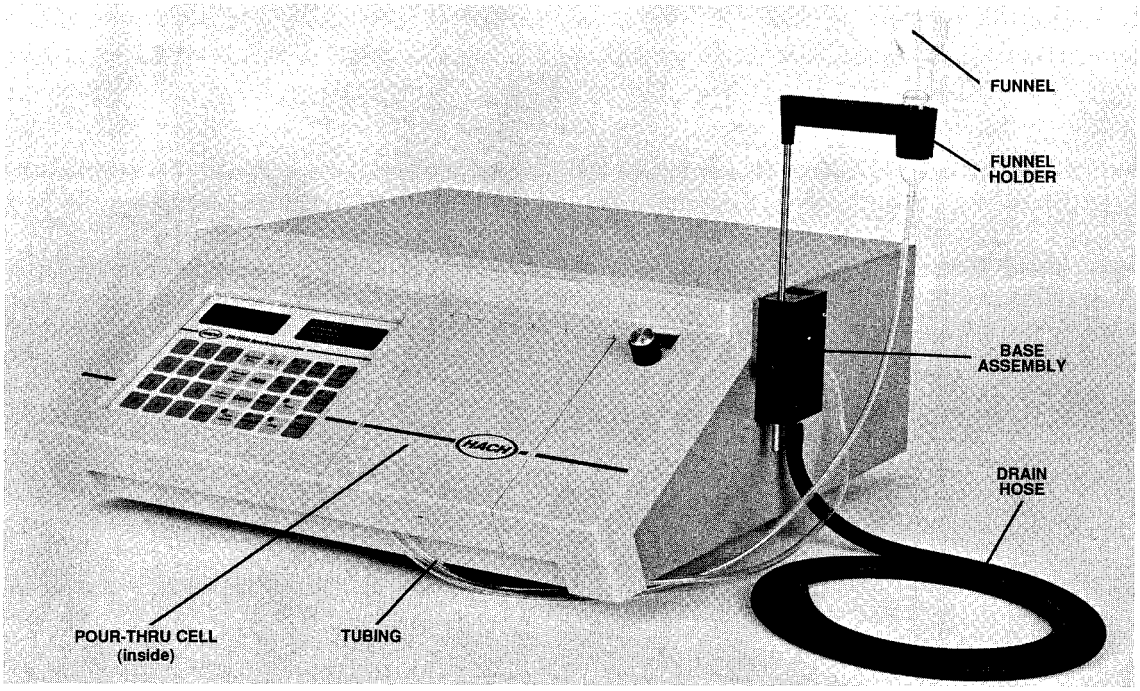


FIGURE 2 DR/3000 SPECTROPHOTOMETER WITH POUR-THRU CELL

1.3 1–cm Cell Adapter

Standard 1–cm square cuvettes can be used with the DR/3000 Spectrophotometer when Hach's 1–cm adapter (*Figure 3*) is installed in the sample cell compartment. One–centimeter cuvettes are not supplied with the instrument but are available as optional accessories either individually or in matched pairs.

1.4 COD Vial Adapter

One of the methods for chemical oxygen demand (COD) determinations included in the analysis procedures uses a COD Reactor and premixed reagent vials for both the digestion process in the reactor and for making the colorimetric measurement. With the COD Vial Adapter (*Figure 4*) installed in the spectrophotometer sample cell compartment, reagent vials can be placed in the instrument for measurement. The adapter is usable only in the Model DR/3000 Spectrophotometer.

1.5 AccuVac Vial Adapter

Hach Company's line of AccuVac Ampul reagents can be used in the DR/3000 Spectrophotometer with the supplied cell adapter and cell for zeroing the instrument. Reagents are packaged in sealed, evacuated vials and are mixed with the water sample by partially immersing the ampul and breaking off the tip to allow sample to be drawn in. Reacted sample can be measured in the ampul once the adapter is installed in the instrument. Proper orientation of the adapter in the sample cell compartment places the grip tab of the adapter toward the right side of the compartment.

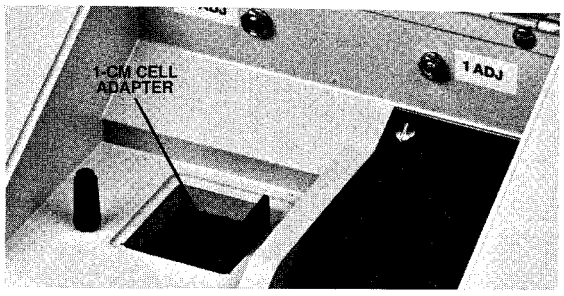


FIGURE 3 SAMPLE COMPARTMENT WITH 1-cm CELL ADAPTER

FIGURE 4 SAMPLE COMPARTMENT WITH COD ADAPTER

SECTION 2 INSTRUMENT PREPARATION FOR USE

2.1 Unpacking

Remove the spectrophotometer and accessories from the shipping container and inspect each item for any damage that may have occurred during shipment. Verify that the following items, in addition to this manual, are present:

Model DR/3000 Laboratory Spectrophotometer
Dust Cover
Sample Cells (2)
1–cm Cell Adapter
Recorder Cable Phone Plug
Power Cord
Trimpot Adjustment Tool
Fuse, 1/2 A
Fuse, 3/4 A (installed)
Spare Lamp
AccuVac Cell and Cell Adapter
COD Adapter

If any items are missing or damaged, please contact the Customer Service Department, Hach Company, Loveland, Colorado for instructions. The toll–free number is 800–227–4224.

2.2 Environmental Considerations

The ambient temperature must be within the range of 10° to 40°C (50° to 104°F) for proper operation of the instrument. Leave at least 15 cm (six inches) clearance at the top and on all sides to allow good air circulation. Keep the underside free of materials that could obstruct the air vents in the bottom of the chassis.

2.3 Operating Voltage Selection

CAUTION

Be sure the voltage selector card is installed properly for the line voltage to be used. Improper installation can result in damage to the instrument when the power is turned on.

The voltage selector card is installed for 120–volt power at the factory. If another selection is more appropriate, convert the instrument as follows:

1. Disconnect the power cord from the instrument receptacle.
2. Slide the window to the left to gain access to the fuse and selector card.
3. Remove the fuse, using the FUSE PULL lever.
4. Remove the selector card and turn it so that the desired voltage value is positioned correctly for reading when the card is aligned for insertion into the instrument. Insert the card.
5. Return the FUSE PULL lever to its normal position and install the appropriate fuse. Use a 3/4 A fuse for 120 or 100 volts and use a 1/2 A fuse for 240 or 220–volt operation. The selected voltage value will be visible when the lever is returned.
6. Slide the window right to close the fuse compartment and reconnect the power cord.

2.4 Recorder Set–up

2.4.1 Recorder Output Selection

The recorder output is factory set for the 0–1 V range. If a recorder output of 0–10 mV or 0–100 mV is required, the jumper plug used to select the recorder output must be repositioned accordingly. Proceed as follows:

1. Set the POWER switch to OFF and disconnect the power cord.

WARNING

Be sure the power cord is disconnected from the rear panel receptacle before removing the instrument cover. Electrical shock can cause serious injury.

CAUTION

Be sure the sample cell compartment is empty before standing the instrument on its side.

2. Remove the five screws securing the instrument cover to the chassis. One screw is on the rear panel and the other four are on the bottom of the instrument. Stand the instrument on its side to gain access to the cover screws.
3. Replace the instrument upright and slide the cover toward the back.

CAUTION

The instrument contains static-sensitive devices take precautionary steps when changing the recorder output jumper plug. The work surface, the operator and any electrical tools must be grounded properly.

4. Locate the recorder output jumper plug near the lower left of the microcomputer circuit board. *See Figure 5.*

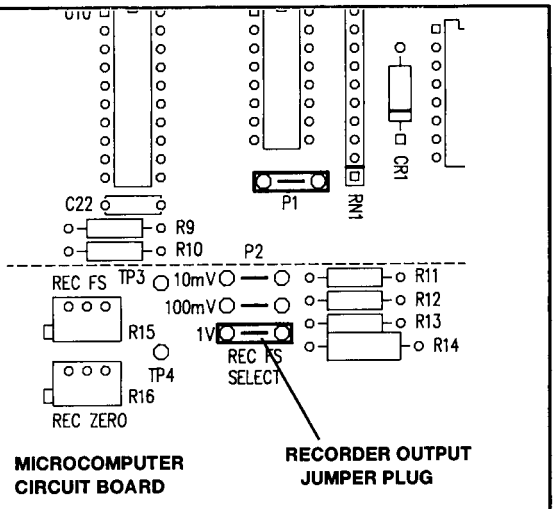


FIGURE 5 RECORDER OUTPUT SELECTION

5. Carefully pull the jumper plug from the 1V position and install it in the desired position.

6. Replace the instrument cover. Make sure the gasket on the top front edge is in place.

2.4.2 Recorder Connection

A recorder output phone plug is supplied with the spectrophotometer to mate with the rear panel receptacle. *Figure 6* illustrates the proper connections for a twisted–pair, shielded recorder cable. The load impedance should be greater than 500 ohms for the 10 mV range, greater than 5000 ohms for the 100 mV range and greater than 50,000 ohms for the 1V range.

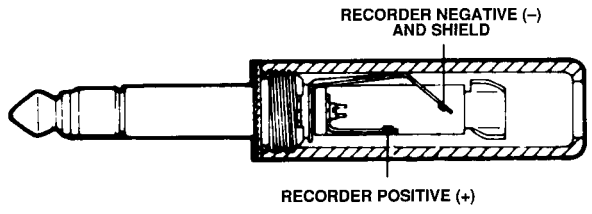


FIGURE 6 RECORDER PLUG CONNECTIONS

2.4.3 Recorder Zero and Full Scale Adjustment

Recorder zero and full scale adjustment potentiometers are accessible through an opening in the rear panel. *See Figure 7.* These controls are used when the recorder in use does not have zero and span controls. If the recorder has these controls, use them instead.

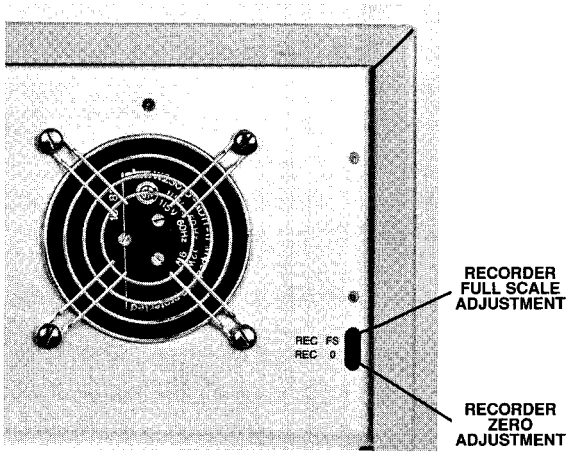
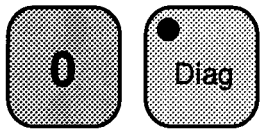


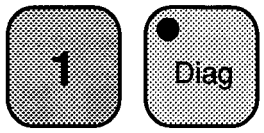
FIGURE 7 RECORDER ADJUSTMENTS

Make the adjustments as follows:

1. With the recorder connected to the spectrophotometer and turned on, set the recorder range (if variable) to 1V.

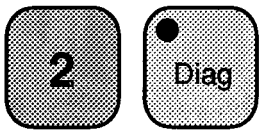
2. Press: 

3. Adjust the zero control (REC 0 on spectrophotometer or zero control on recorder) for a zero indication on the recorder.

4. Press: 

5. Adjust the span control (REC F.S. on spectrophotometer or span control on recorder) for a full scale indication on the recorder.

6. Repeat Steps 2 and 4 to verify both adjustments are correct.

7. Press: 

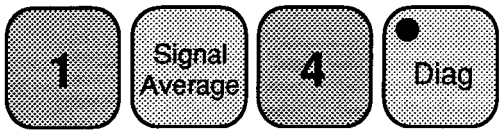
Recorder should indicate midscale. Recorder setup is now complete.

NOTE

These diagnostics can be used to verify recorder calibration during normal operation.

2.5 Calibration Check

Check the spectrophotometer's zero (0 ADJ) and absorbance gain (1 ADJ) adjustments as described below. Be sure the instrument has been warmed up for at least 15 minutes.

1. Press: 

2. Open the sample compartment door and close the shutter by turning the shutter control fully clockwise. *See Figure 8.*

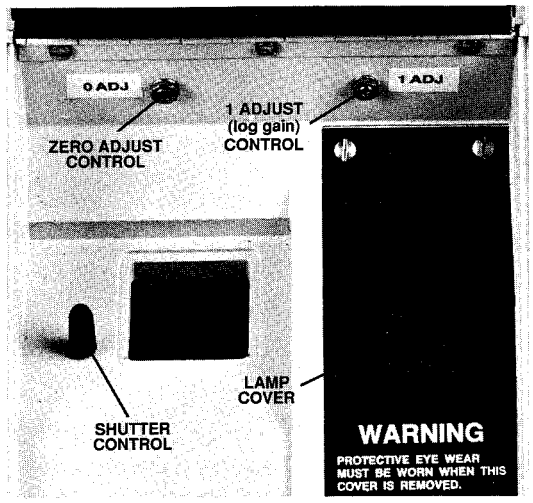


FIGURE 8 CALIBRATION CONTROLS

If the setting is correct the following conditions will exist:

a. ZERO LIGHT indicator may flash occasionally.

b. Display will be erratic. Fluctuation between 3.0 and 3.8 is common.

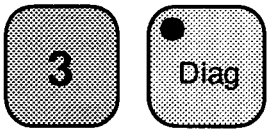
c. Maximum positive reading should be between 3.6 to 3.8 A.

d. If adjustment is needed, *refer to Zero Calibration,* paragraph 4.2.1.

3. Open the shutter by turning the shutter control fully counterclockwise; it will snap into position. The shutter must be open for normal operation.

4. Set the wavelength to 630 nm.

5. Verify that the sample cell compartment is empty and close the sample compartment door.

6. Press: 

The instrument will measure, calculate and display the absorbance gain. Correct value is 1.000. If adjustment is needed, *refer to Absorbance Gain Calibration,* paragraph 4.2.2.

2.6 Pour–Thru Cell Set–up

Figure 9 illustrates the 1–inch Pour–Thru Cell, assembled and installed in the spectrophotometer. The 1–cm unit is installed in the same manner.

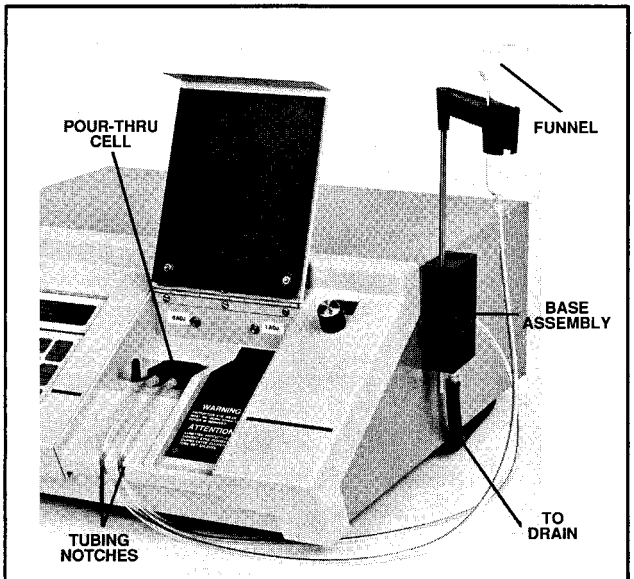


FIGURE 9 POUR-THRU CELL INSTALLATION

Proceed with the set–up as follows:

1. Assemble the pour–thru cell, connecting one of the tubing segments between the left–hand fitting on the cell and the bottom of the funnel. Connect the other segment between the right–hand cell fitting and the inlet fitting on the side of the base assembly. Connect the drain hose to the bottom of the base assembly.

2. Mount the base assembly on the side of the instrument case with the funnel installed in its holder.

3. Clean the windows in the pour–through cell to remove fingerprints or film from optical surfaces.

4. Install the pour–thru cell in the sample cell compartment with the tube fittings toward the

front. Use the notches in the instrument case to secure the tubing and allow the sample compartment door to close.

5. Run the drain hose attached to the bottom of the base assembly so it will drain freely. If possible, insert the end of the tube into a drain. Use a suitable collecting vessel if treatment is necessary before discharge.

6. Test by pouring 25 to 50 mL of water into the funnel and allowing the funnel to drain. If you wish to increase or decrease the flow rate through the system, adjust the funnel up or down.

2.7 1–cm Cell Adapter Installation

The adapter for using 1–cm square cuvettes is placed in the DR/3000 Spectrophotometer sample compartment with the handling tab to the right. *See Figure 10.* This position orients the adapter correctly in the light path. When using glass cuvettes, place them in the adapter with the clear sides in the front–to–back optical path. The sample compartment door must be closed while taking readings.

FIGURE 10 1-CM ADAPTER INSTALLATION

2.8 COD Vial Adapter Installation

The COD vial adapter for the DR/3000 Spectrophotometer should be placed in the instrument's sample cell compartment with the V orientation mark toward the front. *See Figure 11.* A light shield cover is included with the adapter and must be in place when taking the COD measurement. The sample compartment door will remain open.

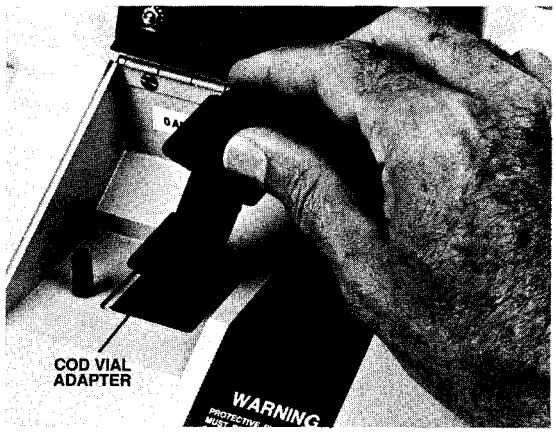


FIGURE 11 COD ADAPTER INSTALLATION

2.9 Serial Interface Option

2.9.1 Description

Hach offers a Serial Interface option (Cat. No. 43590–00) for the DR/3000 Spectrophotometer to equip it with an RS–232–C serial communications link. It allows the spectrophotometer to be controlled from an external computer or smart terminal to supply measurement data on command. The spectrophotometer can be purchased with this option factory–installed or updated in the field.

The package includes an interface circuit board assembly and an internal cable to connect the new board with the existing power supply/signal processing board. No external cable is furnished.

Baud rates of 2400, 4800 and 9600 baud can be selected with a movable jumper block on header J5 of the serial interface circuit board assembly. Header J2 allows selection of either one stop bit with a jumper between pins 1 and 2, or two stop bits with a jumper between pins 2 and 3.

Two functional modes of operation are provided in this serial interface package. In the command mode the interface receives sequences of characters from an external source and enters simulated key strokes to the DR/3000 microprocessor. In the interrogation mode the interface receives a hexadecimal character causing the spectrophotometer to respond with an eight–bit data character.

Command Mode Sequences

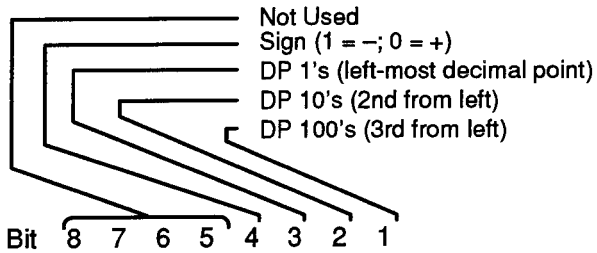
In the following table, the various key strokes for the DR/3000 Spectrophotometer are listed with the corresponding nine–character sequence of hexadecimal values required to actuate the key strokes.

Table 1. Hexadecimal Values for Key Strokes

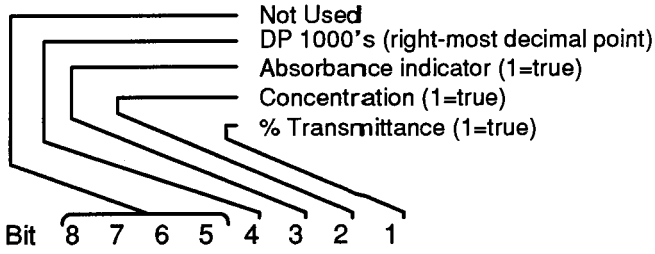
DR/3000 Spectrophotometer Key	Character Number								
	1	2	3	4	5	6	7	8	9
0	10	11	13	14	15	1E	1A	12	16
•	10	11	1B	14	15	1E	1A	12	16
–	10	11	13	1C	15	1E	1A	12	16
CLEAR	10	11	1B	1C	15	1E	1A	12	16
AUTO UPDATE	10	11	13	14	1D	1E	1A	12	16
STANDARD 2	10	11	1B	14	1D	1E	1A	12	16
DIAG	10	11	13	1C	1D	1E	1A	12	16
STORED PROGRAM	10	11	1B	1C	1D	1E	1A	12	16
1	18	11	13	14	15	1E	1A	12	16
2	18	11	1B	14	15	1E	1A	12	16
3	18	11	13	1C	15	1E	1A	12	16
SIGNAL AVERAGE	18	11	1B	1C	15	1E	1A	12	16
CONC	18	11	13	14	1D	1E	1A	12	16
STANDARD 1	18	11	1B	14	1D	1E	1A	12	16
TIMER	18	11	13	1C	1D	1E	1A	12	16
4	10	19	13	14	15	1E	1A	12	16
5	10	19	1B	14	15	1E	1A	12	16
6	10	19	13	1C	15	1E	1A	12	16
RECORDER FULL SCALE	10	19	1B	1C	15	1E	1A	12	16
ABS	10	19	13	14	1D	1E	1A	12	16
CONC FACTOR	10	19	1B	14	1D	1E	1A	12	16
BEST FIT CALCULATE	10	19	13	1C	1D	1E	1A	12	16
MANUAL PROGRAM	10	19	1B	1C	1D	1E	1A	12	16
7	18	19	13	14	15	1E	1A	12	16
8	18	19	1B	14	15	1E	1A	12	16
9	18	19	13	1C	15	1E	1A	12	16
RECORDER ZERO	18	19	1B	1C	15	1E	1A	12	16
%T	18	19	13	14	1D	1E	1A	12	16
ZERO	18	19	1B	14	1D	1E	1A	12	16
BEST FIT STANDARD	18	19	13	1C	1D	1E	1A	12	16
BEST FIT PROGRAM	18	19	1B	1C	1D	1E	1A	12	16

Interrogation Mode Functions

Transmitting a character to the DR/3000 Spectrophotometer with the hexadecimal value 2C will cause the spectrophotometer to return an eight–bit character containing the following information:

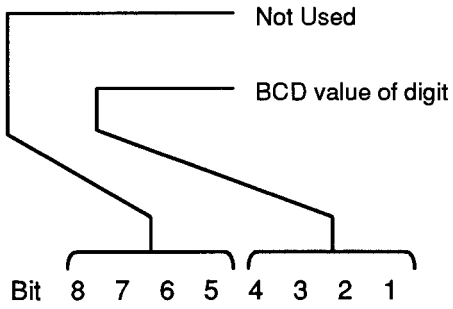


Transmitting a character to the spectrophotometer with the hexadecimal value 2D will cause the spectrophotometer to return an eight–bit character containing the following information:



Transmitting characters to the spectrophotometer with the following values will return the current reading for the measurement type being made:

HEX Character	Data
28	Most significant digit
29	2nd–most significant digit
2A	3rd–most significant digit
2B	Least significant digit



A binary value of 15 is returned for a blanked leading zero.

Transmitting a character to the spectrophotometer with a hexadecimal value of 17 will cause the above data and status values to be "frozen" (DATA HOLD). Transmitting a character with a hexadecimal value of 1F will disable the DATA HOLD function and allow new data values to be read.

Transmitting a character with a hexadecimal value of 1E disables the spectrophotometer keyboard and enables remote control; transmitting a character with hexadecimal value 16 enables the keyboard and disables remote control.

NOTE

It is necessary to interrogate the complete set of six data and status nibbles twice and verify that the second set is the same value as the first set to confirm that the reading is stable.

RS–232–C Connector Terminations

An external cable, suitable for your application, must be obtained to link the 25–pin DR/3000 Spectrophotometer serial interface connector with the external computer. Pin information for the spectrophotometer connector are given in Tables 2 and 3 below. This interface is configured as a Data Communication Equipment (DCE).

Table 2. J2 (RS-232-C) Definition Table

Designation	Pin	Function
SHIELD	1	Connects to cable shield
RX INPUT	2	Serial data input pin
TX OUTPUT	3	Serial data output pin
RTS	4	Connected together internally
CTS	5	
R1	22	
DTR	20	Connected together internally
DSR	6	
DCD	8	
SIG GND	7	Signal Ground
Note	9-19, 21, 23,25	Not Used

Table 3. Operating Characteristics DC Characteristics

Symbol	Parameter	Limits Min.	Max.	Unit
V_{OH}	High Level Output Voltage (Pin 3)	4		V
V_{OL}	Low Level Output Voltage (Pin 3)		-4	V
I_{OH}	High Level Output Current (Pin 3)		1.33	mA
I_{OL}	Low Level Output Current (Pin 3)		-1.133	mA
V_{IH}	High Level Input Voltage (Pin 2)	3	15	V
V_{IL}	Low Level Input Voltage (Pin 2)	-3	-15	V
I_{IH}	High Level Input Current (Pin 2)		0.43	mA
I_{IL}	Low Level Input Current (Pin 2)		-0.43	mA

2.9.2 Installation Instructions

The DR/3000 Serial Interface Kit consists of a circuit board assembly, one input/output cable and a nut to secure the ground lug. The board is mounted on the inside of the back panel *as shown in the drawing.* Follow the steps below to install the kit components.

1. Turn off power and unplug the power cable.

WARNING

Be sure the power cord is disconnected before removing the spectrophotometer cover. Electrical shock can cause serious injury.

2. Open the sample compartment lid and make sure nothing is in the sample compartment.

3. Tip the instrument onto its left side (as you face the front) and remove the five screws holding the top cover to the bottom of the instrument. One of the screws is at the top middle of the rear panel and the other four are on the bottom of the instrument chassis.

4. Turn the instrument upright again and carefully slide the cover back and off of the instrument.

CAUTION

The spectrophotometer contains devices that are sensitive to static electricity. Take precautionary steps when handling components. The work surface, operator and any electrical tools must be grounded properly to prevent instrument damage.

5. Remove the plate covering the connector hole in the back panel.

6. Remove the board from its bubble pack, handling the board by the edges only.

7. Referring to the installation drawing below, mount the circuit board assembly on the back panel with the connector inserted into the hole provided. Use the four 1/4" No. 4 screws that are threaded into the standoffs on the connector side of the board.

8. Connect the I/O cable between the circuit board connector of the serial interface board and the spectrophotometer power supply/signal processing board *as shown in Figure 12 below.* Orient the cable connectors as illustrated in details A (power supply/signal processing board connection) and B (serial interface board connection). Note that the wires from the serial interface connector exit from the side nearest the edge of the board. The board connectors have locking devices that are operated with a small screwdriver or trimpot tool. Turn fully counterclockwise to unlock and fully clockwise to lock after the connectors are mated.

9. Route the ribbon cable under the fan assembly to prevent interference with air flow.

10. Install the spectrophotometer cover, making sure the gasket along the top front edge is positioned properly.

11. Connect the power cord to the rear panel.

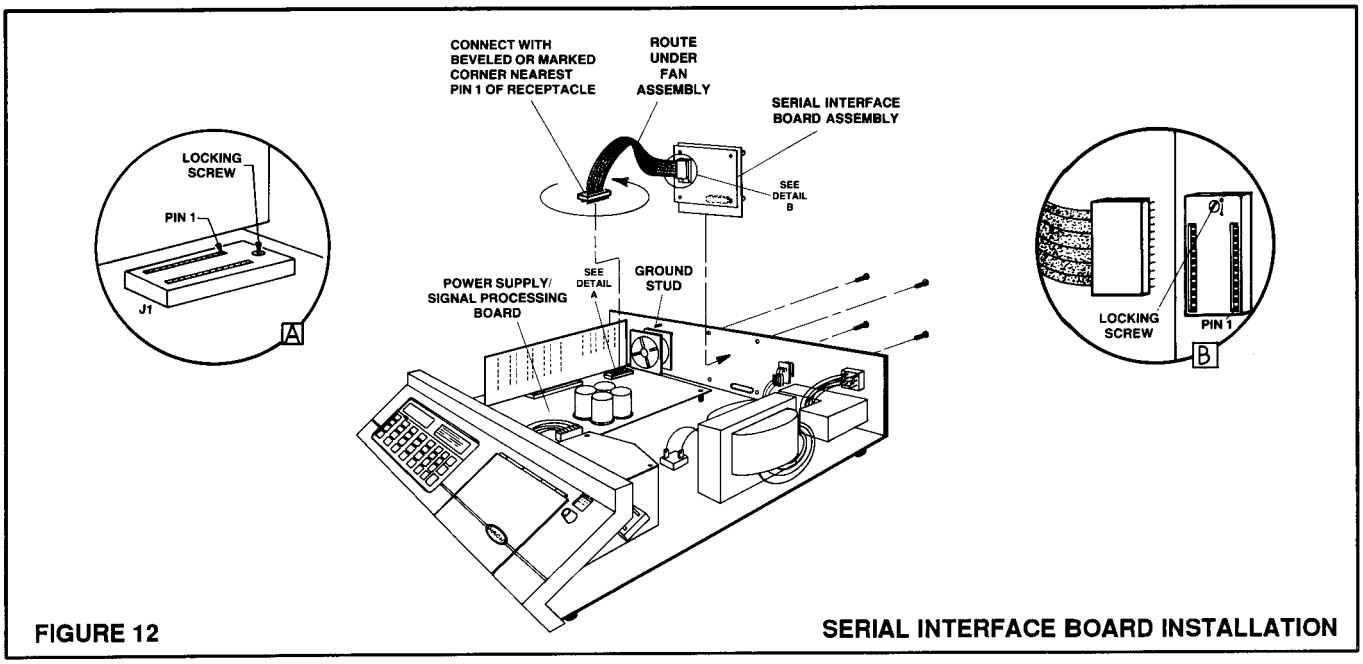


FIGURE 12 SERIAL INTERFACE BOARD INSTALLATION

3.1 Description of Controls

Figure 13 illustrates the operating controls, indicators and interface connections of the spectrophotometer. Functional descriptions of each are given in the accompanying table.

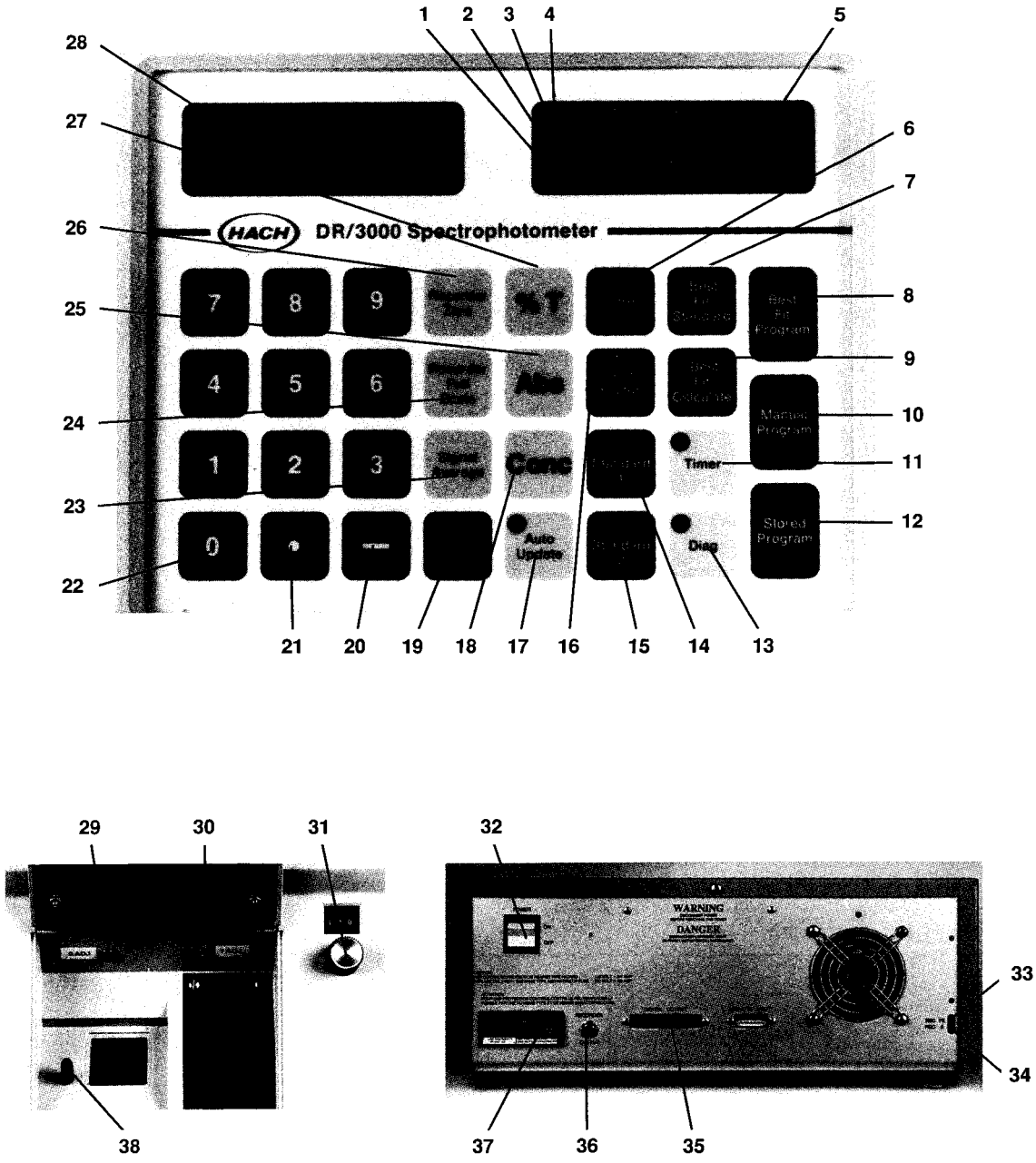


FIGURE 13 OPERATING CONTROLS AND INDICATORS

Table 4. Operating Controls and Indicators

Item No.	Name	Description
1	SET WAVELENGTH Indicator	Prompting light to select wavelength specified by digital display (item 28). Occurs when a factory-stored program is selected.
2	CONCENTRATION Indicator	Status light to indicate concentration readout has been selected. Digital readout will be in appropriate unit of measure such as mg/L.
3	ABSORBANCE Indicator	Status light to indicate concentration readout has been selected. Digital readout will be in absorbance units.
4	% TRANSMITTANCE Indicator	Status light to indicate percent transmittance (%T) readout has been selected. Digital readout will be in percent transmittance.
5	ZERO LIGHT Indicator	Low energy indication. If lit, light at photocell is not adequate for a measurement.
6	Zero Key	ZERO key with prompting status light. Allows operator to set the instrument to 0.000 absorbance, or 100%T, simply by pressing the key. Zeroing the instrument is necessary before obtaining absorbance or percent transmittance readings. When zero is used to calibrate the instrument, it can be rezeroed at any time.
7	Best Fit Standard Key	BEST FIT STANDARD key with status and prompting light. This key is used to enter concentration values of standards when running the BEST FIT PROGRAM or STORED PROGRAM 0.
8	Best Fit Program Key	BEST FIT PROGRAM key with status light. This mode will perform linear regression analysis on two or more standards. *See paragraph 3.3.3.*
9	Best Fit Calculate Key	BEST FIT CALCULATE key with prompting status light. When using the BEST FIT PROGRAM, this key will initiate calculation of the best fit line and display the correlation of determination (r^2). This key also terminates the entry of data when using Stored Programs 0 and 1.
10	Manual Program Key	MANUAL PROGRAM key with status light. This mode is used for taking routine absorbance or percent transmittance readings. Linear calibrations may also be conducted using two standards, or one standard and a known concentration factor (slope).
11	Timer Key	TIMER KEY with status light. Used to initiate the built-in digital timer. Periods of up to 1440 minutes (24 hours) can be timed.
12	Stored Program Key	STORED PROGRAM key with status light. Measurements of more than 60 parameters using Hach methods and reagents may be conducted by recalling the programs stored in the instrument. Two additional programs, Stored Program 0 and Stored Program 1, assist the user in performing nonlinear calibrations.
13	Diag Key	DIAGNOSTIC key with status light. Diagnostic software can be used to verify instrument performance and recorder calibration.
14	Standard 1 Key	STANDARD 1 key with prompting and status light. Used to enter the concentration value of a known standard when generating a linear calibration using the Manual Program mode. Also used in Stored Program 1 to enter the absorbance value of a standard when conducting a nonlinear calibration.

Table 4. Operating Controls and Indicators(continued)		
Item No.	**Name**	**Description**
15	Standard 2 Key	STANDARD 2 key with prompting and status light. Used to enter the concentration value of a second standard when generating a linear calibration using the Manual Program mode. Also used in Stored Program 1 to enter the concentration value of a standard when conducting a nonlinear calibration.
16	Conc Factor Key	CONCENTRATION FACTOR key with prompting status light. This key is used to enter or recall a known concentration factor when running the Manaual Program mode. The concentration factor is defined as follows: $\text{CONCENTRATION FACTOR} = 1/\text{SLOPE} = \frac{\text{CHANGE IN CONCENTRATION}}{\text{CHANGE IN ABSORBANCE}}$ For linear calibrations, this key can be used to recall the concentration factor.
17	Auto Update Key	AUTO UPDATE key with status light. When status light is on, instrument will continuously update the display to reflect the latest measurement. When the status light is not on, the display is in the "push-to-read" state and will update only when the activated measurement mode key (Abs, %T or Conc) is pressed. If a new measurement mode is selected, automatic update is reinstated and remains so until the AUTO UPDATE key is pressed again. Successive presses of the AUTO UPDATE key will cause the instrument to alternate between automatic update and "push-to-read."
18	Conc Key	CONCENTRATION key. This key is used to select the concentration measurement mode, providing direct readouts in mg/L, etc. Also used to update the display when in "push-to-read" state. *Refer to item 17* description and paragraph 3.2.5.
19	Clear Key	CLEAR key. Used to clear any value in the display.
20	– Key	CHANGE SIGN key. Used to change the sign of a numerical value in the display.
21	• Key	DECIMAL POINT key. Used to set a decimal point when entering numerical values into the display.
22	Number Keys	All number keys used to enter a value into the display.
23	Signal Average Key	SIGNAL AVERAGE key. Used to enter or recall the number of signals averaged before being displayed. Useful when taking readings of "noisy" samples. *Refer to paragragh 3.4.*
24	Recorder Full Scale Key	RECORDER FULL SCALE key. Used to enter or recall an assigned value for the upper limit of a recorder scale. *Refer to paragraph 3.6.*
25	Abs Key	ABSORBANCE key. This key is used to select the absorbance measurement mode, providing instrument readouts in units of absorbance. Also used to update the display when in "push-to-read" state. *Refer to item 17 description.*
26	Recorder Zero Key	RECORDER ZERO key. Used to enter or recall an assigned value for the lower limit of the recorder scale. *Refer to paragraph 3.6.*
27	% T Key	PERCENT TRANSMITTANCE key. This key is used to select %T measurement mode, providing instrument readout in %T. Also used to update the display when in "push-to-read" state. *Refer to item 17 description.*

Table 4. Operating Controls and Indicators(continued)		
Item No.	**Name**	**Description**
28	Digital Indicator	4-digit display provides test readout in absorbance, %T or concentration.
29	0 ADJ Control	Zero calibration control used to zero the instrument with shutter closed. *Refer to paragraph 4.2.1.*
30	1 ADJ Control	Absorbance gain calibration control. *Refer to paragraph 4.2.2.*
31	Wavelength Control	Used to select wavelength in nm. For best repeatability, approach the desired wavelength from the same direction each time.
32	Power Switch	Turns on instrument power. Digital display momentarily gives stored program procedures number and then, at single audible beep, displays zero. Prompting lights for Zero, Conc Factor and Standard 1 begin flashing. Instrument is in Manual Program mode and is prompting for calibration. Hach recommends the power be turned off when the instrument is not in use to extend lamp life.
33	REC FS Control	Recorder full-scale adjustment. Used to set an external recorder zero indication. *Refer to paragraph 2.4.3.*
34	REC 0 Control	Recorder zero adjustment. Used to set an external recorder zero indication. *Refer to paragraph 2.4.3.*
35	Interace Connector	Connector for optional RS-232-C link.
36	Recorder Jack	Output jack for external recorder. Mating, 3-circuit plug supplied with the spectrophotometer.
37	Power Connector	Power receptacle with voltage selector card, fuse and noise filter.
38	Shutter Control	Used block light to the photocell during zero adjustment in calibration procedure. Control is detented in the open position which is the normal operating position.

3.2 General Key Information

3.2.1 Prompting

The DR/3000 Spectrophotometer uses prompting lights to direct the operator through calibration. When one of the program modes (Manual, Stored or Best Fit) has been selected, the instrument will prompt the operator as to the calibration requirements by flashing key status lights. In the Manual Program mode, calibration can be achieved in a number of different ways. The Best Fit and Stored Program modes have fewer combinations and are more defined. In any case, the instrument makes the operator aware of the options.

In the Manual Program mode, the prompting will stop if a zero is entered and either the %T or Absorbance key is pressed. A zero is all that is needed for a %T or Absorbance reading. However, concentration requires at least two values; therefore two of the following keys must be pressed: Zero, Concentration Factor, Standard 1 or Standard 2. When the calibration requirements are met, two key status lights will be lit. Any attempt to read concentration without two of the above key entries will result in an error beep and return to the prompting.

3.2.2 Instrument Status

The key status lights inform the operator of the instrument status. If, for example, the instrument is in the Manual Program mode and a Zero and Concentration Factor have been entered, those particular key status lights will be lit. The same

would apply for the Standard 1 and Standard 2 key status lights had they been used.

Function keys consist of the Manual, Stored and Best Fit Program keys along with the Timer, Auto Update, and Diagnostic keys. When a function key is active its key status light will be lit.

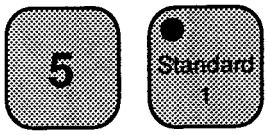
If a status light (Absorbance, Transmittance, or Concentration) is lit, the value displayed is in that light's particular unit of measurement. If the Set Wavelength status light is flashing, set the wavelength to the displayed wavelength. Then press the clear key to indicate compliance.

3.2.3 Data Entry/Recall

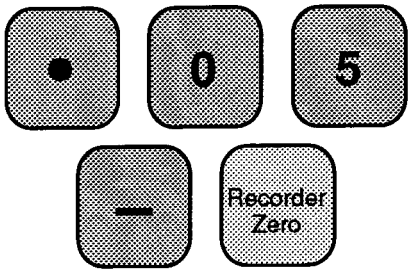
In addition to the calibration entry keys, there are several keys (Recorder Zero, Recorder Full Scale and Signal Average) which must have values associated with them. They have no key status indicators because they are not associated with either status or prompting. These keys have assigned values when power is applied, but the values can be changed or examined at any time. To assign a value to these keys or any calibration key, the operator enters the value and follows it by the desired key function.

Examples:

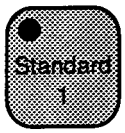
To assign a value of 5 to Standard 1

Press: 

To assign a value of –0.05 to Recorder Zero

Press: 

To recall these function values, press the desired function key:

Press: 

display reads 5.000

Press: 

display reads –0.050

Some key status lights are used only for prompting. An example is the Best Fit Standard key. Because multiple entries are made on this one key for a calibration, it is impossible to recall any one of them. At the completion of calibration, the Best Fit Standard key status light is turned off.

The values of two keys with key status lights cannot be recalled even though the status lights are on. They are the Zero and Best Fit Calculate keys. For linear calibrations, where the Concentration Factor was not entered, a calculated concentration factor can be recalled, despite the fact its status light is not lit, by pressing the Concentration Factor key.

3.2.4 Error Indication

When proper key entries are made, the DR/3000 Spectrophotometer acknowledges by beeping once. If the operator attempts to enter a key improperly an "error beep" (three rapid beeps) sounds. Some causes of error beeps follow:

1. Pressing the Concentration key prior to completion of calibration.
2. Pressing the Absorbance or Transmittance key without having entered a zero.
3. Pressing Best Fit Standard without having entered a value.
4. Pressing the Diagnostic key without having entered a diagnostic number.
5. Pressing Auto Update without being in a measurement mode (Abs, %T, or Conc).
6. Pressing Best Fit Calculate after the status light is on.
7. Attempting to key five numbers into the four–digit display.

3.2.5 Decimal Point Positioning

The number of digits displayed to the right of the decimal point has been predetermined in all program modes, but the operator has the option of altering this number. The Best Fit and Stored Program modes are preset to display three (3) digits to the right of the decimal point. The Stored Program mode, which has more than 60 calibration procedures, has three, two,

one and zero (3,2,1 and 0) digits to the right of the decimal point, depending o n the concentration and/or the accuracy desired in a particular procedure.

The instrument must be calibrated and only the concentration measurement (not the Absorbance or Transmittance measurements) may be formatted. To change the format, the operator keys in the number of digits to the right of t he decimal point desired and presses the Concentration key. Example: If a concentration value is 1.267 and the operator presses keys 2 and CONC, the display will read 1.27. The value is rounded and not truncated. The formatnumber should be either 0, 1, 2, or 3.

3.3 Operating Modes

CAUTION

Do not place sample cells or reagent bottles on top of the instrument. Accidental spills could cause serious instrument damage.

3.3.1 Stored Program Mode

Measurements in direct concentration are possible in this mode when using Hach reagents and methods. The DR/3000 Spectrophotometer contains more than 60 preprogrammed calibrations that are recalled from instrument memory by entering the parameter program code. This code number is recalled in Step 1 of each colorimetric procedure.

Each set of ROMs has its own Stored Program Procedures Code identified with a control number such as P 1.0. This "P" number is displayed momentarily when the spectrophotometer is first turned on.

When the stored program code for a particular parameter is entered, the proper wavelength for that test will be displayed and the SET WAVELENGTH and ZERO prompting lights will flash. The operator then dials the wavelength indicated in the display and presses the clear key to indicate the wavelength has been set. The SET WAVELENGTH light will cease flashing, but the ZERO prompting light will continue until the zero value is established with the blank later in the procedure. The final test results displayed will be in concentration units.

If the sample concentration exceeds the precalibrated range, the display will flash the upper limit value. A flashing negative value at this time indicates a possible interference in the sample, a procedural error, or possible instrument zero drift which can be corrected by reinserting the blank and pressing the ZERO key.

3.3.2 Manual Program Mode

Routine absorbance and %T data can be obtained by using the MANUAL PROGRAM mode. Linear calibrations for concentration readings also can be conducted, using two standards, or one standard and a known concentration factor (slope). Concentrations then are read directly from the display.

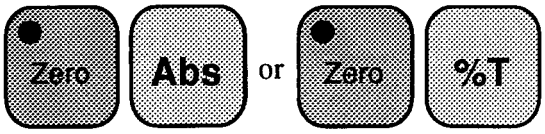
3.3.2.1 Procedure for Abs, %T Measurements

1. Place the instrument in the MANUAL PROGRAM mode.

Press: 

2. Turn the wavelength selector dial to the proper wavelength setting.

3. To obtain absorbance or percent transmittance readings, the instrument first must be set at a zero point (0.000 Abs or 100%T). This is done with a sample blank. Place the blank in the sample cell compartment and close the sample compartment door. Zero the instrument.

Press: 

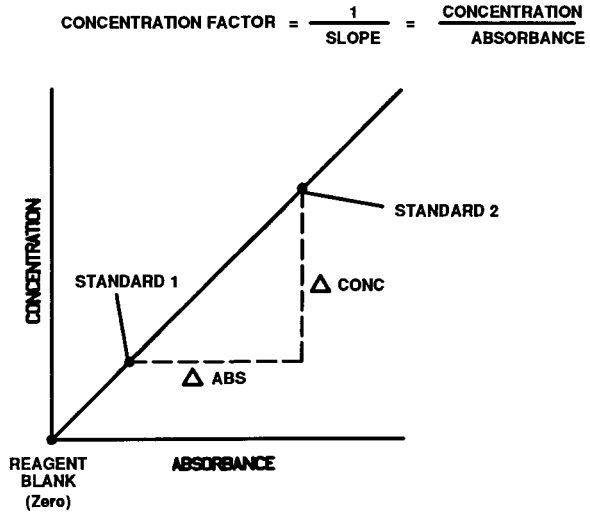
The display should read 0.000 Abs or 100.0% T, respectively. If not, press the ZERO key again. (For "noisy" samples, *refer to the SIGNAL AVERAGING procedure,* paragraph 3.4.)

4. Place the sample in the sample cell compartment and close the sample compartment door. Read the absorbance or %T value.

3.3.2.2 Procedure for Conc Measurement

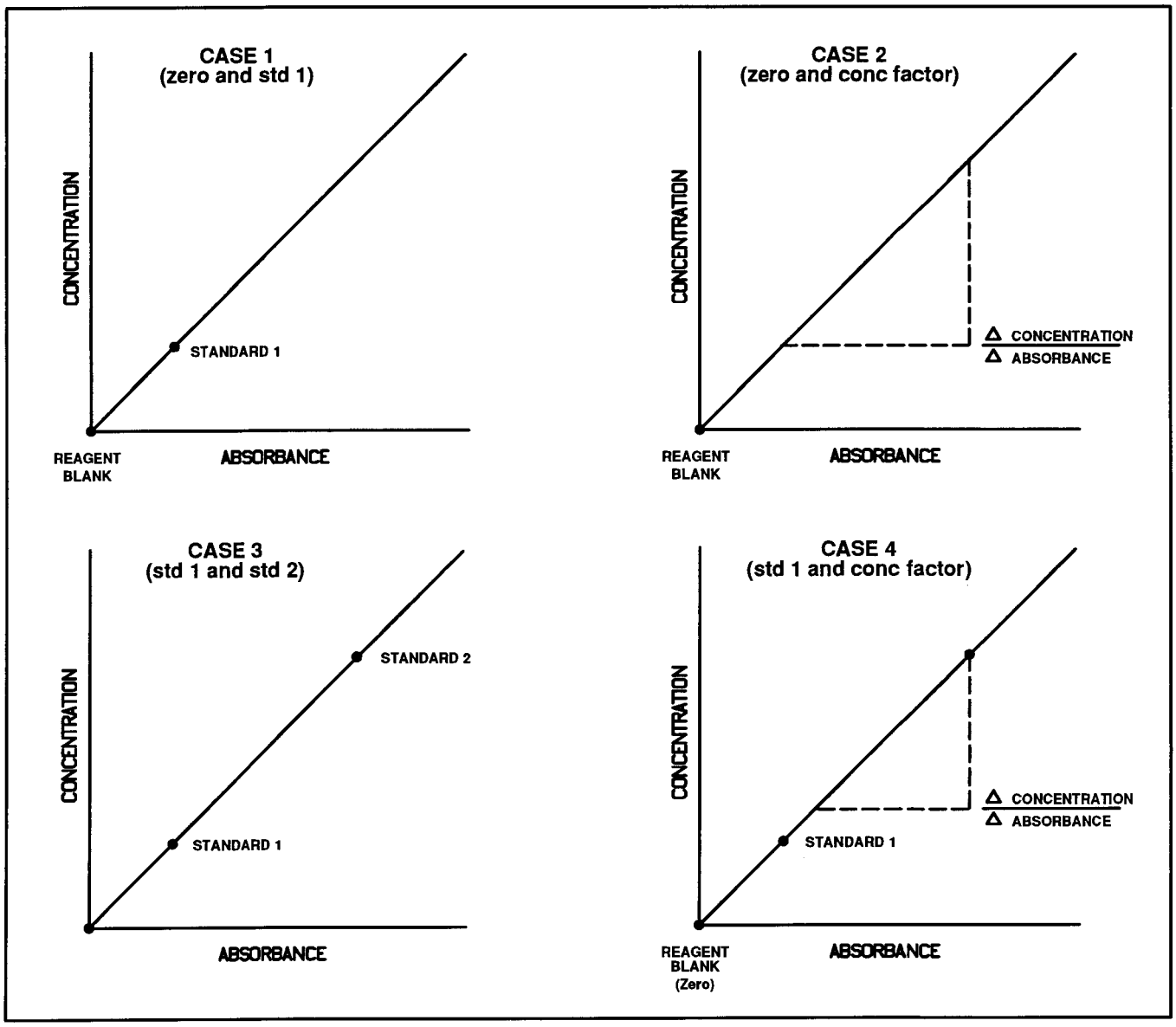
The Manual Program mode also can be used to make concentration measurements. Standards and samples must conform to Beer's Law throughout the concentration range to be measured. *Refer to the Stored Program 0 procedure,* paragraph 3.3.4, for nonlinear calibrations. Linear calibrations can be constructed using two standards or one standard and a known concentration factor. Concentration values for samples are read directly from the display.
To enter more than two standards, *refer to the Best Fit Program procedure,* paragraph 3.3.3.

Example of Beer's Law Calibration



When the instrument is placed in the Manual Program mode, the Zero, Standard 1 and Conc Factor (slope) prompting lights will flash. To generate the calibration line, the user must fulfill one of these parameters as a first step. Prompting lights will indicate the options for fulfilling the second criteria.

Cases 1 and 2 are similar to Cases 3 and 4 except that a reagent blank is being defined as zero concentration. Zeroing the instrument on the reagent blank allows the operator to obtain absorbance or %T data along with the concentration data. Absorbance or %T values are not possible in Cases 3 and 4, even though concentration values will be displayed. Step–by–step procedures for each case follow:



Case 1 - Reagent Blank Plus Standard

This example deals with the most common test method. A reagent blank and a color-developed standard must be prepared.

Press:	Display	Comments
		(Allow for sufficient instrument warm-up time.)
Manual Program	0	Instrument set in Manual Program mode. The Zero, Conc Factor and Standard 1 prompting lights will flash. Turn the wavelength selector dial to the proper wavelength setting. Place reagent blank in sample cell compartment. Close sample compartment door.
Zero Abs	0.000	Instrument zeroed. Display should read 0.000. If not, press the Zero key again. (Note: The instrument can be rezeroed at any point during the calibration using the reagent blank.) Place the prepared standard in the sample cell compartment. Close sample compartment door. When absorbance reading has stabilized, enter concentration value for standard. (Example: Standard equals 5 mg/L.)
5 Standard 1	5.000	Standard values entered. Input for Manual Program complete. The concentration factor of the calibration line and the concentration value for Standard 1 can be recalled any time during the analysis simply by pressing their respective keys. Place instrument in concentration readout mode.
Conc		Place sample in sample cell compartment. Close sample compartment door. Read concentration value of sample directly from display.

Case 2 - Reagent Blank Plus Concentration Factor

In this case, a concentration factor and a reagent blank are required. The concentration factor must be obtained from prior DR/3000 data.

Press:	Display	Comments
		(Allow for sufficient instrument warm-up time.)
Manual Program	0	Instrument set in Manual Program mode. The Zero, Conc Factor and Standard 1 prompting lights will flash. Turn the wavelength selector dial to the proper wavelength setting. Place reagent blank in sample cell compartment. Close sample compartment door.
Zero Abs	0.000	Instrument zeroed. Display should read 0.000. If not, press the Zero key again. (Note: The instrument can be rezeroed at any point during the calibration using the reagent blank.) Enter the known concentration factor. (Example: Concentration factor equals 75.)
7 5 Conc Factor	75.00	Concentration factor entered. Input for Manual Program complete. The concentration factor can be recalled any time during the analysis simply by pressing the Conc Factor key. Place instrument in concentration readout mode.
Conc		Place sample in sample cell compartment. Close sample compartment door. Read concentration value of sample directly from display.

Case 3 - Two Standards

This case requires preparation of two developed color standards. Only concentration values can be read from the display. Absorbance and %T values require a zero concentration blank, as in Cases 1 and 2.

Press:	Display	Comments
		(Allow for sufficient instrument warm-up time.)
Manual Program	0	Instrument set in Manual Program mode. The Zero, Conc Factor and Standard 1 prompting lights will flash. Turn the wavelength selector dial to the proper wavelength setting. Place the first prepared standard in the sample cell compartment. Close the sample compartment door. Enter the concentration value of the standard. (Example: Standard equals 5 mg/L.)
5 Standard 1	5.000	Standard 1 value entered. Standard 1 and Conc Factor prompting lights will flash. Place the second prepared standard in the sample cell compartment. CLose the sample compartment door. Enter the concentration value of the standard. (Example: Standard equals 10 mg/L.)
1 0 Standard 2	10.00	Standard 2 value entered. Input for Manual Program complete. The concentration values for Standard 1 and 2 and the concentration factor of the calibration line can be recalled any time during the analysis simply by pressing their respective keys. Place instrument in concentration readout mode.
Conc		Place sample in sample cell compartment. Close sample compartment door. Read concentration value of sample directly from display.

Case 4 - Standard Plus Concentration Factor

This case requires one color-developed standard and a known concentration factor. The concentration factor must be obtained from prior DR/3000 test data. Only concentration values can be read from the display. Absorbance and %T values require a zero concentration blank, as in cases 1 and 2.

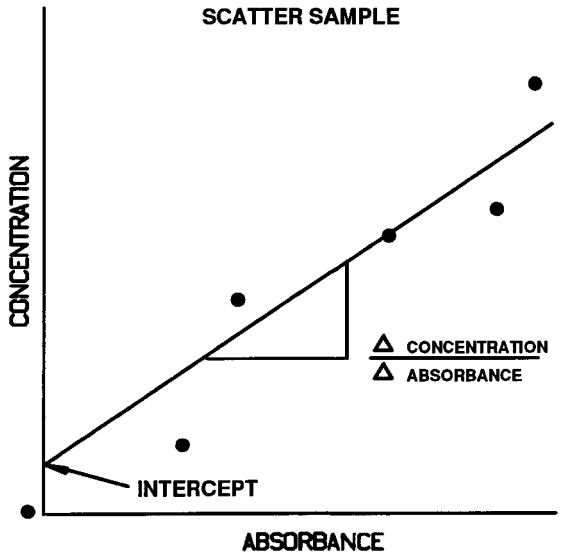
Press:	Display	Comments
		(Allow for sufficient instrument warm-up time.)
Manual Program	0	Instrument set in Manual Program mode. The Zero, Conc Factor and Standard 1 prompting lights will flash. Turn the wavelength selector dial to the proper wavelength setting. Place the prepared standard in the sample cell compartment. Close the sample compartment door. Enter the concentration value of the standard. (Example: Standard equals 5 mg/L.)
5 Standard 1	5.000	Standard 1 value entered. Standard 2 and Conc Factor prompting lights will flash. Enter the known concentration factor. (Example: Concentration factor equals 75.)
7 5 Conc Factor	75.00	Concentration factor entered. Input for Manaul Program complete. The concentration value for Standard 1 and the concentration factor can be recalled any time during the analysis simply by pressing their respective keys. Place the instrument in concentration readout mode.
Conc		Place sample in sample cell compartment. Close sample compartment door. Read concentration value of sample directly from display.

3.3.3 Best Fit Program Mode

When trying to obtain a linear calibration curve from a number of absorbance vs. concentration data points, a certain degree of "scattering" may be encountered. This scattering is the result of experimental variables such as standard preparation, reagent addition and development of color.

Example:

	Experimental Data	
Sample	**Concentration**	**Absorbance**
Blank	0 mg/L	0.000
Standard A	25 mg/L	0.301
Standard B	50 mg/L	0.585
Standard C	75 mg/L	0.929
Standard D	100 mg/L	1.197
Sample	"unknown"	0.769



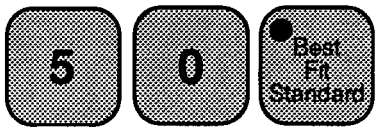
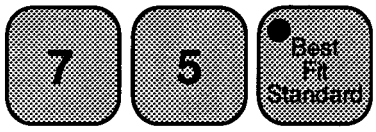
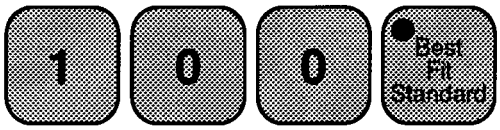
In order to convert absorbance values for "unknowns" into concentration values, it is necessary to construct the best line possible through the data points. The Hach DR/3000 Best Fit Program performs linear regression analysis on two or more standards and generates the best fit calibration line in memory. Concentration values of unknown samples are then read directly from the digital display. A step–by–step procedure for running the best fit program, using the data from the above example, is shown on the next page. The procedure must be followed exactly for proper execution. Prompting lights help direct the user to the next step in the procedure.

Before running a best fit program, make sure the color of the sample has been developed fully and the wavelength is correct. Open the shutter completely by turning the shutter control fully counterclockwise until it snaps in to place. The best fit line can be calculated using a minimum of two standards, although the instrument will accept data from an unlimited number of standards. The standards can be entered in a random fashion. Values for absorbance, concentration, correlation of determination (r2), concentration factor and intercept should be recorded, for use in interpretation of results. The exact calibration curve can be regenerated at any time from this data simply by using the Manual Program mode. *Refer to paragraph 3.3.2.* A poor value for the correlation of determination may indicate a nonlinear chemistry. In this case, calibration could be done using Stored Program 0 or 1, specifically designed for non–linear calibrations.

Best Fit Procedure Example

Press:	Display	Comments
		(Allow for sufficient instrument warm-up time.)
Best Fit Program	0	Program started. Zero prompting light will flash. A reagent blank is used to zero the instrument. Place reagent blank in sample cell compartment. Close compartment door.
Zero, Abs	0.000	Instrument is zeroed. Display should read 0.000. Rezero if necessary. Best Fit Standard prompting light will flash. If reagent blank is defined as zero concentration, enter as the first standard.
0, Best Fit Standard	1	Best Fit Standard is entered. Best Fit Standard will continue to flash. Place Standard A in the sample cell compartment. Close sample compartment door.
Abs	0.301	Absorbance value noted. When reading has stabilized, enter concentration value.
2, 5, Best Fit Standard	2	Standard A values entered. Best Fit Calculate prompting light will flash. Calculate best fit line, or enter additional standard. Place Standard B in the sample cell compartment. Close sample compartment door.
Abs	0.585	Absorbance value noted. When reading has stabilized, enter concentration value.

Best Fit Procedure Example (continued)

Press:	Display	Comments
	3	Standard B values entered. Calculate best fit line, or enter additional standard. Place Standard C in the sample cell compartment. Close sample compartment door.
	0.929	Absorbance value noted. When reading has stabilized, enter concentration value.
	4	Standard C values entered. Calculate best fit line, or enter additional standard. Place Standard D in the sample cell compartment. Close sample compartment door.
	1.197	Absorbance value noted. When reading has stabilized, enter concentration value.
	5	Standard D values entered. Calculate best fit line, or enter additional standard.
	0.999	Best fit line calculated. Correlation of determination (r^2) displayed. Place unknown sample in sample cell compartment. Close sample compartment door.
	0.769	Absorbance value noted. When reading has stabilized, calculate concentration value of unknown.
	63.77	Concentration value of unknown sample displayed.

NOTE

If the user intends to reconstruct the best fit line calculated at a later time using the manual program mode, the following information will be necessary.

Best Fit Procedure Example (continued)

Press:	Display	Comments
Conc Factor	82.64	Concentration factor displayed. To obtain the intercept value, place the reagent blank in the sample cell compartment. Close the sample compartment door.
Zero Conc	0.220	Intercept value displayed.

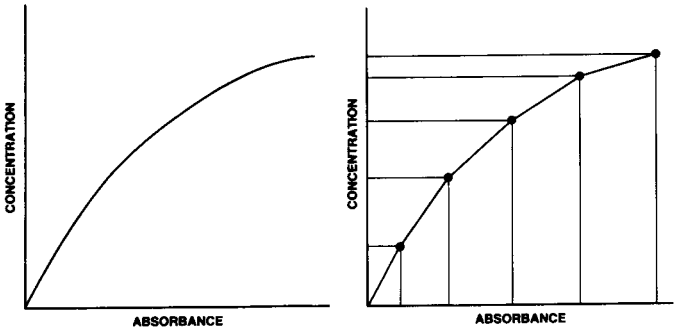
The best line may be reconstructed at a later time using only a reagent blank. Place the instrument in the Manual Program mode. Key in the concentration factor and press CONC FACTOR.

Place the reagent blank in the sample cell compartment. Key in the intercept value and press STANDARD 1.

Place the unknown sample in the sample cell compartment. Press CONC and read concentration directly.

3.3.4 Stored Programs 0 and 1 Modes

Colorimetric or turbidimetric analyses may yield a nonlinear calibration curve. The DR/3000 provides two stored programs to assist in performing non–linear calibrations. Stored program 0 is used for point–to–point interpolation between entered standards. A series of small straight lines approximating the nonlinear curve is generated *as shown below.*

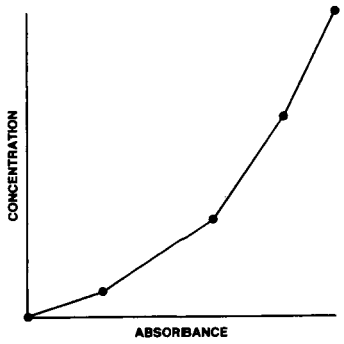


Stored program 1 can be used to re–enter the nonlinear calibration data at any time, thereby eliminating the need to repeat the calibration.For greatest reproducibility, the shutter must be opened completely by turning the shutter control fully counterclockwise until it snaps into place.

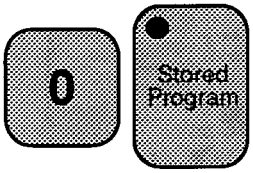
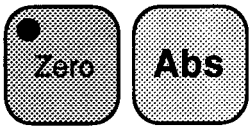
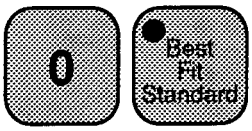
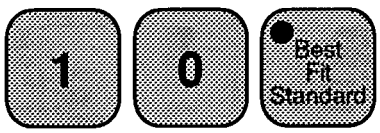
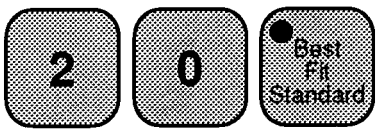
3.3.4.1 Procedure for Stored Program 0

Up to nine standards can be entered in Stored Program 0. When nine standards have been entered, the instrument automatically will terminate the entry procedure and calculate the calibration curve. **Standards must be entered in order of increasing absorbance.** Making a record of the absorbance data for possible use in later analyses is recommended. The absorbance value of unknown samples must fall within the absorbance range defined by the standards. An example of a nonlinear calibration constructed from five standards follows:

Concentration	Absorbance
0 (Reagent Blank)	0.000
10 mg/L	0.318
20 mg/L	0.542
30 mg/L	0.663
40 mg/L	0.709
"unknown sample"	0.424



Procedure

Press:	Display	Comments
		(Allow for sufficient instrument warm-up time)
	0	Stored Program 0 initiated. The Zero prompting light will flash. Turn the wavelength selector dial to the proper wavelength setting. Place the cell containing the reagent blank into the sample cell compartment. Close the sample compartment door.
	0.000	Instrument zeroed. Display should read 0.000. If not, press the Zero key again. (Note: The instrument can be rezeroed at any point during the calibration using the blank. The instrument will adjust all other values accordingly.) The Best Fit Standard prompting light will flash. Enter the concentration value of the blank.
	1	Data for first calibration point entered. Best Fit Standard prompting light will continue to flash. Place the next standard in the sample cell compartment. (Note: Standards are used in order of increasing absorbance value.) Close the sample compartment door.
	0.318	Absorbance value of standard displayed. When reading has stabilized, enter concentration value of standard.
	2	Data for second calibration point entered. First segment on nonlinear curve complete. The Best Fit Calculate prompting light will flash. Calculate nonlinear calibration curve at this point or continue with next standard. Place next standard in sample cell compartment. Close the sample compartment door.
	0.542	Absorbance value of standard displayed. When reading has stabilized, enter concentration value of standard.
	3	Data for third calibration point entered. Second segment of nonlinear curve complete. Calculate nonlinear calibration curve at this point or continue with next standard. Place next standard in sample cell compartment. Close sample compartment door.
	0.663	Absorbance value of standard displayed. When reading has stabilized, enter concentration value of standard.

Procedure (continued)

Press:	Display	Comments
3 0 Best Fit Standard	4	Data for fourth calibration point entered. Third segment of nonlinear curve complete. Calculate nonlinear calibration curve at this point or continue with next standard. Place next standard in sample cell compartment. Close sample compartment door.
Abs	0.709	Absorbance value of standard displayed. When reading has stabilized, enter concentration value of standard.
4 0 Best Fit Standard	5	Data for fifth calibration point entered. Fourth segment of nonlinear curve complete. Calculate nonlinear calibration curve at this point or continue with next standard.
Best Fit Calculate	0	Input for Stored Program 0 complete. (Note: Additional standard cannot be entered once the Best Fit Calculate key has been pressed.) Place "unknown" sample into sample cell compartment. Close sample compartment door. Place instrument in concentration readout mode.
Conc	14.73	Concentration value read directly from display. Absorbance or %T values of sample also may be displayed by pressing the Abs or %T keys.

Summary of Stored Program 0 Procedure

1. Warm up instrument. Initiate program mode. Set wavelength.
2. Zero the instrument with reagent blank.
3. Place standard in instrument. Enter concentration value.
4. Repeat Step 3 with additional standards (in order of increasing absorbance).
5. Terminate entry with Best Fit Calculate key. Place instrument in Conc readout mode.
6. Place sample in instrument. Read concentration directly.

3.3.4.2 Procedure for Stored Program 1

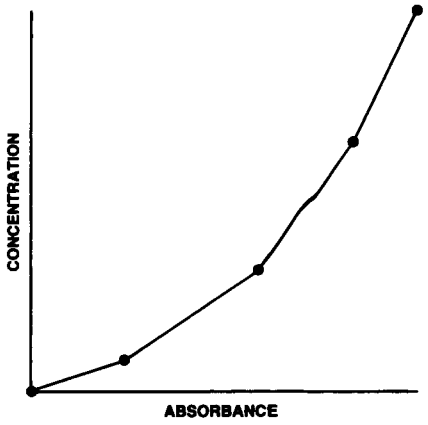
Data from previous nonlinear calibrations can be re–entered at any time directly from the keyboard, eliminating the need to repeat the calibration chores of preparing standards. However, this program should be used only in situations where the color formed by the reagent(s) is reproducible from one day to the next. Different lots of reagents may have different color forming ability. In these cases, perform a new calibration each time the reagent is prepared.

The example shows how to perform a nonlinear calibration using data from a previously established calibration curve. The operator prepares a blank and the sample to be tested. Values for up to nine standards can be entered. When nine standards are entered, the instrument will automatically terminate the entry procedure and calculate the calibration curve. **Values must be entered in order of increasing absorbance.** The absorbance value of unknown samples must fall within the absorbance range defined by the entered standards.

Example:

Data

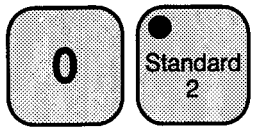
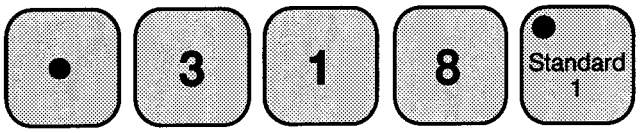
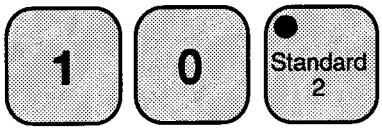
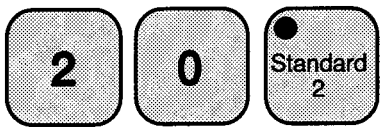
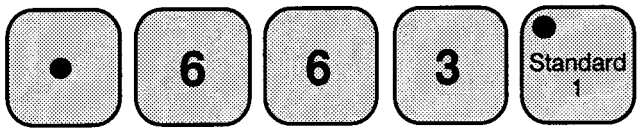
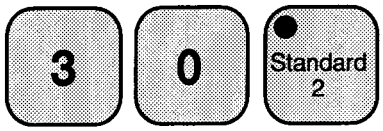
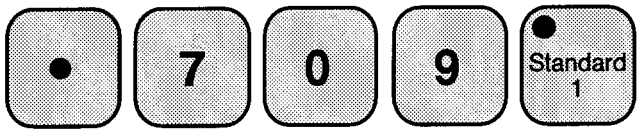
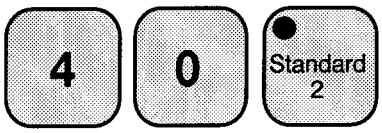
Concentration	Absorbance
0 (Reagent Blank)	0.000
10 mg/L	0.318
20 mg/L	0.542
30 mg/L	0.663
40 mg/L	0.709
"unknown sample"	0.424



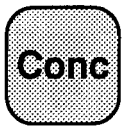
Procedure

Press:	Display	Comments
		(Allow for sufficient instrument warm-up time)
1 Stored Program	0	Stored Program 1 initiated. The Zero prompting light will flash. Turn the wavelength selector dial to the proper wavelength setting. Place the cell containing the reagent blank into the cell holder. Close the compartment door.
Zero Abs	0.000	Instrument zeroed. Display should read 0.000. If not, press Zero key again. (Note: The instrument can be rezeroed at any point during the calibration using the blank. The instrument will adjust all other values accordingly.) The Standard 1 prompting light will flash. This key is used to enter the absorbance data for each standard. The Standard 2 key is used to enter the concentration value. (Note: Standard values should be entered in order of increasing absorbance.) Enter the values for the blank.
0 Standard 1	0.000	Absorbance value for blank entered. Standard 2 prompting light will flash. Enter the concentration value of the blank.

Procedure (continued)

Press:	Display	Comments
	1	Data for first calibration point entered. Enter the absorbance value for the next standard.
	0.318	Absorbance value for standard entered. Enter the concentration value for this standard.
	2	Data for second calibration point entered. The Best Fit Calculate prompting light will begin to flash. Calculate calibration curve at this point or enter absorbance value for additional standard.
	0.542	Absorbance value for standard entered. Enter the concentration value for this standard.
	3	Data for third calibration point entered. Calculate calibration curve or enter absorbance value for additional standard.
	0.663	Absorbance value for standard entered. Enter the concentration value for this standard.
	4	Data for fourth calibration point entered. Calculate calibration curve or enter absorbance value for additional standard.
	0.709	Absorbance value for standard entered. Enter the concentration value for this standard.
	5	Data for fifth calibration point entered. Calculate calibration curve or enter absorbance value for additional standard.

Procedure (continued)

Press:	Display	Comments
	0	Input for Stored Program 1 complete. (Note: Additional standards cannot be entered once the Best Fit Calculate key has been pressed.) Place color developed sample in sample cell compartment. Close sample compartment door. Place instrument in concentration readout mode.
	14.73	Concentration value read directly from display. Absorbance or %T value of sample also may be displayed by pressing the Abs or %T keys.

Summary of Stored Program 0 Procedure

1. Warm up instrument. Initiate program mode. Set wavelength.
2. Zero the instrument with reagent blank.
3. Enter absorbance and concentration values of standards (in order of increasing absorbance). Standard 1 key is used for absorbance entries and Standard 2 key is used for concentration entries.
4. Terminate entry with Best Fit Calculate key. Place instrument in Conc readout mode.
5. Place sample in instrument. Read concentration directly.

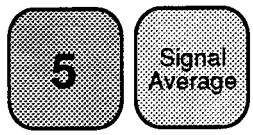
3.4 Signal Average Feature

In colorimetric analysis, samples that yield unstable readout values may be encountered. Such "noisy" signals are due to a variety of reasons, including undissolved particles, unstable complexes or nonuniform samples. During these instances, the operator may choose to use the DR/3000 signal average function. The signal average will display an updated average of the signal, creating a more stable readout.

When the operator turns the instrument on or selects a different program mode, the signal average automatically is set at a value of 1. This means that measurements are taken and displayed approximately two and one–half (2.5) times per second. The operator may select a signal average value (n) from 1 to 10. The displayed value is the average value of the last "n" measurements.

Procedure for Using Signal Average

1. At any point during an analysis, the operator may use the signal average key. Enter a value from 1 to 10 and press the Signal Average key. (Example: signal average = 5)



   The instrument will display and update the average value of the last five signal readings.

2. Press Conc, %T or Abs key for mode desired.

3. Proceed with the analysis.

NOTE

The signal average can be verified or recalled at any time by pressing the signal average key.

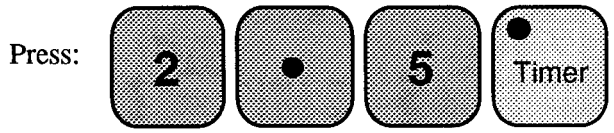
3.5 Timer Function

The DR/3000 Spectrophotometer has a built–in digital timer. The operator may select time periods of up to 1440 minutes (24 hours). The instrument will signal the end of the time period with four audible beeps. All other functions of the instrument can be used while the timer is timing. Minutes remaining in the time period are displayed when the Timer key is pressed. The remaining time displayed is updated every 0.1 minutes (six seconds). The timer can be reset at any time by selecting the new time followed by pressing the Timer key. The timer can be cancelled by pressing 0 Timer.

Procedure for Using Digital Timer

1. Select the number of minutes to be timed and press the TIMER key. The value may include tenths of minutes.

   Example: Timer period = 2.5 minutes



   The Timer key light will come on and the display will feature the count down of the period.

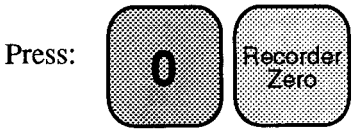
2. The operator may return to any other instrument mode. The remaining time period can be displayed by pressing the Timer key. Four audible beeps will signal when time has expired.

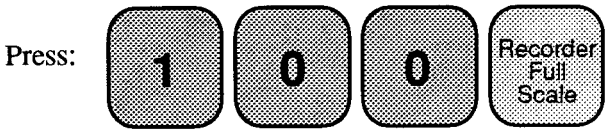
3.6 Recorder Output Control

NOTE

The voltage output and recorder interface Instructions are covered in the Recorder Set–up procedures in paragraph 2.4 of the manual.

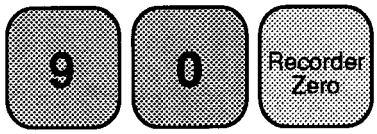
When using a recorder with the DR/3000 Spectrophotometer, the operator must assign numerical values for both the upper and lower limits of the recorder scale. This is done with the keyboard controls. Numerical entries are made using the Recorder Zero and Recorder Full Scale keys. These values will correspond to the readout mode chosen by the operator: %T, Abs, or Conc. For instance, if %T values are desired, the operator may want to record a range of 0 to 100. This can be done as follows:

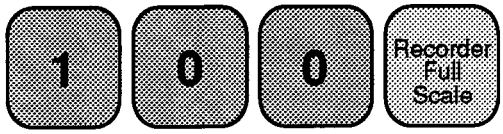




Other ranges may also be expanded to full scale.

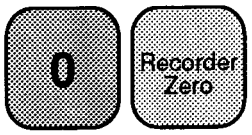
Example:

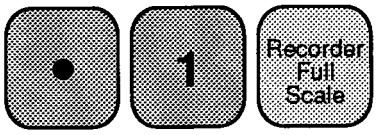
Press: 

Press: 

The recorder will now represent a full scale range of 90 to 100. For absorbance recordings, select the desired absorbance range. When the instrument is turned on, the recorder range is automatically preset from 0.000 to 2.000, a commonly used absorbance range. However, the operator can enter other absorbance recording limits with the Recorder Zero and Recorder Full Scale keys.

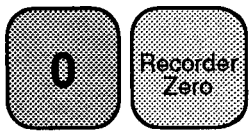
Example:
Desired absorbance recording range = 0.000 to 0.100

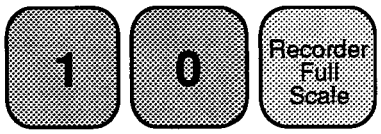
Press: 

Press: 

The recorder limits also can represent concentration values when the operator is using the concentration readout mode. The lower and upper limits of the recorder scale are set in the same manner as the %T and Abs examples.

Example:
Desired concentration recording range = 0 to 10

Press: 

Press: 

The value for each recorder limit can be displayed at any time by pressing the Recorder Zero or Recorder Full Scale keys.

3.7 Pour–Thru Cell Operation

In many cases, when a procedure says to place a normal 25–mL sample cell containing a blank or sample into the DR/3000 sample cell compartment, the solution may be poured instead into the funnel of the installed Pour–Thru Cell Assembly. Take care to avoid any spills on the instrument. Adjust the funnel for height and orientation to allow for easy sample pouring. The height of the funnel also determines how fast the sample flows through the cell. Measurements or Instrument commands should be made only after the solution has stopped its flow through the cell. Remove the Pour–Thru Cell occasionally to check for accumulation of film on the windows. If the inside window surface appears dirty or hazy, *refer to paragraph 4.1.3.*

CAUTION

Do not use or clean the Pour–Thru Cell with organic solvents such as chloroform, toluene or cyclohexanone.

SECTION 4 INSTRUMENT MAINTENANCE

4.1 Cleaning

4.1.1 Spectrophotometer

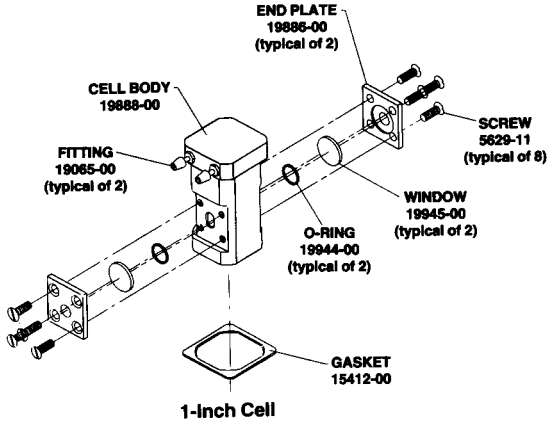
Keep the instrument clean and wipe up any spills promptly. Windows in the cell holder can be wiped with lens tissue or a soft, lint–free cloth that will not leave an oil film.

4.1.2 Sample Cells

Clean the Sample cells with detergent and hot water, rinse several times with tap water and then rinse thoroughly with demineralized water. Sample cells used with organic solvents (chloroform, benzene, toluene) should be rinsed with acetone before the detergent wash and again as a final rinse before drying.

4.1.3 Pour–Thru Sample Cell

Check the windows of the Pour–Thru Cell regularly. If they appear hazy, soak the cell in a detergent bath and then rinse thoroughly with demineralized water. The cell may be disassembled for cleaning. *See Figure 14.* Take care not to overtighten the screws during reassembly. The threads strip easily.



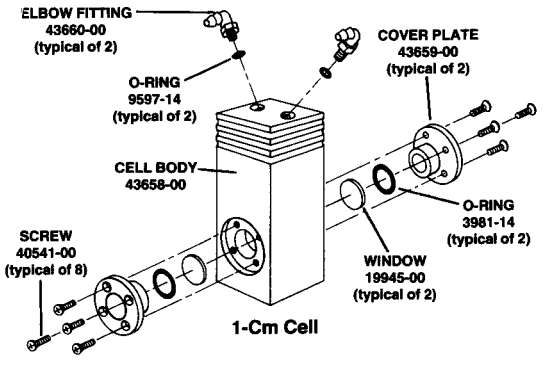


FIGURE 14 POUR-THRU CELLS

4.1.4 Air Filter

The air filter, located on the bottom of the instrument, will accumulate dust and must be cleaned periodically. How often cleaning is necessary to prevent overheating depends on the particular environment and should be determined empirically. Clean as follows:

1. Turn off instrument power and disconnect the power cord. Empty the sample compartment.
2. Carefully stand the instrument on its left side to gain access to the filter holder on the bottom side.
3. Remove the four screws securing the filter holder to the bottom of the instrument and remove the holder and filter. *See Figure 15.*
4. Wash the filter in warm water using a mild detergent. Rinse thoroughly and blot dry with paper towels or gently blow dry.
5. Reinstall the filter and filter holder. If the filter shows damage, replace it with a new filter.

CAUTION

Use only the replacement filter listed in the Replacement Parts in Section 6. Thickness and pore density affect cooling and dust filtering.

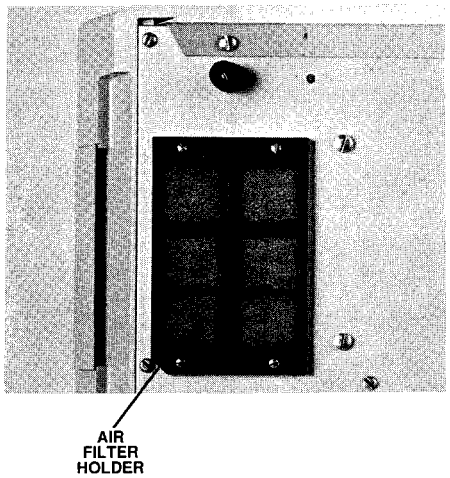


FIGURE 15 AIR FILTER LOCATION

4.2 Calibration

Calibration of the 0 ADJ and 1 ADJ controls should be checked periodically during normal instrument use to ensure the best possible instrument performance.

4.2.1 Zero Calibration

Allow at least 15 minutes of operation for warm–up. Perform the zero calibration as follows:

1. Press: 

2. Close the shutter by turning the shutter control fully clockwise. *See Figure 8.*

3. Using the trimpot tool provided with the instrument, adjust the 0 ADJ control located in the sample compartment. At the correct setting the 0 ADJ control becomes very sensitive. Always allow five to 10 seconds after makingan adjustment to observe the high and low readings. Do not expect to see the same exact values twice. When the 0 ADI is set properly, the readings will be erratic and the value 3. 5XX must be seen or occur within the range of the erratic reading.

NOTE

The ZERO LIGHT indicator may flash occasionally or not at all, but it must not flash at a repetitious rate.

Improper Setting Examples:
The reading varies between 3.640 and 3.715. Adjustment is needed. A 3.5XX reading does not show up, nor does it occur between 3.640 and 3.715. The adjustment has been set too high.

The reading varies between 3.145 and 3.425. Adjustment is needed. For the same reasons as in the previous example, the adjustment has been set too low.

Proper Setting Examples:
The reading varies between 3.010 and 3.715. No adjustment is needed. Despite the fact that a 3.5XX was not seen, it does occur between 3.010 and 3.715 and that is all that is required.

The reading varies between 3.385 and 3.525. No adjustment is required. A 3.525 reading was displayed.

4. Open the shutter by turning the control fully counterclockwise until the shutter detent is felt.

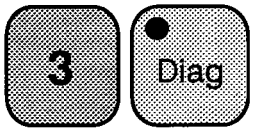
4.2.2 Absorbance Gain (1 ADJ) Calibration

After warm–up of at least 15 minutes, perform the absorbance gain calibration as follows:

1. Set the wavelength to 630 nm and verify that the sample compartment is empty.

2. Verify that the shutter is opened completely. The knob will snap into position at the end of the shutter control counterclockwise travel.

3. Close the sample compartment door.

4. Press: 

The instrument will measure, calculate and display the absorbance gain. The display should be 1.000 when calibrated properly.

5. If 1.000 is not displayed, adjust the 1 ADJ control using the trimpot tool provided. *See Figure 8.* Clockwise rotation increases the value. Repeat Steps 3, 4 and 5 as necessary until the display is 1.000.

NOTE

The instrument will not respond to gain adjustment until 3 Diagnostic is keyed again.

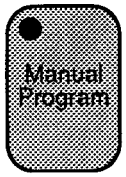
4.3 Instrument Linearity Check

Use the following procedure to determine that the instrument is giving a linear response and ensure the instrument's optical system is functioning properly.

1. Prepare a set of five cobalt chloride standards of varying concentrations in 50–mL volumetric flasks. Fill the first flask to the mark with Cobalt Chloride Solution, Cat. No. 14222.

2. Using transfer pipets and pipet filler, pipet 40.0, 30.0, 20.0 and 10.0 mL of the Cobalt Chloride Solution into separate 50–mL volumetric flasks and dilute to the marks with demineralized water. Stopper and invert to mix.

3. Set the instrument to the Manual Program mode. (Allow for sufficient instrument warm up time.)

Press: 

4. Adjust the wavelength selector dial to a setting of 510 nm.

5. Fill a clean 1–inch sample cell with demineralized water and place it in the sample cell compartment. Close the sample compartment door.

6. Zero the instrument as follows:

Press: Zero Abs

The display should read 0.000. If not, press the Zero key again.

7. Read the absorbance value of each Cobalt Chloride Solution in order of increasing strength. The same 1–inch cell may be used for each reading simply by rinsing the cell with a small amount of each solution before filling.

8. Graph the results on linear–linear paper, plotting the mL of Cobalt Chloride used for each sample preparation versus the absorbance reading obtained. *See Figure l6.*

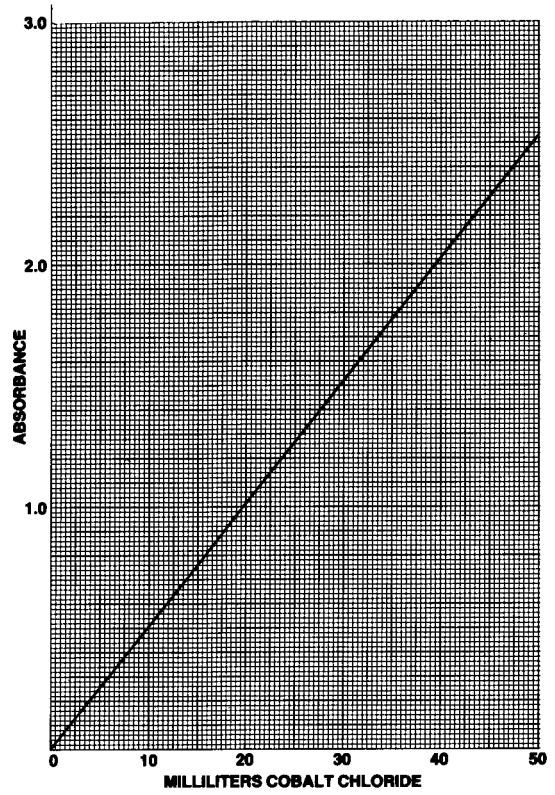


FIGURE 16 LINEARITY CHECK GRAPH

If the operator has used careful technique, the result should be a straight line passing through zero. If results are unsatisfactory, contact your nearest Hach Service Center. *Refer to Section 7.*

4.4 Instrument Wavelength Accuracy Check

The wavelength dial setting of the DR/3000 may be checked by using the following procedure.

1. Make sure the instrument has been properly warmed up. Set the instrument to the Manual Program mode.

Press: Manual Program

2. Adjust the wavelength selector dial to a setting of 575 nm.

3. Fill a clean 1–inch sample cell with deionized water and place in the sample cell compartment. Close the sample compartment door.

4. Zero the instrument as follows:

Press: Zero Abs

The display should read 0.000. If not, press the Zero key again.

5. Fill a clean 1–inch sample cell to the 25–mL mark with Neodymium Chloride Solution (Cat. No. 14210–14) and place it in the sample cell compartment. Close the sample compartment door and read the absorbance value.

6. Adjust the wavelength selector dial to 575.5 nm and repeat Steps 3 through 5.

7. Repeat Step 6, increasing the wavelength setting by 0.5 nm each time. Determine which wavelength yields the highest absorbance value. The wavelength dial is adjusted accurately if the wavelength setting determined in Step 7 is 577 ± 2 nm.

NOTE

This test is only a "secondary" check of the wavelength accuracy and does not necessarily indicate the absolute value for the DR/3000 which is factory set at ± 1 nm or better.

4.5 Sample Cell Matching

Although each spectrophotometer has matched 1–inch sample cells, small differences may occur at certain wavelengths. Take care during handling and cleaning to prevent nicks, scratches or fingerprints. For greatest accuracy, precision and repeatability, place the sample cells into the cell holder in the same orientation. For example, place the label toward the front of the instrument facing the operator. Use the following procedure to check the match between two sample cells.

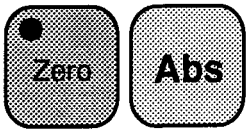
1. Turn the instrument on and allow for sufficient warm–up time (15 minutes). Select the wavelength. Clean the two sample cells thoroughly.

2. Fill both cells with demineralized water. Label one cell as the reference cell. Set the instrument to the manual program mode.

   Press: 

3. Place the reference cell in the sample cell compartment and close the sample compartment door. The 25–mL mark should face the front of the instrument for proper orientation.

4. Zero the instrument and read in units of absorbance.

   Press: 

   The display should read 0.000. Zero instrument again if necessary.

5. Place the other sample cell in the sample cell compartment and close the sample compartment door. Read the absorbance. Repeat for verification.

   If the cells do not exactly match at the desired wavelength, they still can be used by compensating for the difference. For instance, if the second sample cell reads 0.002 absorbance units higher than the reference cell, future readings using these same cells at this wavelength can be corrected by subtracting 0.002 absorbance units from the reading. Likewise, if the sample cell had a negative absorbance value relative to the reference cell, that value should be added to the reading.

4.6 Lamp Replacement and Alignment

4.6.1 Lamp Replacement

WARNING

Halogen lamps, such as the one that is used in the DR/3000 Spectrophotometer, operate under pressure and could shatter if the envelope is damaged. Always wear eye protection when the lamp cover is removed if power is on. Allow lamp to cool before handling.

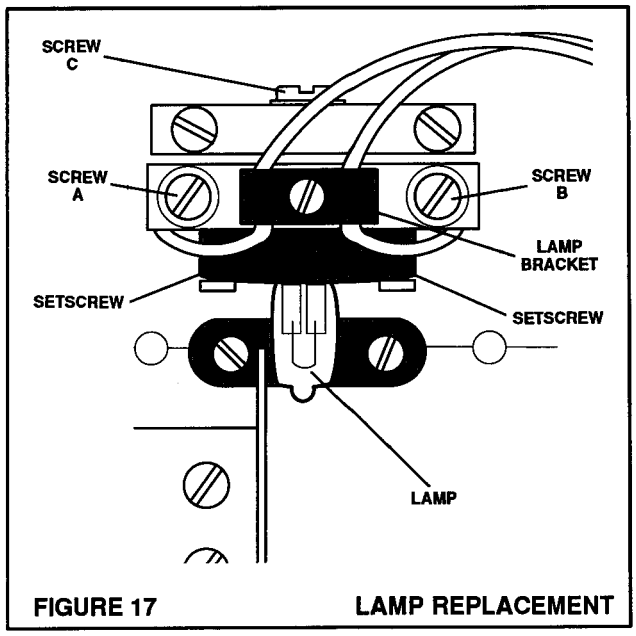


FIGURE 17 LAMP REPLACEMENT

NOTE

Hach recommends keeping a spare lamp on hand at all times.

1. Set the POWER switch to OFF and disconnect the power cord. If the lamp is hot, allow time to cool before touching it.

2. Open the sample compartment door and remove the lamp cover by removing the four screws that secure the cover. *See Figure 8.*

3. Remove screws A and B with their associated washers. *See Figure 17.*

4. While holding the lamp leads, loosen screw C (counterclockwise) until the lamp bracket assembly is disengaged.

5. Remove the lamp bracket assembly with lamp from the lamp compartment.

6. Loosen the two setscrews that secure the lamp in the socket approximately one turn. Pull the lamp from the socket, noting the positioning of the lamp leads in the socket.

CAUTION

Avoid touching the lamp envelope with bare hands. Natural skin oils can cause etching of the quartz glass and shorten lamp life. If the lamp envelope is touched, wipe it with a clean cloth dampened with alcohol.

7. Using a soft tissue to grasp the replacement lamp, insert the lamp leads into the small slots **behind** the setscrew plate. Push the lamp into the socket until the leads bottom in the socket. Lamp leads **must not** be between the setscrew and setscrew plate. Tighten the setscrews in half–turn increments, alternating between the two to ensure the lamp is seated properly and is not damaged. Pull gently on the lamp to verify it is secured and the leads are seated properly in the slots.

8. Reposition the lamp bracket and lamp under adjustment screw C. Turn screw C clockwise until the lamp bracket assembly is engaged. Turn screw C approximately five more turns.

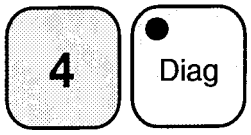
9. Reinstall screws A and B with washers and tighten until the lock washers begin to compress. Do not overtighten or the bracket will not adjust in Step 5 of paragraph 4.6.2.

4.6.2 Lamp Alignment

WARNING

Wear eye protection when the lamp is on while the lamp cover is removed.

1. Connect the power cord and set the instrument POWER switch to ON.

2. Press: 

3. Set the wavelength to 350 nm.

4. Cover the sample cell compartment with the lamp cover to prevent room light from affecting the optical output.

5. Adjust screw C back and forth until the maximum negative reading is displayed. The reading peak typically is more negative than –0.500.

6. Tighten screws A and B to lock the lamp in place. If the screws are set properly, the readings will not decrease more than 0.004 when the screws are tightened.

7. Reinstall the lamp cover.

NOTE

The lamp cover must be positioned properly prior to tightening the screws to prevent light leaks into the sample cell compartment. If light is visible around the edges of the lamp cover, positioning is not correct.

4.7 ROM Replacement

The DR/3000 stored program capabilities are expanded periodically to incorporate new calibrations. The new reprogrammed ROM kits will be made available to all DR/3000 Spectrophotometer users. A simple ROM replacement, as described in the following steps, will update your instrument to the newest configuration.

1. Set the POWER switch to OFF and disconnect the power cord. Verify that the sample cell compartment is empty.

WARNING

Be sure the power cord is disconnected before removing the instrument cover. Electrical shock can cause serious injury.

2. Place the instrument on its left side.

3. Remove the five screws that secure the instrument cover to the chassis. One screw is at the top of the rear panel and the other four are on the bottom of the instrument chassis.

4. Turn the instrument upright and slide the cover toward the rear until the microcomputer circuit board is accessible.

CAUTION

The instrument contains static sensitive devices that make it necessary to take precautionary

steps when replacing components. The work surface, operator and any electrical tools must be grounded properly to prevent instrument damage.

5. Locate ROM U2 in the upper left–hand portion of the microcomputer board. *See Figure 18.* Note orientation of the notch on the top of the ROM.

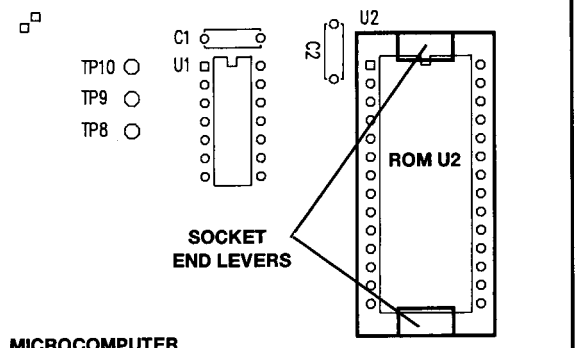


FIGURE 18 **ROM REPLACEMENT**

6. Push the levers at the ends of the U2 ROM socket apart to eject the ROM from the socket.

7. With the notch oriented upward, align the replacement ROM leads with the socket. Press the ROM firmly into the socket. When the ROM is fully seated, the socket end levers will extend over the ends of the ROM to lock it in place.

8. Replace the instrument cover, making sure the gasket along the top front edge is positioned correctly.

9. If new pages for your manual are included with the ROM replacement set, use them to update your manual.

10. If a Stored Program Procedures Card was supplied with your instrument, please discard it. The card will not be compatible with your updated instrument. Cards are no longer used.

SECTION 5 TROUBLESHOOTING

5.1 Introduction

Should the instrument malfunction or otherwise perform unacceptably, the following troubleshooting guide, Table 5, may be helpful in correcting set–up or operational problems. If the problem still exists after checking the troubleshooting guide, go to the diagnostics chart, Table 6, and complete diagnostic Steps 0 through 16. For linearity or wavelength accuracy problems, verification can be done with procedures in paragraphs 4.3 and 4.4, respectively.

Internal troubleshooting should not be attempted by unqualified personnel. If an internal problem is suspected, please contact your nearest Hach Service Center. *Refer to Section 7.* Under no circumstances should the monochromator be opened other than at the factory by Hach personnel. Unauthorized service or repair will void the instrument warranty.

Table 5. Troubleshooting Guide

Symptom	Action
1. Instrument dead: Display and Fan - OFF	1. Verify that power connections to the instrument are good. 2. Verify that the line voltage selector card is installed properly for your line requirements. 3. Verify that the fuse is not blown. Check ampere rating and verify it is correct for your line voltage. 4. Try switching power ON to OFF several times. 5. If the above fails, call service center.
2. Instrument display is on (may be dimly lit) but "locked up". No keyboard response. Fan - ON	1. Turn power to OFF. After 2-3 seconds, turn to ON to reset the instrument. 2. Verify that the line voltage selector card is installed properly for your line requirements. 3. If the above fails, call service center.
3. Instrument display erratic or erroneous. If a recorder is used, it also is erratic.	1. Verify that the line voltage selector card is installed properly for your line requirements. 2. Verify that the light shutter is completely opened. Turn control fully counterclockwise until the detent-locking action is felt. 3. Verify that the program procedures and entries were done correctly. 4. Verify that the sample cell orientation is correct. **WARNING** **Halogen lamps operate under pressure and may shatter. Protective eyewear must be worn when the lamp cover is removed and the power is on.** 5. Verify that the lamp is ON by removing the lamp cover plate in the sample compartment. If the lamp is OFF, press Keys 5 and DIAG.

Table 5. Troubleshooting Guide (continued)	
Symptom	**Action**
	If the displayed value is correct, 6.00 ± 0.250, replace the lamp per lamp replacement procedure in paragraph 4.6. If the value is incorrect and/or the replaced lamp still is OFF, call service center. 6. Verify sample stability is not a problem by setting wavelength to 630 nm and with an empty sample cell compartment press Keys 4 and DIAG. If the signal level is correct, display value should be between -1.500 and -2.550. If display is stable (least significant figure does not fluctuate more than ± 1 digit) after 20-30 seconds, the problem is probably due to the sample. If the displayed level is incorrect, erratic, or drifting rapidly, try replacing the lamp. If the problem persists call service center. 7. Go to the diagnostics chart.
4. Recorder - erroneous or erratic readings - displayed signal is stable and seems correct.	1. Verify recorder and connections are good. 2. Verify the Recorder Zero and Recorder Full Scale keys are set at correct values. 3. Verify that the recorder range jumper plug is set at correct output (factory-set for 1 V full scale). 4. Go to the diagnostics chart.
5. Customer calibration cannot be achieved.	1. Repeat calibration procedure. If still a problem go to the diagnostics chart.
6. Fan not on. Instrument performance appears normal.	1. Turn off the instrument and call service center.
7. Display segment or key indicator faulty.	1. Press Keys 1, 2 and DIAG. Indicators/Display all light for several seconds. If not, call service center. 2. Go to the diagnostics chart.
8. E 01 displayed at power up.	1. Reset: Switch power OFF, then after 2-3 seconds, ON. If problem persists, call service center.
9. E 02 displayed at power up.	1. Reset: Switch power OFF, then after 2-3 seconds, ON. If problem persists, call service center.
10. E 03 displayed at power up.	1. Reset: Switch power OFF, then after 2-3 seconds, ON. If problem persists, call service center.
11. E 04 displayed at power up.	1. Reset: Switch power OFF, then after 2-3 seconds, ON. If problem persists, call service center.

Table 5. Troubleshooting Guide (continued)	
Symptom	**Action**
12. E 05 displayed while operating instrument.	1. An entry has resulted in an attempt to divide by 0. Procedural problem; repeat procedure.
13. E 06 displayed while operating instrument.	1. A display overflow condition has occurred. Recheck calibration entries.
14. Key entry problem.	1. When the DIAG key indicator is ON, the keyboard will not respond. If a key entry is made before the diagnostic is complete (key indicator is OFF), the instrument will record any key entry and immediately act on it at the completion of the diagnosis. Do not key in additional data while the Diagnostic indicator is ON. 2. If a single key or column of keys will not enter or enters incorrectly, call service center.

5.2 Using Diagnostic Steps

The diagnostic steps are troubleshooting tools that can help isolate certain problems. Certain portions of the microcomputer and power supply systems must be operational to utilize the diagnostic capability.

Prior to doing diagnostics 3, 4, 6 and 7, listed in Table 6, complete the following steps:

1. Set the wavelength to 630 nm.
2. Open the light shutter completely. The light shutter control will snap into place when turned completely counterclockwise.
3. Empty the sample compartment.
4. Close the sample compartment door.

These prerequisites are noted with applicable diagnostics. However, to avoid confusion, these prerequisites may be set up prior to beginning the diagnostic chart, as they will not affect other diagnostic steps.

Many diagnostic steps require from 5 to 55 seconds to measure, calculate and/or display or perform the task. During this period, the diagnostic key indicator will be on, indicating a diagnostic task is in progress. While this indicator is on, **do not** key in additional information. While a diagnostic request is being serviced, the keyboard will seem dead, but the instrument can still record up to two key strokes. At the completion of the diagnostic step, the keyed information would be acted upon immediately, allowing the diagnostic information to be displayed for only a moment. Generally, if the diagnostics all check out properly, the instrument is performing properly.

Table 6. Diagnostics Chart

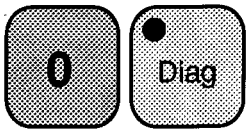
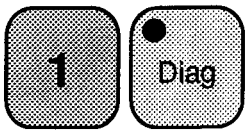
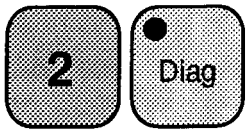
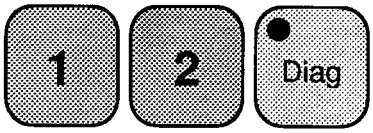
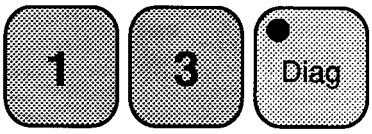
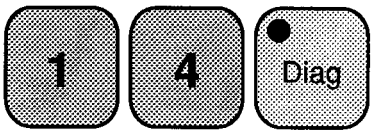
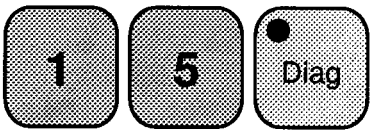
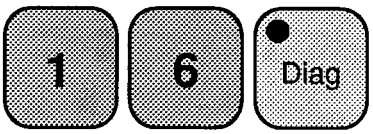
Press:	Result	If Not:
	The instrument outputs a zero condition to the recorder.	1. Check the recorder. 2. Check recorder connections. 3. Adjust the recorder zero if possible. 4. Adjust the instrument REC 0 if necessary (back of instrument). 5. Call service center.
	The instrument outputs a full scale condition to the recorder.	1. Adjust the recorder span if available. 2. Adjust the instrument REC FS if necessary (back of instrument). 3. Call service center.
	The instrument outputs a 1/2 scale condition to the recorder.	1. Is the recorder linear? 2. Continue diagnostics.

Table 6. Diagnostics Chart (continued)		
Press:	**Result**	**If Not:**
3 Diag	The instrument display should read 1.000. *See prerequisites in heading.*	1. Adjust the 1ADJ pot in the sample compartment per calibration procedure 4.2.2. 2. Is the lamp ON? 3. Is the lamp alignment good? 4. If the adjustment procedure fails, call the service center.
4 Diag	The instrument displays the Log $\frac{ref}{sig}$, (a direct measurement of signal strength). The display should read between -1.500 and -2.550.	1. Is the lamp ON? 2. Is the lamp alignment good? 3. Change lamp. 4. Call service center.
5 Diag	The instrument displays the lamp voltage. The display should read between 5.75 and 6.25.	1. Call service center.
6 Diag	The instrument displays the preamp output (TSIG). The display should read between 0.300 and 3.300. *See prerequisites in the heading.*	1. Is the lamp ON? 2. Is the lamp alignment good? 3. Call service center.
7 Diag	The instrument measures, then calculates, the attenuation factor. The display should read between 9.970 and 10.03. *See prerequisites in the heading.*	1. Is the lamp ON? 2. Is the lamp alignment good? 3. Call service center.
8 Diag	The instrument ramps the recorder output from full scale to zero. Time span = 52 seconds. With a recorder hooked to the output and chart speed set at an approximate speed of 10 to 20 inches/minute, verify a nice smooth linear decline.	1. Call service center.
9, 10, 11	(For factory use only.)	

Table 6. Diagnostics Chart (continued)

Press:	Result	If Not:
	The instrument will flash all displays and indicators on the keyboard ON for several seconds.	1. Call service center if any fail to light.
	Each digit of the instrument will simultaneously count through the following sequence: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, -, E, H, L, P, blank	1. Call service center if any digit misses any or part of the sequence.
	The instrument measures and displays the -12 V supply output. The display should read: -12.00 V ±0.250 V.	1. This is a factory setting. Call service center.
	The instrument measures and displays the reference voltage. The display should read: 1.850 V ± 0.001 V.	1. This is a factory setting. Call service center.
	The instrument measures and displays the +5V supply output. The display should read: 5.08 V ± 0.22 V.	1. Call service center if the displayed value is incorrect.

SECTION 6 REPLACEMENT PARTS

Ref.	Description	Cat. No.
	Adapter, AccuVac Vial	43784–00
	Adapter, l–cm cell	44895–00
	Adapter Kit, COD vial	44799–00
CR1, CR2	Bridge Rectifier	13774–00
A6	Circuit Board, detector/preamp	19632–00
A4	Circuit Board, display	19626–00
A3	Circuit Board, microcomputer	19912–00
A2	Circuit Board, power supply	19629–00
	Dust Cover	22907–01
	Fan Assembly, ventilating, with leads	19638–00
	Fitting, hose barb, for Pour–Thru Cell, 1–inch	19065–00
	Fitting, hose barb, for Pour–Thru Cell, 1–cm	43660–00
	Fitting, hose barb, for Pour–Thru Cell, base assembly drain	19576–00
	Filter, air	19889–00
	Funnel, for Pour–Thru Cell	21123–00
A1F1	Fuse, 3/4A, for 100, 120V operation	10045–24
AlFl	Fuse, 1/2A, for 220, 240V operation	3310–24
A2F1	Fuse, power supply board, 2 1/4A	19762–00
A2F2	Fuse, power supply board, 4A	19763–00
	Gasket, instrument cover	42552–00
A5	Keyboard Assembly	19591–00
A7	Kit, serial interface (optional)	43590–00
AlDS1	Lamp	19786–00
	Lamp Holder Assembly, with leads	19636–00
	DR/3000 Instrument Manual	19600–89
	O–ring, Pour–Thru Cell, 1–inch	19944–00
	O–ring, Pour–Thru Cell, 1–cm	3981–14
A1R1	Potentiometer, 0 ADJ, 20K	19881–00
AlR2	Potentiometer, 1 ADJ, 5K	19882–00
	Pour–Thru Cell Kit, 1–inch (optional)	19941–00
	Pour–Thru Cell Kit, 1–cm (optional)	43667–00
	Power Cord	18010–00
	Recorder Phone Plug	16084–00
	ROM Update Kit	19585-01
	Sample Cell, Matched Pair, l–cm (optional)	20951–00
	Sample Cell, Matched Pair, 1–inch	19935–00
A1S2	Switch, power	18006–00
A1T1	Transformer Assembly	19876–00
AlQ1, Q2	Transistor Assembly, power	18912–03
	Trimpot Tool	18933–00
	Tubing, tygon, for Pour–Thru Cell (2 required)	19637–00
	Tubing, rubber, for Pour–Thru Cell drain hose	560–18
	Window, Pour–Thru Cell, 1–inch and 1 1–cm	19945–00
	Zeroing Vial	21228–00

SECTION 7 REPAIR SERVICE

For instrument service, please contact the Hach Factory Service Center serving your location.

In the United States:
Hach Company
100 Dayton Ave.
P.O.Box 907
Ames, Iowa 50010
800–227–4224 (U.S.A. only)
FAX: (515) 232–1276
Telephone: (515) 232-2533

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

In Latin America, the Caribbean, the Far East, the Indian Subcontinent, Africa (excluding Mediterranean Africa) or the Pacific Basin:
Hach Company, World Headquarters
P.O. Box 389
Loveland, Colorado 80539
U.S.A.
Telephone: (303) 669–3050*
FAX: (303) 669–2932*
Telex: 160840
**After April 15, 1995:*
Telephone: (970) 669–3050
FAX: (970) 669–2932

SYSTEMS FOR ANALYSIS

AUTOMATIC ANALYZERS FOR

ALKALINITY

CHELANT

CHLORINE

CHLORINE DIOXIDE

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PHOSPHATE

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