SPECTRONIC™ 20+ and SPECTRONIC 20D+ User Guide

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Contents

Introduction

The SPECTRONIC™ 20+ and SPECTRONIC™ 20D+ are single-beam spectrophotometers. Durable and easy to use, the 20 series is ideal for a student laboratory as well as for simple QC and water analysis laboratories.

This manual describes the spectrophotometer and how to use it. You will find everything from specifications for the instrument to routine maintenance procedures.

In addition to this manual, you also received a box of ½ inch test tubes and a ½ inch adapter with your spectrophotometer. The adapter is already installed, so the instrument is ready to use.

Conventions used in this manual

This manual includes safety precautions and other important information presented in the following format:

Note Notes contain helpful supplementary information. ▲

Notice Follow instructions labeled "Notice" to avoid damaging the system hardware or losing data. ▲

⚠ Caution Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. ▲

⚠ Warning Indicates a hazardous situation which, if not avoided, could result in death or serious injury. ▲

⚠ Danger Indicates a hazardous situation which, if not avoided, will result in death or serious injury. ▲

The following safety symbols may be used on this product:

Symbol	Description	Indication
	Black graphical symbol inside a yellow triangle with a black triangular band	This is a warning symbol. The graphic in this symbol is used to alert the user to potential hazards.
	Black graphical symbol inside a red circular band with a red diagonal bar	This is a prohibition symbol. The graphic in this symbol is used to alert the user to actions that shall not be taken or shall be stopped.
	White graphical symbol inside a blue circle	This is a mandatory action symbol. It is used to indicate that an action shall be taken to avoid a hazard.
	Black graphical symbol inside a yellow triangle with a black triangular band	This is the general warning sign. Failure to heed the safety precautions could result in personal injury.
	White graphical symbol inside a blue circle	This is the general data loss or property damage symbol and is not related to personal injury. Failure to heed these precautions can result in irreparable damage to property or permanent data loss.

Questions or concerns

In case of emergency, follow the procedures established by your facility. If you have questions or concerns about safety or need assistance with operation, repairs or replacement parts, you can contact our sales or service representative in your area or use the information at the beginning of this document to contact us.

Spectrophotometer Basics

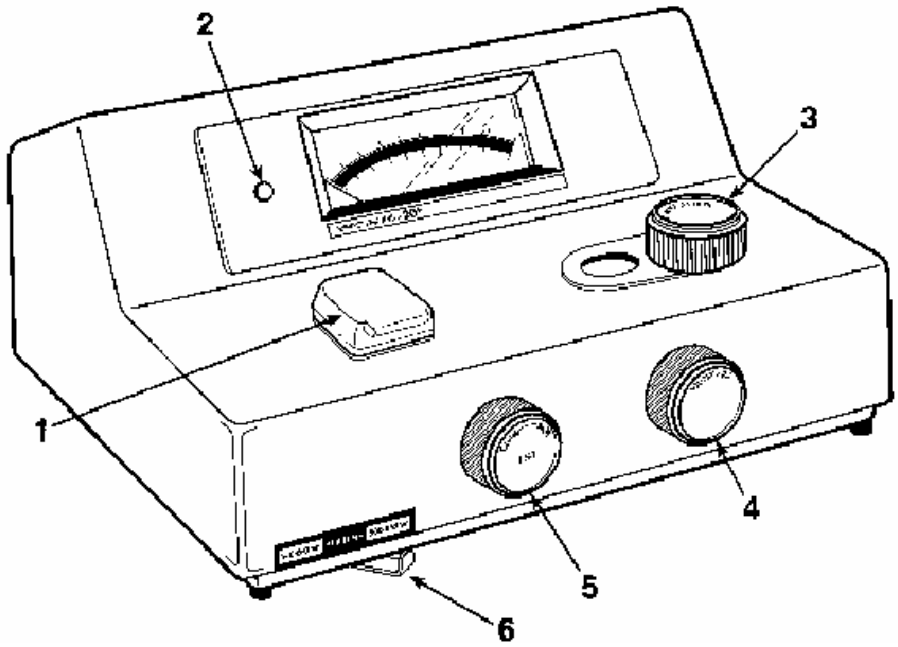
This spectrophotometer series was designed to meet the needs of a wide range of routine spectrophotometric analyses. As a basic laboratory instrument, it provides reliable and repeatable results.

The SPECTRONIC 20+ has an analog meter readout. The SPECTRONIC 20D+ has an LCD digital display. Both models have an overall wavelength range of 340 nm to 950 nm and a nominal spectral bandwidth of 20 nm (consistent over the entire wavelength range).

Spectrophotometer components

The following illustrations identify some major components visible on the outside of a typical SPECTRONIC 20 series.

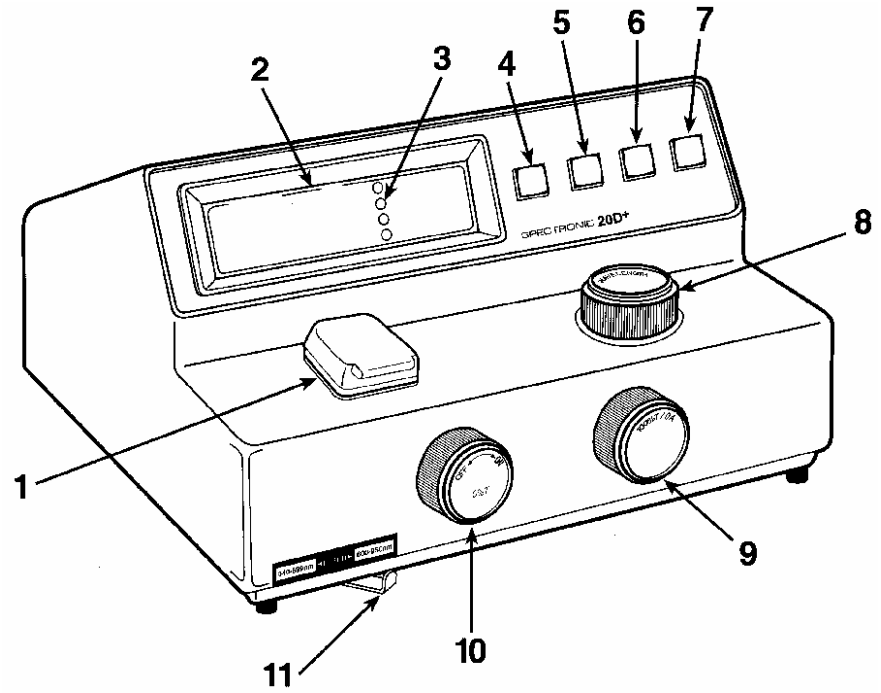
SPECTRONIC 20+



Key:

1 Sample compartment
2 Pilot lamp
3 Wavelength control
4 Transmittance/Absorbance control (100%T/0A)
5 Power switch/Zero control
6 Filter lever

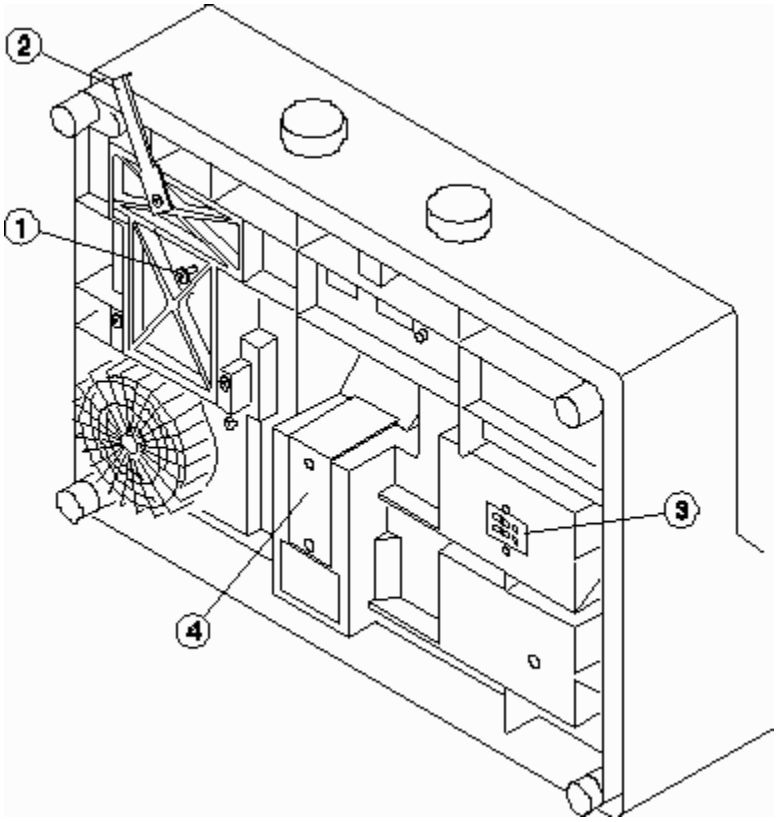
SPECTRONIC 20D+



Key:

1	Sample compartment
2	Digital readout
3	Mode indicators
4	Mode selection
5	Decrease
6	Increase
7	Print
8	Wavelength control
9	Transmittance/Absorbance control (100%T/0A)
10	Power switch/Zero control
11	Filter lever

Bottom view



Key:

1 Lamp access door with thumbscrew
2 Filter lever
3 Analog output jack/Serial I/O port
4 Line voltage switch (under this plate) [international models only]

Accessories

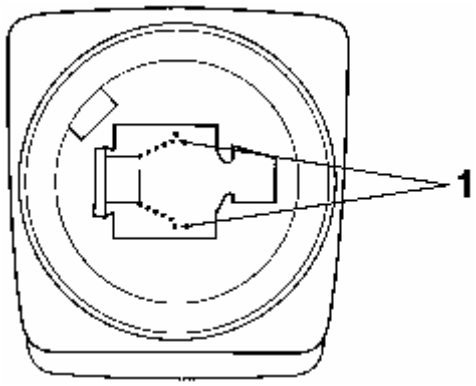
Glassware selection and sampling options.

In addition to the standard ½-in test tube and ½-in adapter supplied with the instrument, several types of glassware are available. The sample adapter must match the glassware.

To change adapters, loosen the small set screw on the inner wall of the adapter using the adapter wrench clipped to the bottom of the instrument

The design of the standard adapter provided with the instrument was changed in 1986. The current adapter accommodates a ½-in diameter test tube or a ½-in square cell. Prior to 1986, the standard adapter accommodated only the ½-in diameter test tube.

To identify the standard adapter easily, turn the adapter bottom end up and look into the barrel of the adapter. The image below illustrates the pre-1986 design which will not accommodate a ½-in square cell. This can be replaced with a current adapter to accommodate ½-in square cells.



Key:
1 Spring found in pre-1986 adapters

Operating features of SPECTRONIC 20+

The main controls for routine operation are the Power Switch/Zero control, Wavelength control, Filter lever and Transmittance/Absorbance control.

Control	Function
Power Switch/Zero control	The ON-OFF main power switch is operated by the Power Switch/Zero Control knob. The Zero Control knob is used to set the display to a 0%T readout when the sample compartment is empty and the adapter cover is closed.
Wavelength control	The Wavelength Control selects the desired analytical wavelength of the instrument. The selected wavelength is indicated on the wavelength scale in the window next to the knob. Red numbers indicate that the 600-950 nm lever position should be used. Black numbers indicate that the 340-599 nm lever position should be used. All graduations are in 5 nm intervals.
Filter lever	This control selects the filter to be used for the measurement. The proper lever position for the set wavelength is indicated on the label above the lever.
Meter	Readings are taken directly from the meter in either %transmittance or absorbance.
Transmittance/Absorbance control	This control sets the display to 100%T (0.0A) when a cell containing a blank reference solution is inserted in the sample compartment. **It must be reset whenever the analytical wavelength has been changed.** When operating at a fixed wavelength for an extended period of time, check the 100%T (0.0A) readout and readjust if necessary.

Control	Function
Analog output jack	This jack is used to connect an analog recorder to the instrument (see Bottom view above). The analog output signal level is fixed at approximately 1 VDC at 100%T. This output is not adjustable. The signals on each pin are listed below: 1 Analog output 2 Analog ground 3 Analog ground 4 Analog output

Operating features of SPECTRONIC 20D+

The main controls for routine operation are the Power Switch/Zero control, Wavelength control, Filter Lever, Transmittance/Absorbance control, the MODE selector and Factor Adjust controls.

The accessory Analog Output/Serial I/O port is located on the underside of the instrument, as shown in the Bottom view.above.

Control	Function
Power Switch/Zero control	The ON-OFF main power switch is operated by the Power Switch/Zero control knob. The Zero control knob is used to set the display to a 0%T readout when the sample compartment is empty and the adapter cover is closed.
Wavelength control	The Wavelength control selects the desired analytical wavelength of the instrument. The selected wavelength appears on the left side of the LED display. The Filter lever should be set to the proper filter for the wavelength setting.
Filter lever	This control selects the filter to be used for the measurement. The proper lever position for the set wavelength is indicated on the label above the lever.
Digital Readout	The Digital Readout displays wavelength and data readings. The four LED status indicators, next to the labels TRANSMITTANCE, ABSORBANCE, CONCENTRATION and FACTOR indicate the MODE currently active.

Control	Function
Transmittance/Absorbance control	This control sets the display to 100%T (0.0A) when a cell containing a blank reference solution is inserted in the sample compartment. **It must be reset whenever the analytical wavelength has been changed.** When operating at a fixed wavelength for an extended period of time, check the 100%T (0.0A) readout and readjust if necessary.
MODE Select	This control selects the TRANSMITTANCE, ABSORBANCE, CONCENTRATION or FACTOR mode.
Factor Adjust controls	The push-buttons labeled INCREASE and DECREASE are used in the CONCENTRATION and FACTOR modes. To set a lower CONCENTRATION or FACTOR value, press and hold down the DECREASE button until the desired value is displayed. To set a higher value, press and hold down the INCREASE button until the desired value is displayed.
Print	This push-button is used to send data to a serial printer or an external device connected to the output jack.
Analog Output/Serial I/O port	Analog output - This port is used to connect an analog recorder to the instrument. The analog output signal level is approximately 1 VDC at 100%T. This output is not adjustable. Serial port - The Serial Input/Output (I/O) Port is used to connect the instrument to the accessory printer or to an external device, enabling the instrument to accept and execute any one of six commands sent from the device in RS232C format. The signals on each pin are listed below: 1 Analog output 2 Clear to sent (CTS) 3 Ground 4 Transmit data (TXD) 5 Receive data (RXD) 6 Print

Installation and Operation

This chapter provides important information about using your instrument to analyze samples.

Setup and Installation

⚠ Caution If the equipment is not used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲

1. **Select the appropriate glassware and adapters.**

   For more information about glassware, adapters and cell holders, refer to the Accessories section.

If you are connecting the instrument to an accessory printer, computer or chart recorder, refer to the following table for information about cabling requirements.

Device	20+	20D+
Analog recorder	Patch cord	Patch cord
Accessory printer	Not available	Serial interface cable kit
PC	Not available	Serial interface cable kit

2. **Plug the power cord into a grounded outlet with the appropriate voltage.**

3. **Turn the Power Switch/Zero Control clockwise and allow the instrument to warm up for at least 15 minutes.**

Technique

Successful use of your spectrophotometer depends on the consistent use of correct laboratory procedures and analytical techniques. To minimize problems, follow these simple rules:

- Keep all solutions free of bubbles.
- Make sure that all sample holders are at least half full.
- Use the same cell for both sample and blank measurements.
- Use square cells with holder for greater accuracy.
- Make sure that the mark (fiducial line) on the test tube aligns with the mark on the adapter toward the front of the instrument.
- During extended operation at a fixed wavelength, check from time to time for 100%T drift. Possible causes of drift are listed in the Troubleshooting section.
- Use clean test tubes and do not touch the test tubes below the fiducial line.

Sample measurements

Once your instrument has been set up properly and has warmed up for at least 15 minutes, you can begin taking measurements.

SPECTRONIC 20+

Note To read the meter properly, align the needle with its reflection in the mirror. ▲

Note It is important to insert the blank and reset the meter to 100%T every time the wavelength is changed. ▲

1. **After the warmup period, set the desired wavelength with the Wavelength Control Knob.**
2. **Set the filter lever to the appropriate position for the selected wavelength.**

3. **Adjust the meter to 0%T with the Power Switch/Zero Control (knob on the front left side of instrument).**

   Make sure the sample compartment is empty and the cover is closed.

4. **Fill a clean cell with water (or blank solution) and wipe the cell with a tissue to remove liquid droplets, dust and fingerprints.**

5. **Place the cell in the sample compartment and align the guide mark on the cell with the guide mark at the front of the sample compartment.**

6. **Press the cell firmly into the sample compartment and close the lid.**

7. **Adjust the meter to 100%T with the Transmittance/Absorbance Control (knob on the front right side of instrument).**

8. **Remove the cell from the sample compartment and empty the water.**

9. **Rinse the cell twice with small volumes of the solution to be measured and fill it with the solution.**

10. **Wipe the cell with a tissue and insert the cell into the sample compartment.**

11. **Align the guide marks and close the lid.**

12. **Read the appropriate value (%T or A) from the meter.**

13. **Remove the cell from the sample compartment and repeat steps 10 through 13 for any remaining sample solutions.**

14. **When all measurements are completed, turn off the spectrophotometer by turning the Power Switch/Zero Control counterclockwise until it clicks.**

Note A flashing display indicates that the reading is out of range and the 100%T/0A control must be adjusted. This adjustment controls an optical occluder which regulates the amount of light passing through the sample.

In %T mode:

A reading of greater than 200%T will cause the display to flash.

- If the flashing reading is -1999, turn the 100%T/0A control clockwise until the display operates normally.
- If the flashing reading is +1999, turn the 100%T/0A control counterclockwise until the display operates normally.

In absorbance mode:

A reading of greater than 2A will cause the display to flash.

- If the flashing reading is -1999, turn the 100%T/0A control counterclockwise until the display operates normally.
- If the flashing reading is +1999, turn the 100%T/0A control clockwise until the display operates normally.

It may require several complete turns of the 100%T control to return to the proper range. ▲

Note Change in wavelength – it is important to insert the blank and reset the display to 100%T or 0.0A every time the wavelength is changed. ▲

Transmittance and Absorbance

1. **Turn on the instrument by turning the Power Switch (knob on the left side of instrument) clockwise.**

   Allow the spectrophotometer to warm up for at least 15 minutes to stabilize.

2. **After the warmup period, set the desired wavelength with the Wavelength Control knob.**

3. **Set the filter lever to the appropriate position for the selected wavelength.**

4. **Adjust the display to 0%T with the Zero Control (knob on the front left side of the instrument).**

   Make sure that the sample compartment is empty and the cover is closed.

5. **Set the display mode to TRANSMITTANCE or ABSORBANCE by pressing the MODE control key until the appropriate LED is lit.**

6. **Fill a clean cell with water (or another blank solution) and wipe the cell with a tissue to remove liquid droplets, dust and fingerprints.**

7. **Place the cell in the sample compartment and align the guide mark on the cell with the guide mark at the front of the sample compartment.**

8. **Press the cell firmly into the sample compartment and close the lid.**

9. **Adjust the display to 100%T or 0.0A with the Transmittance/Absorbance Control (knob on the right side of instrument).**

10. **Remove the cell from the sample compartment and empty the water.**

11. **Rinse the cell twice with small volumes of the solution to be measured and fill it with the solution.**

12. **Wipe the cell with a tissue and insert the cell into the sample compartment.**

13. **Align the guide marks and close the lid.**

14. **Read the appropriate value (%T or A) from the display.**

15. **Remove the cell from the sample compartment and repeat steps 11 through 14 for any remaining sample solutions.**

16. **When all measurements are completed, turn off the spectrophotometer by turning the Power Switch counterclockwise until it clicks.**

Concentration measurements using CONCENTRATION mode

1. **Follow steps 1 through 9 of the Transmittance and Absorbance procedure (using the Absorbance mode).**
2. **Rinse the cell twice with small volumes of the standard solution of known concentration and fill the cell with the solution.**
3. **Wipe the cell with a tissue and insert the cell in the sample compartment.**
4. **Align the guide marks and close the lid.**
5. **Press the MODE control key until the LED beside "concentration" is lit.**
6. **Press the INCREASE or DECREASE key until the displayed value matches the concentration of the standard solution.**

Note Limits are 0 to 1999. ▲

7. **To determine the factor, press the MODE control key until the LED beside the "Factor" is lit. Read and record the factor value.**
8. **Press the MODE control key until the LED beside "Concentration" is lit.**
9. **Remove the standard solution and rinse and fill the cell with the sample solution of unknown concentration.**
10. **Wipe the cell with a tissue and insert the cell in the sample compartment.**
11. **Read the concentration of the sample directly from the display.**
12. **Remove the cell from the sample compartment and repeat steps 9 through 11 for each of the samples.**
13. **When all measurements are completed, turn off the spectrophotometer by turning the Power Switch counterclockwise until it clicks.**

Concentration measurements using FACTOR mode

Note Refer to Choosing a Readout Mode section for more information about the FACTOR mode. ▲

1. **Determine the factor value by following steps 1 through 4 of the procedure for CONCENTRATION mode above.**
2. **Press the MODE control key until the LED beside "factor" is lit.**
3. **Press the INCREASE or DECREASE key until the desired factor is displayed (a value between 0.100 and 1000).**
4. **Press the MODE control key to select the CONCENTRATION mode.**
5. **Rinse and fill the cell with the sample solution of unknown concentration.**
6. **Wipe the cell with a tissue and insert the cell in the sample compartment.**
7. **Read the concentration of the sample directly from the display.**
8. **Remove the cell from the sample compartment and repeat steps 5 through 7 for each of the samples.**
9. **When all measurements are completed, turn off the spectrophotometer by turning the Power Switch counterclockwise until it clicks.**

Printing

Note For SPECTRONIC 20D+ only. ▲

Normally, the spectrophotometer is in the print mode when it is first turned on and operates at a rate of 1200 baud. A range of other transmission rates, from 110 to 9600 baud, may also be accommodated (see Baud rate settings section).

1. **Set the baud rate on the Accessory Printer to 1200.**
2. **Push the PRINT key for a printout.**

Command set

An external device may send the commands listed in the following table.

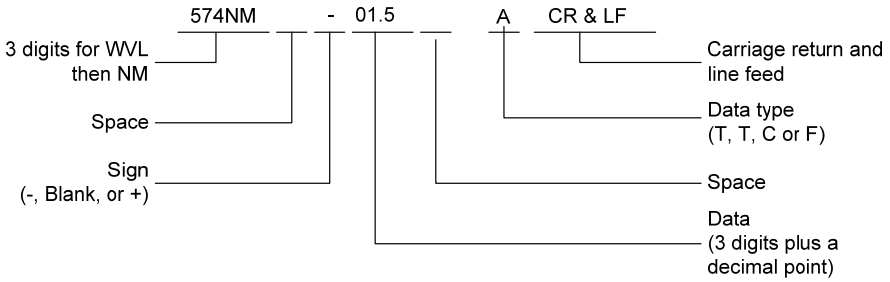
Convention	Function
Word length	8 data bits, 1 stop bit; most significant bit set to 0
Parity	None
Echo	None
Terminators	Ignores all carriage return or line feed characters sent by external device (except for CR in Auto Baud Rate mode). Transmits ASCII CR/LF after every data line.

The following table lists conventions for serial I/O data:

Command	Function
P	Print
A	Set the data mode to absorbance
T	Set the data mode to transmittance
C	Set the data mode to concentration
F	Set the data mode to factor
Control X	Reset the spectrophotometer to initial power-up condition
E (or an ASCII carriage return, CR)	Set the spectrophotometer's baud rate to the rate used by a computer connected to the serial output port

Data format

Data from the instrument to a printer or other remote device is sent as shown in the following example:



Baud rate settings

Data is sent to the printer (or received from an external device) at a rate of 1200 baud if the instrument is turned on with the PRINT line "high" (at logic 1, greater than 2.0 VDC). Other baud rates may be selected when the spectrophotometer is connected to a computer. These rates include 110, 300, 1200, 2400, 4800 and 9600 baud.

If the spectrophotometer is turned on with the PRINT line "low" (logic 0, less than 0.8 VDC), it adjusts to the computer's baud rate upon receipt of either the letter "E" or a carriage return (CR) character from the computer.

Note The PRINT line is normally “high.” The PRINT line can be set “low” by pressing the PRINT button. ▲

Choosing a Readout Mode

Transmittance mode

All SPECTRONIC 20+ series spectrophotometers measure the relative amount of light transmitted, yielding results in transmittance. The transmittance mode is useful for calibration, stray radiant energy tests and filter studies. Furthermore, very low concentrations may be measured with greater sensitivity in the transmittance mode. When the transmittance mode is used, the reagent blank sets 100%T, and the results for standard solutions and unknown samples are obtained as percent transmittance.

A standard curve may be constructed on semi-logarithmic paper by plotting the percent transmittance on the logarithmic axis vs. the concentration of known standard solutions on the linear axis. The best line is drawn through these points. The concentration of unknown samples may then be determined by locating the concentration value which corresponds to the percent transmittance of the unknown on the standard curves.

Absorbance mode

Usually, the operator desires results in absorbance for direct correlation of concentration by Beer's law: A=abc. Results in percent transmittance may be converted to absorbance values by use of transmittance-absorbance conversion tables or by the formula $A=-\log_{10}T$. Results in absorbance may be plotted against the concentration of known standards on rectilinear graph paper. The best line is drawn through these points to construct a standard curve.

The concentration of unknowns may then be determined by locating on the standard curve the concentration value which corresponds to the absorbance of the unknown.

To eliminate %T to A calculations, each model of the instrument provides conversion of transmittance to absorbance:

- The SPECTRONIC 20+ has an absorbance scale marked with values corresponding to percent transmittance. The operator may simply read the absorbance scale and use these values to construct a standard curve as described above.

- The SPECTRONIC 20D+ offers precise electronic conversion of transmittance to absorbance. When the absorbance mode is used, the reference blank sets 0.000A, and the results for standards and unknowns are obtained in absorbance. Results in absorbance may be related to concentration by Beer's law, A=abc, if the absorptivity and pathlength are known, or by constructions of a standard curve as described above.

Absorbance measurements are useful for kinetics studies and for reaction systems which do not obey Beer's law and therefore have non-linear standard plots.

Concentration Mode

The SPECTRONIC 20D+ provides a more convenient readout, the concentration mode, which eliminates the necessity for constructing a standard curve. The instrument electronically converts results in absorbance to concentration units by multiplying the absorbance value by the factor which is the inverse of the slope of the standard curve (factor = 1/ab).

Note that the concentration mode can be used only if the linearity of the standard curve has been verified for the test conditions used. These test conditions include wavelength, concentration range of interest, cell pathlength and analytical procedure. Furthermore, the concentration mode may be used only if the standard curve has a positive slope; i.e., absorbance increases with concentration.

When using entered standard solutions, the 1/ab factor is used to convert absorbance to concentration, according to the equation

$$C = f * A$$

The Concentration Measurements using FACTOR mode describes how to use the factor mode.

Note It is not actually necessary to know the 1/ab factor because this factor is introduced into the instrument when the concentration adjust control is used to set the digital display to read the concentration of the standard. ▲

Concentration-Factor-Check feature

To verify that operating conditions do not vary between reagent batches or from day to day, use the concentration-factor-check features as follows: After the concentration mode has been set up with standard solutions, press the MODE select control until the FACTOR LED lights, and read and record the factor given on the digital display. Every time new standard solutions are used for the same test (such as for a new reagent batch or when setting up the instrument), press the MODE select control until the FACTOR LED lights, and note the factor on the digital display.

A change in the factor indicates a change in the slope of the standard curve due to variation in operating conditions. It is recommended that a standard always be used to set the concentration mode. The operator may choose, however, to set the blank to 000A, then switch to the concentration mode.

Maintenance

The information given in this section deals only with those parts of maintenance or service that can be safely carried out by the user. Work other than that detailed should be carried out by our trained service engineer.

Cleaning instrument exterior

The exterior and sample compartment of the instrument can be cleaned periodically as follows:

⚠ Caution Do not allow moisture to leak into the instrument. ▲

1. **Switch off the spectrophotometer and disconnect from AC power source.**
2. **Using a lint free cloth dampened with a weak solution of detergent and water, wipe the exterior surface of the instrument as necessary.**
3. **Wipe over with a cloth dampened with plain water.**
4. **Dry the surface with another cloth.**

Lamp Replacement

Because of the functional design and reliability of the SPECTRONIC 20+ and SPECTRONIC 20D+ spectrophotometers, routine customer maintenance has been reduced to replacement of the 6.0-volt, 3.00-amperes source lamp

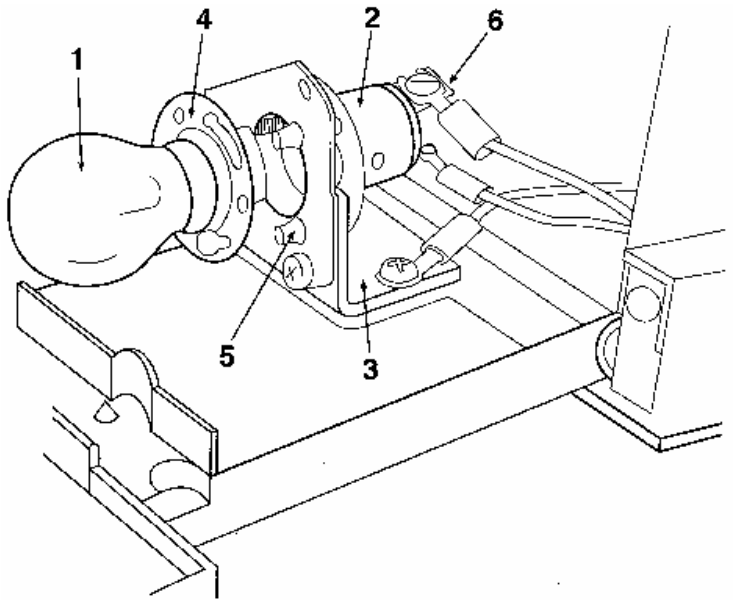
Note The source lamp has a nominal life of 250 hours. ▲

The user may also perform routine checks for wavelength calibration and photometric accuracy.

The lamp gets very hot during operation. Before removing the lamp, turn off the instrument and allow the lamp to cool down for 10 minutes.

Turn off and unplug the instrument before removing the lamp door.

1. **Turn off and unplug the instrument.**
2. **Tilt up the unit and set it on its back.**
3. **Loosen the thumbscrew on the lamp access door and open the door (see the Bottom view).**
4. **Using finger pressure, press the lamp flange toward the mounting bracket.**



Key:
1 Lamp
2 Lamp socket
3 Mounting bracket
4 Lamp flange
5 Locating pins
6 Terminals

⚠ Warning Do not touch the lamp with your fingers. ▲

5. **Push the lamp toward the lamp socket and rotate counterclockwise to remove it.**

   To avoid getting skin oils on the surface of the lamp, use a dry clean cloth to grip the lamp.

6. **Install a new lamp by properly aligning the large openings in the lamp flange with the locating pins.**

7. **Press the lamp and the lamp socket toward each other and rotate the lamp clockwise until secure.**

8. **Clean the lamp of fingerprints and oils, close the door and tighten securely. This is essential for proper operation.**

Note Do not push on the lamp socket terminals. This will inhibit the installation of a new lamp. ▲

Cleaning the sample compartment

Turn off and unplug the instrument before cleaning the sample compartment.

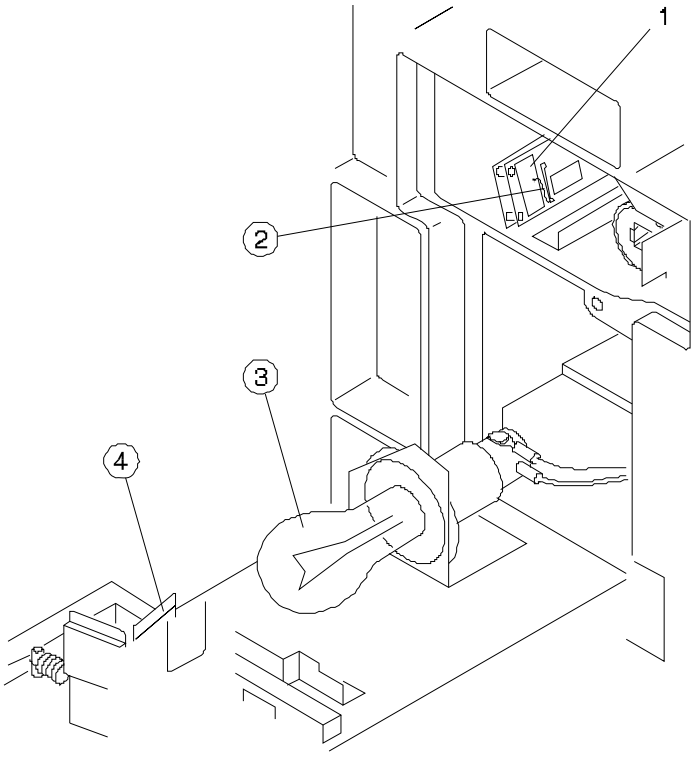
In the event a test tube breaks in the sample compartment, it is important to remove the glass and any spilled liquid as soon as possible.

1. **Turn off and unplug the instrument.**

⚠ Warning Use protective equipment (safety goggles, gloves, lab coat, etc.). ▲

2. **Using tweezers, remove broken pieces of glass from the sample compartment.**
3. **While supporting the instrument, move it to the edge of the lab bench so that the lamp access door may be opened.**
4. **Loosen the lamp access door thumbscrew and carefully open the door.**

   Spilled fluid may be present inside. Make sure to clean up all liquid that was spilled.
5. **Reach inside the lamp compartment and remove any remaining glass.**
6. **Tip the instrument back on the lab bench and clean the sample compartment with an appropriate cleaning solvent.**
7. **Visually inspect the lamp, photodiode, and filters to determine if any liquid has spilled on them.**



Key:
1 Photodiode
2 Connection wire
3 Lamp
4 Filter

8. **Remove any liquid spilled on the lamp, filter or photodiode surfaces:**

   Lamp and filter surfaces: Clean with a soft cloth or the softest area of a cotton swab and glass cleaner

   Photodiode: The photodiode is easily damaged; therefore, cleaning should be performed by our service organization. Clean the photodiode only if liquid is spilled on it. Use very light pressure with the softest area of a cotton swab dipped in high-grade isopropyl alcohol. Do not touch the wire connected to the detector.

9. **Close the door and tighten the thumbscrew.**

10. **Check the calibration of the instrument using the procedures below or call technical support, if necessary.**

Wavelength calibration check

Under normal operating conditions, the SPECTRONIC 20+ and SPECTRONIC 20D+ spectrophotometers should retain their wavelength accuracy indefinitely. If the instrument is subjected to a severe shock or other abuse, wavelength performance may be checked by one of three methods:

1. Cobalt solution check.
2. Didymium filter from the accessory filter kit.
3. Wavelength Accuracy Test from SPECTRONIC Standards.

An explanation of the cobalt solution check follows. Instructions on use of the didymium filter and SPECTRONIC Standards are found in the user's manual for each accessory.

Cobalt solution check

To prepare a stock cobalt solution:

1. **In a 1-liter volumetric flask, place 200 ml distilled water.**
2. **Slowly and cautiously add 10mL concentrated hydrochloric acid (ACS grade).**
3. **Mix and make to volume with distilled water to obtain 1% hydrochloric acid solution.**
4. **In a 1-liter volumetric flask, place 22 to 23 gm cobalt chloride (CoCl2, ACS grade).**
5. **Dissolve in the 1% hydrochloric acid.**
6. **Dilute to volume with 1% hydrochloric acid to obtain cobalt chloride stock solution.**

To perform the cobalt solution check:

1. **Turn on the Power Switch/Zero Control and allow the instrument to warm up for at least 15 minutes.**

2. **If you have a SPECTRONIC 20D+, set the display mode to Transmittance.**

3. **With the sample compartment empty and the cover closed, adjust the Power Switch/Zero Control until the meter or display reads 0%T.**

4. **Set the Wavelength Control to 500 nm.**

5. **Set the Filter Lever to 340 – 599 nm.**

6. **Insert the glassware filled with distilled water into the sample compartment and use the Transmittance/Absorbance Control to set the meter or display to 100%T.**

7. **Replace the distilled water with the cobalt chloride solution.**

8. **Insert the glassware filled with the cobalt chloride solution into the sample compartment.**

9. **Read %T on the meter or display.**

10. **Repeat steps 4 through 9 at 505, 510, 515 and 520 nm.**

    The instrument is in proper calibration when minimum transmittance (maximum absorbance) occurs between 505 and 515 nm. The specific transmittance (or absorbance) values are unimportant.

Wavelength calibration adjustment

If the wavelength accuracy is out of tolerance, refer to the Service Procedure section. Customer recalibration is not recommended.

Photometric linearity check

If the photometric linearity of the instrument is questionable, first check your analytical procedure and technique (see the Technique section above).

If proper operation is still in doubt, use the Photometric Accuracy/Linearity Test from SPECTRONIC Standards to test and evaluate photometric performance of your instrument.

The alternate method below uses specially prepared potassium dichromate solutions.

1. **Turn on the Power Switch/Zero Control and allow the instrument to warm up for at least 15 minutes.**

2. **Make sure that the sample compartment is empty and the cover is closed, then adjust the Power Switch/Zero Control until the display reads 0%T.**

3. **If you have a SPECTRONIC 20D+, set the display mode to Absorbance.**

4. **Prepare 0.01N sulfuric acid diluent by adding 0.3 ml of concentrated sulfuric acid to about 500 ml of deionized or distilled water in a clean 1 liter volumetric flask.**

5. **Fill to volume with deionized or distilled water.**

6. **Prepare a stock solution of potassium dichromate by weighing 0.500 g of potassium dichromate (e.g., Fisher Certified A.C.S. potassium dichromate, formula weight 294.19) and dissolving it in about 400 ml of 0.01N sulfuric acid solution in a 500 ml volumetric flask.**

7. **Fill to volume with 0.01N sulfuric acid solution.**

   This is your stock 1.0g/l potassium dichromate solution.

8. **Measure 2.5 ml of the stock 1.0g/l potassium dichromate solution into a clean 100 ml volumetric flask containing about 75 ml 0.01N sulfuric acid solution.**

9. **Fill to volume with 0.01N sulfuric acid solution.**

   This is your 0.025g/l potassium dichromate solution.

10. **Measure 5.0 ml of the stock 1.0 g/l potassium dichromate solution into a clean 100 ml volumetric flask containing about 75 ml 0.01N sulfuric acid solution.**

11. **Fill to volume with 0.01N sulfuric acid solution.**

    This is your 0.05 g/l potassium dichromate solution.

12. **Set the Wavelength Control to 350 nm. Set Filter Lever to 340 - 950 nm.**

13. **Fill a 10 mm pathlength rectangular cell with 0.01N sulfuric acid solution and place it in the sample compartment.**

14. **Set the readout of the instrument to 0A.**

15. **Fill the 10 mm pathlength rectangular cell with 0.025 g/l potassium dichromate solution, place it in the sample compartment and read the absorbance.**

    You should expect to read 0.248A.

16. **Fill the 10 mm pathlength rectangular cell with 0.05 g/l potassium dichromate solution, place it in the sample compartment and read the absorbance.**

    You should expect to read 0.496A.

Note Values should be within 0.02A of the expected absorbance values, if the solutions have been prepared carefully. ▲

Service procedure

If the instrument develops a malfunction that cannot be corrected by operator maintenance, it may be serviced by your local sales or service organization.

- If you are in the U.S.A., contact technical support whether the instrument is still under warranty or is past the warranty period.
- If you are outside the U.S.A., contact the distributor from whom you purchased the instrument whether the instrument is still under warranty or is past the warranty period.

If it is necessary to ship the instrument:

1. **Wrap the spectrophotometer in plastic and then pack carefully in a crush-resistant carton with at least three inches of shock absorbing material to prevent transit damage.**
2. **Include a detailed letter inside the shipping carton, fastened to the instrument, describing the trouble.**

   Please include the name and phone number of the person or department head most familiar with the problem.

   This information enables service personnel to make required repairs promptly and at least expense.
3. **In the United States, mark on the shipping container:**

   FIRST CLASS LETTER ENCLOSED

   First class postage is required only on the letter. The carton is accepted at standard mail rates.

Troubleshooting

The following table outlines some diagnostic techniques that may help you isolate the cause of a problem.

Problem	Possible Cause	Possible Solution
Instrument does not function.	Power line cord not connected to outlet.	Plug in the power line cord.
	Dead power outlet.	Try a different power outlet.
	Internal fuse blown.	Refer to service manual or service center.
	Defective electronic component.	Refer to service manual or service center.
Meter/Display does not zero.	Sample compartment cover not closed.	Close cover.
	Lamp access door not tightly closed.	Close door and retighten thumbscrew.
	Phototube defective.	Replace as required.
	Defective electronic component	Refer to service manual or service center.
Readings are drifting or incorrect.	Poor sampling technique.	Eliminate bubbles or particles in solution. Set 100%T on appropriate blank solution.
	Filter selection lever is in wrong position.	Set filter lever to proper position.
	Fumes from sample.	Remove sample immediately after analysis.
	Excessive line voltage variation.	Check voltage and grounding.
	Wrong line voltage setting (international models only).	Reset line Voltage Selection Switch.
	Source lamp defective.	Replace with new lamp.
	Phototube defective.	Replace as required.
	Defective electronic component.	Refer to service manual or service center.

Problem	Possible Cause	Possible Solution
Cannot set 100%T (0.0A), or display flashes.	100%T not properly set.	Set 100%T with blank solution in the sample compartment and cover closed. Several turns of the 100%T control may be necessary.
	Filter selection lever in wrong position.	Set filter lever to proper position.
	0%T not properly set (all models except SPECTRONIC 20D+)	Set 0%T with the sample compartment empty and the cover closed.
	Occluder closed	Install test tube in sample compartment.
	Sample holder not fully inserted into adapter.	Insert fully.
	Source lamp weak or burned out.	Replace with new lamp.
	Wrong line voltage setting (international models only).	Reset Line Voltage Selection Switch.
	Phototube weak	Replace as required.
	Error in wavelength calibration.	Check calibration.
	Defective electronic component.	Refer to service manual or service center.
Readings are not repeatable even though the 0%T and 100%T readings are set correctly.	Loose lamp.	Tighten thumbscrew on lamp access door.
	Loose sample holder adapter.	Tighten set screw inside adapter.
	Poor analytical technique.	Clean or replace dirty test tubes; remove bubbles, etc. See Technique section.
	Test tube position not repeating.	Always position fiducial line in exactly the same place when test tube is inserted into adapter. Use square cuvettes.

Optical Diagram