# MILTON ROY

# SPECTRONIC®
# 501 & 601
## SPECTROPHOTOMETERS

## OPERATOR'S INSTRUCTIONS

◆ **MILTON ROY**

# SPECTRONIC®
# 501 & 601
## SPECTROPHOTOMETERS



# OPERATOR'S INSTRUCTIONS

## WARM-UP/PRE-OPERATIONAL SEQUENCE

a. Plug power cord into appropriate power source

b. Turn on spectrophotometer (move back panel toggle switch to the right).

c. The message "SELF TEST" will appear on the 501/601's display while the instrument performs a pre-operation self-check.

d. Approximately twenty seconds after you switch the power on, "SELF-TEST" will be replaced by the message "GOING TO XXX NM" (XXX = pre-programmed wavelength value), and then by wavelength and data values.

NOTE

For effective operation, the spectrophotometer must warm up for one-half hour after being turned on. Allow an additional 15 minutes for stabilization when you turn a lamp on or off.

Allow an additional 5 minutes for stabilization when switching the LAMP SAVE function for the tungsten lamp on or off.

NOTE

Check the voltage label plate on the spectrophotometer's back panel to determine what voltage (100, 115, 220, or 240) has been set before you plug your SPECTRONIC 501 or 601 in. If the voltage shown on the label plate is not the same as the voltage of your power source, do not plug the instrument in—call your authorized Bausch & Lomb Sales/Service representative to arrange for a voltage conversion.
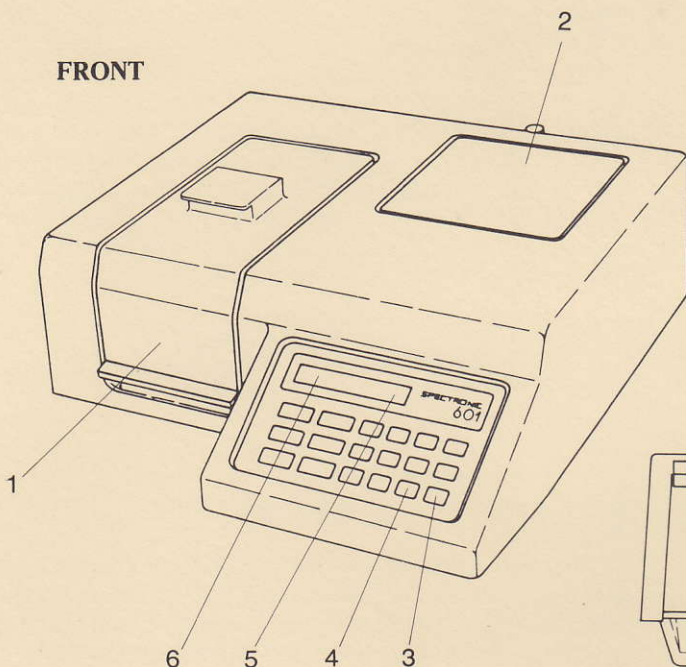
**FRONT**
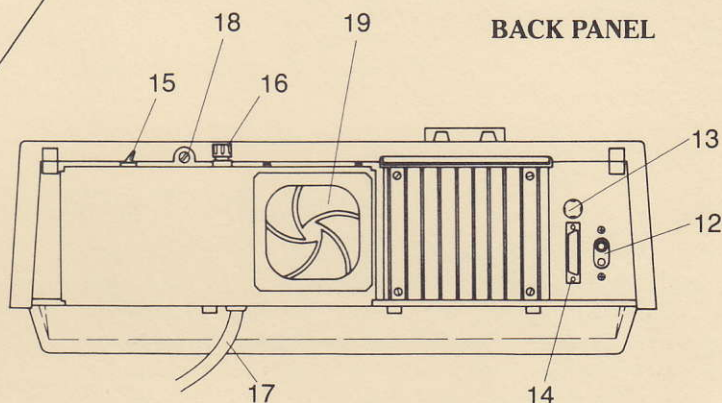


**BACK PANEL**
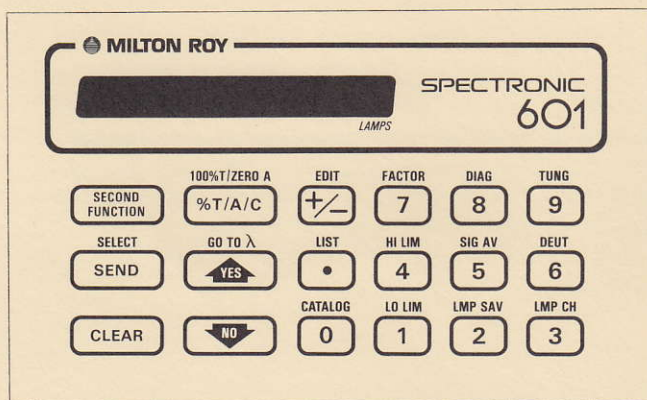


**KEYBOARD**



**SAMPLE COMPARTMENT**

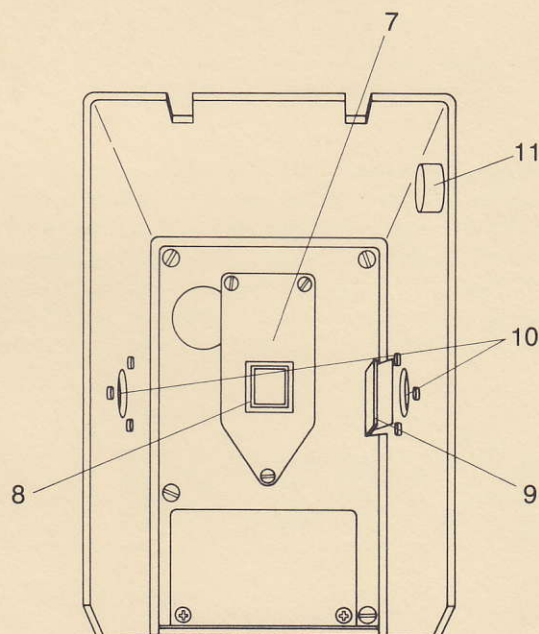# SUMMARY OF KEYBOARD FUNCTIONS

**[SECOND FUNCTION]** Activate a key's second function.

**[SELECT/SEND]** Send data to optional RS-232 interface, for printer, Accessory Control Module, or remote computer.

**[CLEAR]** Delete erroneous data entry.

**[%T/A/C]** Set Transmittance, Absorbance, or Concentration data mode.

**[SECOND FUNCTION] [100%T/ZERO A / %T/A/C]** Set transmittance data to 100% or ABS data to 0.0A.

**[GO TO λ / YES]** Move monochromator up in wavelength.

**[NO]** Move monochromator down in wavelength.

### NOTE
The <YES> and <NO> keys function as "accept" or "reject" keys only when the spectrophotometer is used in conjunction with an APPLIPAK cartridge and the Accessory Control Module (or certain diagnostics).

**[SECOND FUNCTION] [GO TO λ / YES]** Cause monochromator to go to entered wavelength.

**[LIST/• ] [EDIT/+⁄−] [CATALOG/0] [TUNG/9]** Numeric entry keys.

**[SECOND FUNCTION] [EDIT/+⁄−]** Edit current test parameters.

**[SECOND FUNCTION] [LIST/•]** List current test parameters on display (or printer).

**[SECOND FUNCTION] [CATALOG/0]** Catalog list of stored tests on display (or printer).

**[SECOND FUNCTION] [SELECT/SEND]** Choose a stored test from those included in catalog.

### NOTE
<SECOND FUNCTION> <EDIT> ... <LIST> ... <CATALOG> ... <SELECT> are active only when the Accessory Control Module is installed and turned on.

**[SECOND FUNCTION] [LO LIM/1]** Display or set lower limit. If data falls below this limit, "out-of-range" flag (an asterisk "*") will appear on the display.

**[SECOND FUNCTION] [LMP SAV/2]** Displays or sets tungsten lamp save (on/off).

**[SECOND FUNCTION] [LMP CH/3]** Display or set lamp interchange wavelength (SPECTRONIC 601 only).

**[SECOND FUNCTION] [HI LIM/4]** Display or set upper limit. If data exceeds limit, an "out-of-range" flag (an asterisk "*") will appear on the display.

**[SECOND FUNCTION] [SIG AV/5]** Display or set signal averaging function.

**[SECOND FUNCTION] [DEUT/6]** Turn Deuterium Lamp on or off (601 only).

**[SECOND FUNCTION] [FACTOR/7]** Display or set concentration factor.

**[SECOND FUNCTION] [DIAG/8]** Access diagnostic tests.

**[SECOND FUNCTION] [TUNG/9]** Turn Tungsten-Halogen Lamp on or off (601 only).

This manual presents basic information on the use of the SPECTRONIC 501/601 spectrophotometer. Terms contained with < > are names of keys found in the keyboard or appropriate alphanumeric key entries.

## LIMITED WARRANTY

SPECTRONIC instrumentation and related accessories are warrantied against defects in materials and workmanship for a period of (1) year from the date of delivery. This warranty is provided only if the warranty registration card is returned to Milton Roy within fifteen (15) days after delivery.

This warranty covers all parts except those specified below and applies only to equipment which has been installed and operated in accordance with the operator's instruction manual and which has been serviced only by authorized Milton Roy dealers or service personnel. This warranty does not apply to equipment and accessories that have been damaged by accident, neglect or conditions beyond Milton Roy's control.

This warranty does not apply to lamps, glassware and similar expendable components. However, such parts and components may be warranted by their manufacturer.

Milton Roy is not responsible under this warranty for loss in operating performance due to environmental conditions.

THIS WARRANTY IS IN LIEU OF ALL WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, INCLUDING, BUT NOT LIMITED TO WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR OF MERCHANTABILITY OR OTHERWISE, and states Milton Roy's entire and exclusive liability and the Customer's exclusive remedy for any claim in connection with the sale or furnishing of services, goods or parts, their design, suitability for use, installation, or operations. The Milton Roy Company will in no event be liable for any direct, indirect, special or consequential damages whatsoever, including loss of goodwill, whether grounded in tort (including negligence), strict liability or contract, and Milton Roy's liability under no circumstances will exceed the contract price for the goods and/or services for which liability is claimed.

## FCC COMPLIANCE STATEMENT FOR U.S.A. USERS

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits in effect at the time of manufacture for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

## NOTE

This operator's instruction manual contains information, instructions and specifications that were believed accurate at the time this manual was written. However, as part of our on-going program of product development, the specifications and operating instructions may be modified or changed from time-to-time. The Milton Roy Company reserves the right to change such operating instructions and specifications. Under no circumstances shall Milton Roy be obligated to notify purchasers of any future changes in either this operator's instructions manual or any other instructions or specifications relating to the SPECTRONIC 501/601 and their accessories nor shall Milton Roy be liable in any way for its failure to notify purchasers of such changes.

# CONTENTS

# SECTION 1. OPERATOR FEATURES

## FRONT

1. Sample Compartment Door.
2. Maintenance/Lamp Access Door provides access for lamp replacement and alignment.
3. Sealed Keyboard controls instrument functions and enters parameter data. Tactile and audible response indicates data entry.
4. Lamp Save allows you to use the tungsten lamp at lower illumination level (to extend lamp life).
5. Lamp Indicator shows "T" when Tungsten-Halogen lamp is on; "D" when deuterium lamp is on; and "B" when both lamps are on.
6. 16-character Alphanumeric Display shows parameters and data values, as well as operating and error messages.

## SAMPLE COMPARTMENT

7. Cell Holder Base is removable for installation of accessory sample holders, e.g., multipurpose cell holder, ambient flowcell, thermoelectric flowcell and automatic cell positioner.
8. 10mm pathlength Cuvette Holder is removable for installation of accessory cell holders, e.g., thermal cell holders, test-tube holder, and long pathlength cell holder.
9. Filter Holder holds filters up to 7mm thick.
10. Sample Compartment Windows.
11. Capped hole available for installation of accessory plug connector.

## BACK PANEL

12. Optional Recorder Interface connector.
13. Sample compartment accessory connector.
14. RS232 Interface connector—used for computer interface, printer, and accessory control box.
15. Power Switch.
16. Line fuse
17. Power cord
18. Maintenance/Lamp cover access screw
19. Exhaust fan

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# SECTION 2. INSTALLATION

## 2.1 CONTENTS CHECK

After carefully unpacking the contents, check the materials against the packing list to ensure that you have received everything in good condition.

If any part is missing or damaged, or you find any other defect, please contact your dealer or Milton Roy sales representative.

## 2.2 OPERATIONAL CHECK

a. Set the unit on a clean lab bench or work area.

NOTE

Take care to allow enough clearance behind the spectrophotometer for efficient operation of the exhaust fan.

b. Check the voltage label plate on the spectrophotometer's back panel to determine what voltage (100, 120, 220, or 240) has been set before you plug your SPECTRONIC 501 or 601 in. If the voltage shown on the label plate is not the same as the voltage of your power source, do not plug the instrument in—call your authorized Milton Roy Sales/Service representative to arrange for a voltage conversion.

c. If the power outlet is satisfactory, plug in the spectrophotometer's power cord.

d. Turn power switch on.

e. Check to make sure that the "Power-On Sequence" operates properly ("SELF-TEST" message, followed by "GOING TO ___ NM", and then by the normal data display).

f. Allow thirty minutes for warm-up.

g. Check lamp alignment by performing the Lamp Alignment Diagnostic (Section 6.6).

# SECTION 3. KEYBOARD FUNCTIONS

3.1 <SECOND FUNCTION> activates a key's second function. The function, or its abbreviation, is printed just above the individual key.

3.2 <SEND> transmits data to the optional serial port accessory. (For a more detailed description, refer to Sections 7 through 10 of this manual.) If the optional printer, or an external computer, is connected to the RS-232C output on the rear panel of the instrument:
- Press <SEND>. The data on the display will be transmitted to the computer or printer.

3.3 <SECOND FUNCTION> <SELECT> allows you to load a stored test (requires the Accessory Control Module and an APPLIPAK cartridge).

3.4 <CLEAR> restores a normal data display and is used to exit several diagnostic tests.

3.5 <%T/A/C>:
a. Changes the data mode:
- Press <%T/A/C> to switch from Absorbance to Transmittance mode.
- Press <%T/A/C> again to enter the Concentration mode.
- Press <%T/A/C> to return to the Absorbance mode.
b. Can be used to enter an absorbance value. Make sure that the spectrophotometer is in the absorbance mode, then:
- Enter <appropriate value>.
- Press <%T/A/C>.
- Display will read "NEW ABS ZERO."
- Display will show the wavelength and new absorbance value.

The absorbance value that you enter will take the place of any previous value. The difference between the new value and the previous value is produced by adjusting, or "offsetting" from zero (e.g., if your previous ABS value was 0.92, and you entered 0.97, the value of zero will be adjusted, or offset, to +0.05).

c. Calculates a factor when you enter a concentration value standard solution:
- Make sure that spectrophotometer is in concentration mode.
- Place solution of known concentration into the sample compartment.
- Enter (appropriate value) for the concentration value. The display will read ENTRY, followed by the value.
- Press <%T/A/C>.
- The display will read "CALCULATE FACTOR," then "FACTOR=," followed by the new value.
- The display will now return to the normal mode, showing the wavelength and newly-entered concentration values.

The concentration value that you enter will be divided by the current Absorbance value to calculate a new factor between −9999 and +9999.

3.6 <SECOND FUNCTION> <100%T/ZERO A> sets transmittance to 100%, or absorbance or concentration to zero.

3.7 <YES>:
a. Moves the monochromator up in wavelength.
b. Causes the monochromator to go to a user-specified wavelength:
- Enter <appropriate value>.
- Press <YES>. The message GOING TO ### NM will be displayed until the monochromator is in the correct position.
c. Accepts prompted values that appear during test type programming (requires Accessory Control Module and APPLIPAK cartridge).
d. Moves forward through a parameter list or EDIT list (requires Accessory Control Module and APPLIPAK cartridge).

3.8 <NO>:
a. Moves the monochromator down in wavelength.
b. Causes the monochromator to go to a user-specified wavelength:
- Press <appropriate value>
- Press <NO>. The message GOING TO ### NM is displayed until the monochromator is in the correct position.
c. Rejects prompted values that appear during test type programming test type (requires Accessory Control Module and APPLIPAK cartridge).
d. Move backward through a parameter list or EDIT list (requires Accessory Control Module and APPLIPAK cartridge).

3.9 <SECOND FUNCTION> <GO TO λ> causes the monochromator to go to a user-specified wavelength:
- Enter <appropriate value>. Display will show ENTRY value.
- Press <SECOND FUNCTION>. The display will now read "2ND," followed by the value.
- Press <GO TO λ>. The message—GOING TO ### NM— will be displayed until the monochromator is in the correct position.

3.10 <.> <±> and <0> through <9> are used to enter positive and negative decimal and integer values.

3.11 <SECOND FUNCTION> <EDIT> changes any of the prompted parameters of the current test (requires Accessory Control Module and APPLIPAK cartridge).

3.12 <SECOND FUNCTION> <LIST> displays the parameters and their values for the current test (requires the Accessory Control Module and APPLIPAK cartridge).

3.13 <SECOND FUNCTION> <CATALOG> lists the catalog numbers and names of user-stored tests (requires the Accessory Control Module and an APPLIPAK cartridge).

3.14 <SECOND FUNCTION> <FACTOR>:
a. Set a known factor for use with the concentration data mode:
- Enter (appropriate value). The display will read ENTRY, followed by the value.
- Press <SECOND FUNCTION>. The display will read 2ND, followed by the value.
- Press <FACTOR>. This value will be used to convert absorbance data into concentration units.

b. Display the current factor.
- Press <SECOND FUNCTION>. The display will read 2ND.
- Press <FACTOR>.

3.15 <SECOND FUNCTION> <HI LIM> displays or sets the highest acceptable final result. Any result above the limit will be flagged as out-of-limits (see Section 4.1, High and Low Limits).

3.16 <SECOND FUNCTION> <LO LIM> displays or sets the lowest acceptable final result. Any result below the limit will be flagged as out-of-limits (see Section 4.1, High and Low Limits).

3.17 <SECOND FUNCTION> <DIAG> accesses the internal diagnostics. See Section 6.3, Diagnostics.

3.18 <SECOND FUNCTION> <SIG AV> displays or sets the signal averaging value (see Section 4.2, Signal Averaging).

3.19 <SECOND FUNCTION> <LMP SAV> turns the tungsten lamp save on and off (see Section 4.3, Tungsten Lamp).
- Enter 0, <SECOND FUNCTION> <LMP SAV> to turn off the lamp save mode.
- Enter 1, <SECOND FUNCTION> <LMP SAV> to turn on the lamp save mode.
- Press <SECOND FUNCTION> <LMP SAV> to display the status.

3.20 <SECOND FUNCTION> <TUNG> turns the tungsten lamp on or off (601 only).

3.21 <SECOND FUNCTION> <DEUT> turns the deuterium lamp on or off (for SPECTRONIC 601 only).
The current lamp status is indicated by the last character on the right of the display.
- "T" indicates that the tungsten lamp is on.
- "D" indicates that the deuterium lamp is on.
- "B" indicates that the both lamps are on.

NOTE

If you attempt to:
1. turn the deuterium lamp off when the unit is below the lamp interchange wavelength, or
2. turn the tungsten-halogen lamp off when the unit is above the lamp interchange wavelength . . .

the message LAMP REQUIRED will be temporarily displayed, and the normal data display will return. This cannot be over-ridden by continually pressing the key.

To turn both lamps off, enter <1> <SECOND FUNCTION> <DIAG>. The lamps will remain off, and the display will read "STANDBY . . .", until you press another key to return to the normal data display.

3.22 <SECOND FUNCTION> <LMP CH> displays or sets the lamp interchange wavelength (see Section 4.6, Lamp Interchange Wavelength). (SPECTRONIC 601 only).

# SECTION 4. DETAILED FEATURE DESCRIPTION

## 4.1 HIGH AND LOW LIMITS <HI LIM> and <LO LIM>

Use <HI LIM> and <LO LIM> to specify the range of test result values that you require. Once you have specified the limits, any final answer that falls outside the specified range will be flagged (an asterisk "*" will appear in the fourth display position from the right).

### NOTE
The "*" flag appears when the instrument measures values outside the range that you have previously specified. Another set of flags are used to indicate that the instrument is measuring values that exceed the range that the spectrophotometer can accommodate. Errors of this type (out-of-range value) are displayed with the message "OVFL" or "UNFL" (see Section 6.4.2, Error Messages).

To enter values for the limits:

a. Press the desired value between $\pm$ 0.0000 and 9999. The display will read ENTRY, followed by the value.

b. Press <SECOND FUNCTION>. The display will read 2ND, followed by the value.

c. Press <LO LIM>. The display will read LO LIM = ####.

d. Press the desired value between $\pm$ 0.0000 and 9999. The display will read ENTRY followed by the value.

e. Press <SECOND FUNCTION>. The display will read 2ND, followed by the value.

f. Press <HI LIM>. The display will read HI LIM = ####.

To display the current HI LIM and LO LIM values:

a. Press <SECOND FUNCTION>. The display will read 2ND.

b. Press <LO LIM>. The display will read LO LIM = ####.

c. Press <SECOND FUNCTION>. The display will read 2ND.

d. Press <HI LIM>. The display will read HI LIM = ####.

## 4.2 SIGNAL AVERAGING <SIG AV>

Signal averaging is a form of electronic filtering which reduces the background noise in the system, as illustrated in Figure 3-1. This feature is particularly useful at higher absorbance levels (above 2A), and at wavelength extremes near 195 nm or 999 nm. The SPECTRONIC 501 and 601 provide three levels of signal averaging, from 0 (minimum filtering) to 2 (maximum filtering).

To change the SIG AV value:

a. Enter an integral value of 0, 1, or 2. The display will read ENTRY, followed by the value.

b. Press <SECOND FUNCTION>. The display will read 2ND, followed by the value.

c. Press <SIG AV>. The display will read SIG AV = #.

To display the current SIG AV value:

a. Press <SECOND FUNCTION>. The display will read 2ND, followed by the value.

b. Press <SIG AV>. The display will read SIG AV = #.
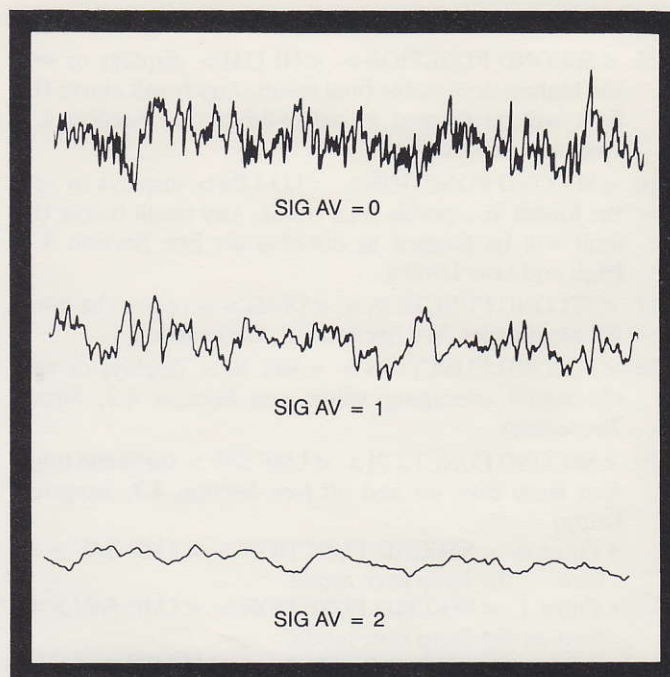


Figure 3-1. Typical Effects of Signal Averaging

## 4.3 TUNGSTEN LAMP

The tungsten-halogen lamp used in both the SPECTRONIC 501 and 601 spectrophotometers can be set to two levels of illumination through the use of the LAMP SAVER (LMP SAV) feature. This feature allows the option of extending lamp life when maximum illumination is not required.

- 0 <SECOND FUNCTION> <LMP SAV> turns the lamp save function off, so the lamp is on at full intensity.
- 1 <SECOND FUNCTION> <LMP SAV> turns the lamp save function on, so the lamp operates at reduced intensity.
- <SECOND FUNCTION> <LMP SAV> displays the current setting.

The LMP SAV feature reduces the level of illumination about 50% at wavelengths below 400 nm, and about 25% at wavelengths above 400 nm, while increasing average lamp life expectancy an average of 400%. Of course, the choice of when to use this feature will depend on a number of conditions, but in general, LMP SAV should be satisfactory for most measurements between 400 and 900 nm, if you are using a full aperture cuvette or test tube.

The SPECTRONIC 501 and 601 spectrophotometer can display the following error message to indicate tungsten lamp problems:

- If the lamp's output has decreased due to aging, or, if the lamp has burned out, the message "TOO LITTLE LIGHT" will appear during the AUTO-ZERO operation (see Section 6.5.1).

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## 4.4 DEUTERIUM LAMP (SPECTRONIC 601 ONLY)

The SPECTRONIC 601 spectrophotometer displays two types or error messages to indicate deuterium lamp problems:

- If the light output has been reduced by aging, or if the lamp has burned out, the message "TOO LITTLE LIGHT" will appear during the AUTO-ZERO operation.
- If the deuterium lamp fails to turn on within 15 seconds, the message "D2 LAMP FAILURE" will appear on the display. (See Section 6.5.2, Lamp Replacement Procedures—Deuterium Lamp.)

## 4.5 LAMP CONTROL (SPECTRONIC 601 ONLY)

On the SPECTRONIC 601 spectrophotometer, you can turn the deuterium or tungsten-halogen lamps on or off by entering:

- <SECOND FUNCTION> <DEUT> for the deuterium lamp, or
- <SECOND FUNCTION> <TUNG> for the tungsten lamp.

If the lamp was off, it will be turned on; if it was on, it will be turned off. The lamp status indicator (the last display character on the right of the LED display) tells you which of the lamps is now activated: "T" = tungsten, "D" = deuterium, or "B" = both.

Another lamp selection option is "STANDBY," which turns both lamps off temporarily. To select the "STANDBY" feature, enter 1 <SECOND FUNCTION> <DIAG>. The lamps will remain off until you press any key, resuming normal operation.

## 4.6 LAMP INTERCHANGE WAVELENGTH <LMP CH> (SPECTRONIC 601 ONLY)

You can set the wavelength at which the 501/601 switches between the tungsten-halogen lamp and the deuterium lamp to any value between 320 and 380 nm. The instrument automatically switches to the deuterium lamp when the wavelength is at or below the lamp interchange wavelength.

To select a new lamp interchange wavelength:

a. Enter a wavelength value between 320 and 380. The display will read ENTRY, followed by the value.

b. Press <SECOND FUNCTION>. The display will read 2ND.

c. Press <LMP CH>. The display will read LAMP CHANGE = ###.

To display the current lamp interchange wavelength:

a. Press <SECOND FUNCTION>. The display will read 2ND.

b. Press <LMP CH>. The display will read LAMP CHANGE = ###.

# SECTION 5. OPERATION

## 5.1 BASIC SPECTROPHOTOMETRIC MEASUREMENTS

To use the SPECTRONIC 501/601 for basic spectrophotometric measurements (absorbance, transmittance, or concentration):

a. Turn Power on.

b. Await completion of SELF-TEST.

c. Enter analytical wavelength.

d. Press <SECOND FUNCTION> <GO TO λ>.

e. Allow 30-minute lamp warm-up.

f. Press <T%/A/C> to choose desired data mode.

g. Open sample compartment door; insert blank into sample holder.

h. Close sample compartment door.

i. Press <SECOND FUNCTION> <100%T/ZERO A>.

j. Open sample compartment door and remove the blank.

k. Insert sample into sample holder and close sample compartment door.

l. Read data that is displayed, or press <SEND> if a printer or computer is installed.

## 5.2 TEST PARAMETER STORAGE

The SPECTRONIC 501/601 can store one set of test parameters as the "default" values. Once stored, these values will be present the next time you turn your spectrophotometer on. The parameters that will be stored are:

• current wavelength
• lamp status (including <LMP SAV> status)
• lamp interchange wavelength
• data mode <%T, A or C>
• factor
• signal averaging value
• high/low limits
• RS-232 interface parameters: baud rate, no. of stop bits, and parity, etc.

To save these parameter values (using Diagnostic 4):

• Enter the desired wavelength and press <GO TO λ>.
• Set all the parameters to the desired status or value.
• Press <1>, then <4>. The display will read ENTRY 14.
• Press <SECOND FUNCTION>. The display will read 2ND 14.
• Press <DIAG>. The display will read "SETUP SAVED" and then return to a normal data display.

These values will now be the "default" values that will be present the next time you turn on your spectrophotometer (even if you enter different parameters into current memory before you turn the unit off). The only way to alter these default, or "power-up" values is to perform another Test Parameter Storage procedure, as described above, but with new values.

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Table 5-1. Parameters/Acceptable Values.

| PARAMETER | FUNCTION | RANGE OF ACCEPTABLE VALUES |
|---|---|---|
| Wavelength <WV> | Wavelength to nearest nanometer. | 195-999nm (601) 325-999nm (501) |
| Low Limit <LO LIM> | Lowest acceptable final answer. If display is below this value, * appears. | ±0.0000 to 9999 |
| High Limit <HI LIM> | Highest acceptable final answer. If display is above this value, * appears. | ±0.0000 to 9999 |
| Signal Average <SIG AV> | Data enhancement technique to reduce background noise. | 0 to 2 (whole numbers only) |
| Lamp Change <LMP CH> | Wavelength at which instrument switches between tungsten-halogen and deuterium lamps. | 320 to 380 nm |
| Factor | Multiplier used to convert absorbance value to a concentration level. | ±0.0000 to 9999 |

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# SECTION 6. MAINTENANCE & TROUBLESHOOTING

## 6.1 PERFORMANCE EVALUATION USING REFERENCE MATERIALS

All precision instruments, including spectrophotometers, are subject to performance degradation. These performance losses, whether gradual or abrupt, obvious or subtle, can lessen the accuracy of analytical results.

Evaluation of your instrument's performance should start immediately, with weekly checks for at least the first month. At the end of this time, monthly evaluations should be sufficient to detect any gradual degradation of performance.

Evaluations should include tests for stray radiant energy, wavelength accuracy, photometric accuracy, and photometric linearity. These tests involve the use of specialized test materials which must:
• Have values of known accuracy;
• Be compatible with the instrument being evaluated; and
• Contribute minimum error to the test results.

Recommended test materials for this instrument are Milton Roy SPECTRONIC Standards, Cat. No. 333150. These standards are designed to fit into the standard cuvette holder of the SPECTRONIC 501 or 601 spectrophotometer and can be used for the relevant tests. For detailed instructions on the use of the standards refer to the SPECTRONIC Standards User's Manual, Cat. No. 333150-10001.

## 6.2 REPLACEMENT PARTS

The following items are available as replacement parts for the SPECTRONIC 501 and 601 spectrophotometers.

| CATALOG NO. | DESCRIPTION |
|---|---|
| 335124 | Tungsten-halogen lamp (box of 10) |
| 343424 | Deuterium lamp |
| 335101-10001 | SPECTRONIC 501/601 Operator's Manual |
| 335101-10020 | SPECTRONIC 501/601 Service Manual |
| 332879 | 2.0-ampere Slo-Blo fuse (box of 5) |
| 335101-164 | Dust Cover |

For a list of accessories that are available for use with the SPECTRONIC 501/601 spectrophotometers, contact your authorized dealer or Milton Roy sales representative.

## 6.3 DIAGNOSTICS

To run a diagnostic program:
• Enter <appropriate value>. The display will read ENTRY followed by the value.
• Press <SECOND FUNCTION>
• Press <DIAG.>

USER DIAGNOSTICS

| DIAG # | FUNCTION |
|---|---|
| 0 | POWER ON RESET |

Executes a POWER-ON reset in the software, allowing you to re-initialize the instrument from the SPECTRONIC 501/601 keyboard.

Allow 5 minutes for lamp to stabilize after using <DIAG> <0>.

| 1 | STANDBY |
|---|---|

Displays the message "STANDBY," turns both lamps off, and waits for any keystroke. Any keystroke will turn the appropriate lamp(s) back on and return to normal data display.

Allow 15 minutes for lamp to stabilize.

| 2 | REVISION LEVEL |
|---|---|

Displays the revision level of the firmware (permanent stored programs) in the instrument. The display lasts one second. For a longer display, hold down any key while the display is present.

| 3 | DISPLAY TEST |
|---|---|

Checks the spectrophotometer's display by testing all segments. First, sixteen '*'.'s will appear, then sixteen '0;'s. The final display scrolls from left to right, presenting the characters A through Z, and 0 through 9. To stop the test, press any key after *.'s and 0;'s have been displayed.

| 4 | RECORDER SETUP routine provides three options for recorder adjustment, but will run only if the Recorder Output Option has been installed. |
|---|---|

When you press 4 <SECOND FUNCTION> <DIAG>, the message "RECORDER SETUP" will appear first. You may now select any of the setup options below by pressing 0, 1, or 2.

If you press 0:
The message "RECORDER ZERO" will be displayed to indicate that analog output has been set to zero. Press <CLEAR> to exit.

If you press 1:
The message "RECORDER 1 UNIT" will appear, and the analog output will be set to 1 volt for recorder adjustment. This corresponds to 1A or 100 % T. Press <CLEAR> to exit.

If you press 2:
The message "RECRDR OUT TEST" will appear, and the analog output will be set at the lowest voltage (approximately −0.3vdc) for three seconds. The voltage level will then then ramp up (in about 4 seconds) to the highest voltage (approximately 3.7 vdc), holding at that voltage for 3 seconds before returning. Press <CLEAR> to exit.

| 6 | 656NM DEUTERIUM PEAK FIND—601 ONLY |
|---|---|

This routine turns on the Deuterium lamp, rotates the mirror, and sets the appropriate gain. It also moves the monochromator from 659 to 653nm and displays the measured peak wavelength. Press <CLEAR> to exit.

| 7 | 486NM DEUTERIUM PEAK FIND—601 ONLY |
|---|---|

This routine is similar to diagnostic 6, except that monochromator scans from 489 to 483nm. Press <CLEAR> to exit.

| 8 | PEAK NOISE MEASUREMENT |
|---|---|

Measures noise for approximately 15 seconds and displays peak-to-peak noise in absorbance. The value is computed on the displayed data, and will apply the <SIG AV> value that was in effect before selecting this diagnostic. Press <CLEAR> to exit.

| DIAG # | FUNCTION |
|---|---|
| 9 | **CLEAR AUTO-ZERO REGISTER**<br>Undoes the AUTO-ZERO function. |
| 10 | **STRAY RADIANT ENERGY (SRE) MEASURE-MENT**<br>Checks SRE by displaying transmittance to within 0.01% resolution. To use this diagnostic, move the spectrophotometer to the appropriate wavelength, set ØA/100%T, and insert the appropriate SRE filter. Then, enter 1Ø, <SPECIAL FUNCTION> <DIAG>. The SRE measurement will be displayed in the form "SRE=XX.XX T," and will be held for 0.5 seconds (for a longer display, depress and hold down any key as long as you wish to see the display). |
| 11 | **SERIAL PORT SETUP**<br>Prompts the operator through the setup of the RS-232-C serial port parameters (baud rate, parity, etc). Refer to Section 9 of this manual for a complete explanation. |
| 12 | **READ INSTRUMENT ID CODE**<br>Displays the spectrophotometer's identification code (for use with Milton Roy disk-based software programs). |
| 13 | **LAMP ALIGNMENT.**<br>Prompts for lamp choice (SPECTRONIC 601 only), moves to appropriate wavelength, then converts the display to a linear-responding bar graph. The left-hand digit of the display indicates the relative gain achieved. Numbers are displayed in hexadecimal format, 0 through 9 and A through F, with 0 being the lowest and F the highest lamp intensity. (See Section 6.6.) |
| 14 | **POWER-ON INSTRUMENT SETUP**<br>This diagnostic stores the current setup of the instrument. The next time that the instrument is |

| DIAG # | FUNCTION |
|---|---|
| | turned on, these parameter values will be present. Parameters saved as part of this procedure include:<br>a) current wavelength<br>b) lamp status (D2 on/off, T on/off, Lamp Save on/off)<br>c) lamp change wavelength<br>d) data made (T A C)<br>e) factor (C multiplier)<br>f) signal averaging value<br>g) high/low limits<br>h) RS-232 setup...baud rate, number of stop bits, parity, etc. |
| 15 | **KEYBOARD TEST**<br>Simply verifies that each key is working. Press the key and observe the display; if keystroke does not produce the character listed in the chart below, contact your authorized Milton Roy service representative. (To exit from this test, turn the spectrophotometer off, and then on again.) |

| KEY: | DISPLAYED AS: |
|---|---|
| <CLEAR> | C |
| <SEND> | S |
| <SECOND FUNCTION> | N |
| <DOWN ARROW> | D |
| <UP ARROW> | U |
| <%T/A/C> | T |
| <+/−> | + |
| <·> | . |
| <0–9> | NUMBER PRESSED |

| DIAG # | FUNCTION |
|---|---|
| 16 | **PRINTER TEST**<br>Checks printer operation by transmitting ASCII codes for SPECTRONIC 501/601'S character set. Operates continuously until you press <CLEAR> to exit. |

## 6.4 MAINTENANCE & TROUBLESHOOTING
### 6.4.1 Troubleshooting Chart
If you experience the problems listed in the "INDICATION" column, check through the "PROBABLE CAUSE" and "ACTION REQUIRED" columns in sequence ("a" through "b", and so forth).

| INDICATION | PROBABLE CAUSE | ACTION REQUIRED |
|---|---|---|
| No display with unit turned on. | a. Unit not plugged in. | Plug in unit. |
| | b. Outlet is dead. | Change outlet. |
| | c. Fuse is blown. | Change fuse. |
| | d. Part malfunction. | Call Milton Roy Service. |
| Display does not read 0.0 T with occluder block in light path. | a. Not in %T mode. | Press <%T/A/C> until in %T mode. |
| | b. Part malfunction. | Call Milton Roy Service. |
| Excessive drift and/or noise. | a. Bubbles or particles in sample. | Check sample preparation. |
| | b. Tungsten-halogen lamp burned out. | Replace lamp. |
| | c. Deuterium lamp burned out. | Replace lamp. |
| | d. Sample compartment windows dirty. | Clean windows. |
| | e. Lamps not aligned properly. | Refer to Section 6.5. |
| | f. Part malfunction. | Call Milton Roy Service. |
| Data display "locked up" | a. Computer or printer connected to optional serial port not "on-line" or ready. | Set up external equipment properly, or disconnect. |
| | b. Microprocessor error or part malfunction. | Turn off unit for 15 sec and turn on again. If problem persists, call Milton Roy Service. |
| Incorrect reading in data display | a. Incorrect blank. | Insert correct blank. |
| | b. Insufficient sample volume. | Increase sample volume. |
| | c. Bubbles or particles in sample. | Check sample preparation. |
| | d. Incorrect wavelength setting. | Go to correct wavelength. |
| | e. Wavelength error. | Check deuterium peaks. |
| | f. Electronic calibration error. | Check using SPECTRONIC Standards. |
| | g. Part Malfunction. | Call Milton Roy Service. |

## 6.4.2 Error Messages

The chart below lists the error messages that the 501/601 will display. The left-hand column lists the error message as it will appear on the 501/601 display; the right-hand column describes what to do if the message appears.

| ERROR MESSAGE | RECOMMENDED ACTION OR PROBABLE CAUSE |
|---|---|
| NEED A NUMBER | Re-enter command sequence with appropriate number. |
| NO FUNCTION | Re-enter number entered in <SECOND FUNCTION> mode. First entry did not correspond to any of the 501/601's functions. |
| ILLEGAL ENTRY | Check parameter table (Section 5.2). Re-enter correct parameter. |
| OUT OF RANGE | Re-enter values, and make sure that they are within the operating range of the spectrophotometer. |
| D2 LAMP FAILURE | Replace the deuterium lamp (see Section 6.5.2). |
| RANGE = 320 TO 380 | Re-enter lamp interchange wavelength value. Choose an appropriate value between 320 and 380 nm. |
| SIG AV = 0 1 OR 2 | Re-enter signal average value. Choose an appropriate value (0, 1, or 2). |
| LAMP REQUIRED | The lamp you tried to turn off is required for operation at the current wavelength. |
| OPTION REQUIRED | Option or accessory selected has not been installed, or CPU has not been instructed that option has been installed. If accessory has been installed and error persists, call Milton Roy service. |
| TOO LITTLE LIGHT | Illumination level may be too low. If LAMP SAVE feature is on, turn it off.<br><br>May also occur if path of light beam in sample compartment is |

| ERROR MESSAGE | RECOMMENDED ACTION OR PROBABLE CAUSE |
|---|---|
| | disturbed, or if the sample has too high an absorbance at the selected wavelength (try diluting sample, or moving to another wavelength). |
| CALIBRATION ERROR | Perform lamp alignment procedures (Section 6.6). If error persists, call Milton Roy service. |
| FILTER ERROR | Check maintenance compartment for obvious obstructions or damage. Verify that instrument has been set up to run at the correct voltage level. If error persists, call Milton Roy service. |
| MONO ERROR | Check maintenance compartment for obvious obstructions or damage. Verify that instrument has been set up to run at the correct voltage level. If error persists, call Milton Roy service. |
| CHOPPER ERROR | Check maintenance compartment for obvious obstructions or damage. Verify that instrument has been set up to run at the correct voltage level. If error persists, call Milton Roy service. |
| 195-999 NM ONLY | Re-enter wavelength value and make sure that it is between 195 nm and 999 nm. (SPECTRONIC 601 only). |
| 325-999 NM ONLY | Re-enter wavelength value and make sure that it is between 325 nm and 999 nm. (SPECTRONIC 501 only). |

---

## WARNINGS FOR LAMP REPLACEMENTS AND ALIGNMENT PROCEDURES

HIGH VOLTAGE: The deuterium lamp operates at extremely high voltage and has dangerous voltages on the terminals even when the lamp is turned off. Be sure to turn power off and disconnect the power cord before you attempt to replace the lamp.

TEMPERATURE: The tungsten lamp, and the surrounding shield, reach temperatures high enough to cause contact burns. Make sure you allow the lamp to cool off for at least five minutes before removing the lamp.

ULTRAVIOLET: The short wavelength UV radiation emitted by the deuterium lamp can be harmful to the eyes and skin. Wear eye protection and avoid exposing skin whenever the lamp cover is removed and the lamp is on (for example, when aligning the lamp mirror).

SHATTERING: The tungsten lamp operates under high pressure. To avoid accidents, protect the lamp from fingerprints, abrasions, and scratches when handling. Wear eye protection when adjusting the lamp interchange mirror, and never operate the lamp with the shield removed.

## 6.5 LAMP REPLACEMENT PROCEDURES

This section contains instructions for replacing and aligning both the Tungsten-Halogen and Deuterium lamps in the SPECTRONIC 501 and 601 spectrophotometers. (See inside back cover for illustrations.) It also contains instructions on several other maintenance procedures necessary from time to time keep your instrument operating at its peak.

### 6.5.1 Tungsten-Halogen Lamp

```
─────────────── CAUTION ───────────────
1. The Tungsten-Halogen lamp operates under high
   pressure. To avoid accidents, protect the lamp from
   fingerprints, abrasions, and scratches when han-
   dling. Wear eye protection when adjusting the lamp
   interchange mirror, and never operate the lamp
   with the shield removed.
2. Allow enough time for the shield and lamp to cool. If
   the spectrophotometer has been operating even for
   a short time, the shield and lamp will be very hot.
   Temperatures are high enough to cause contact
   burns, so allow at least 5 minutes before removing
   the shield and lamp.
```

a. Turn the spectrophotometer off and disconnect the power cord.

b. Remove the Maintenance/Lamp Door by loosening the Lamp/Maintenance Compartment Access Screw three to five complete turns and lifting up the door at the back edge.

c. Remove the Tungsten-Halogen Lamp Shield (29) from the instrument chassis by loosening the two Tungsten-Halogen Lamp Shield Screws (32). The base of the shield is slotted as seen in Figure 6-1, so that you can slide it out from under the two screws and lift it straight up. BE CAREFUL TO AVOID SCRATCHING THE LAMP INTERCHANGE MIR-ROR (20).

d. Pull the 2-pin Tungsten-Halogen Lamp (31) straight out from the socket.

```
─────────────── CAUTION ───────────────
Use a clean, lint-free cloth or wear lint-free gloves to
handle the new lamp; fingerprints on the lamp detract
from its peak performance and shorten the life of the
lamp.
```

e. Turn the instrument 90 degrees to locate the lamp socket more easily.

f. Carefully align the pins on the new lamp with the socket (Figure 6-2).

g. Slowly push the lamp straight into the socket until fully seated; be sure that the lamp is straight to avoid bending the pins.

h. Carefully remove any fingerprints or dirt from the lamp with a clean, lint-free cloth.

i. Carefully replace the shield and secure it with the two screws loosened in step c.

j. Perform the alignment procedure, described in Section 6.6, Lamp and Mirror Alignment, before using the instrument.

### 6.5.2 Deuterium Lamp (SPECTRONIC 601 only)

```
─────────────── CAUTION ───────────────
The deuterium lamp operates at an extremely high
voltage and has dangerous voltages on the terminals
even when the lamp is turned off. Be sure to turn off
the power and disconnect the power cord before you
attempt to replace the lamp.
```
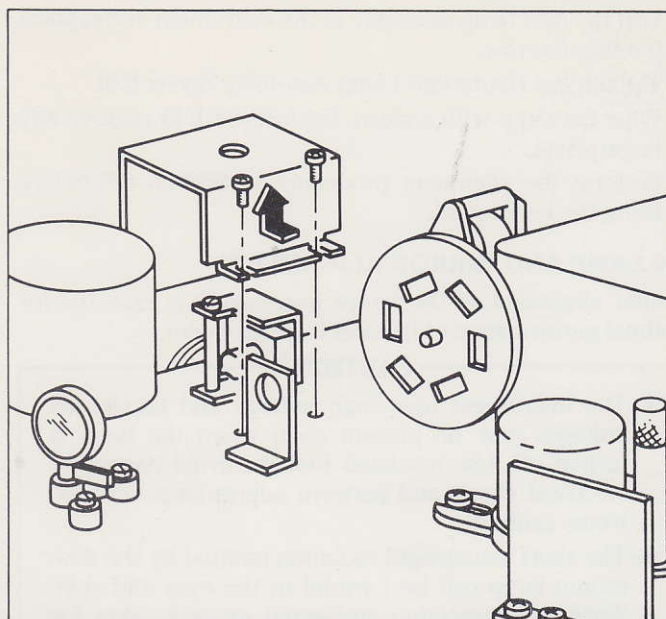


Figure 6-1. Removing the Tungsten-Halogen Lamp Shield.
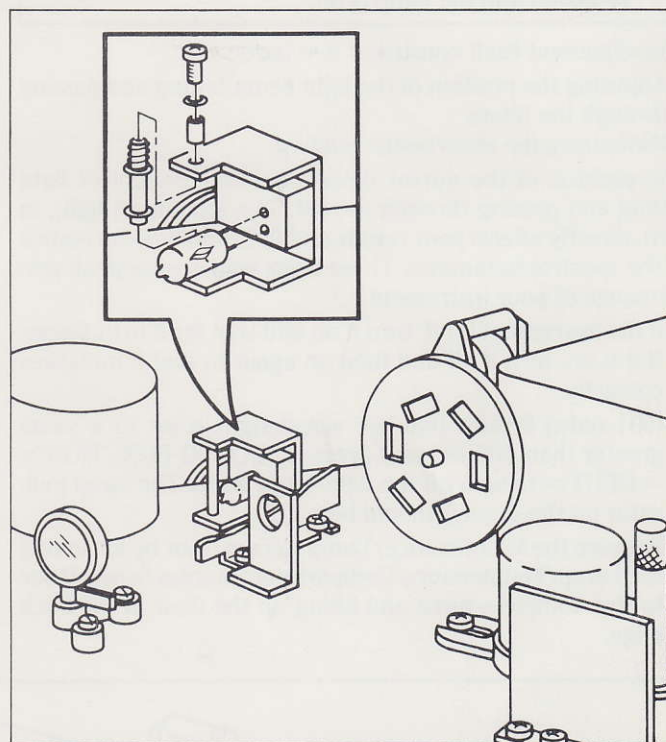


Figure 6-2. Locating the Socket for the Tungsten-Halogen Lamp.

a. Turn off the spectrophotometer and unplug the power cord.

b. Remove the Maintenance/Lamp Access door by loosening the Lamp/Maintenance Compartment Access Screw three to five complete turns.

c. Disconnect the three Deuterium Lamp Connector Wires (25) from the sockets.

d. Loosen, but do not remove, the Deuterium Lamp Assembly Screw (26).

e. Remove the Thumbscrew (23) holding the Deuterium Lamp Assembly in place, and remove the old lamp assembly.

f. Connect the new Deuterium Lamp Connector Wires. **Be sure the red wire is connected to the center socket.**

g. Seat the new lamp assembly in the instrument and replace the thumbscrew.

h. Tighten the Deuterium Lamp Assembly Screw (26).

i. Wipe the lamp with a clean, lint-free cloth to remove any fingerprints.

j. Perform the alignment procedure in Section 6.6 before using the instrument.

## 6.6 LAMP AND MIRROR ALIGNMENT

Proper alignment of the lamps and mirror is essential for optimal performance of the spectrophotometer.

---
**CAUTION**

1. The instrument uses high voltage and dangerous voltages may be present even when the lamp is turned off. Use insulated tools to avoid danger of electrical shock and perform adjustments with extreme caution.

2. The short wavelength radiation emitted by the deuterium lamp can be harmful to the eyes and skin. Wear eye protection and avoid exposing skin for more than a few minutes when the lamp cover is removed and the lamp is on.

---

The alignment itself consists of two parts:

• Adjusting the position of the light beam hitting and passing through the filters

• Minimizing the absorbance reading.

The position of the mirror determines the amount of light hitting and passing through the slit. The amount of light, in turn, directly affects your results and the overall performance of the spectrophotometer. These steps help ensure peak performance of your instrument.

a. If the instrument is off, turn it on and wait for it to initialize. If it is on, turn if off and then on again so that it initializes correctly.

b. (601 only.) Ensure that the wavelength is set to a value greater than 400 nm and press <SECOND FUNCTION> <DEUT> to turn off the deuterium lamp. The lamp indicator on the display should be a "T."

c. Remove the Maintenance/Lamp Access Door by loosening the Lamp/Maintenance Compartment Access Screw three to five complete turns and lifting up the door at the back edge.
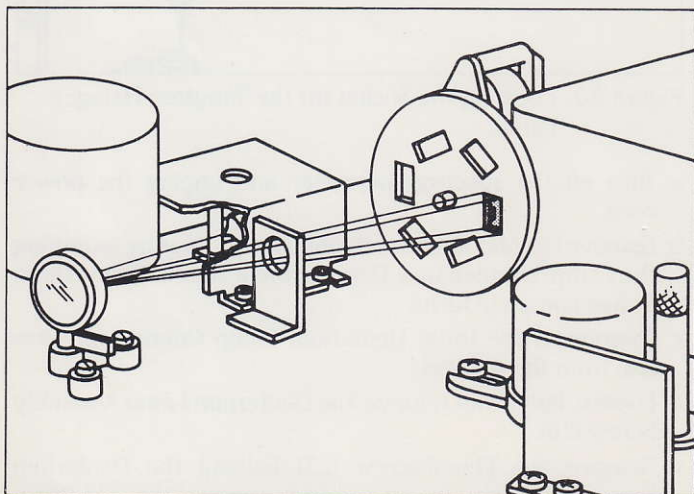
d. Examine the illuminated filter on the filter wheel to determine the position of the light. Light should be centered on the filter and on the slit, as shown in Figure 6-3a.

e. If light is not passing through the center of the filter as shown in Figure 6-3b, adjust the Tungsten-Halogen Lamp Adjustment Screw (22) and/or the Tungsten-Halogen Lamp Vertical Adjustment Screw (30) until the light is centered on the filter.

f. Press <630> <GO TO λ> to set the wavelength to 630 nm.

g. Use the %T/A/C key to put the instrument into Absorbance mode.

h. Press <1> <%T/A/C> and wait for the instrument to display an absorbance value. (It should be near 1.0.)

i. Use a flatblade screwdriver with an insulated handle to turn the Tungsten-Halogen Lamp Adjustment Screw (22) until the instrument displays a **minimum** absorbance reading.

If the instrument displays a negative absorbance reading, stop and repeat step h.

j. Use a Phillips screwdriver to turn the Tungsten-Halogen Lamp Vertical Adjustment Screw (30) until the instrument displays a **minimum** absorbance reading.

k. Repeat step i.

l. (601 only) Press <240> <GO TO λ> to set the wavelength to 240 nm.

m.(601 only) Use the %T/A/C key to put the instrument into Absorbance mode.

n. (601 only) Press <1> <%T/A/C> and wait for the instrument to display an absorbance value. (It should be near 1.0.)

o. (601 only) Use a flatblade screwdriver with an insulated handle to turn the Deuterium Lamp Adjustment Screw (21) until the instrument displays a **minimum** absorbance reading.

If the instrument displays a negative absorbance reading, stop and repeat step n.

p. (601 only) Repeat step o.

q. When adjustments are complete, turn the instrument off and then on again to re-initialize it.

r. Reposition the Maintenance/Lamp Access Door and secure it by tightening the Lamp/Maintenance Compartment Access Screw.
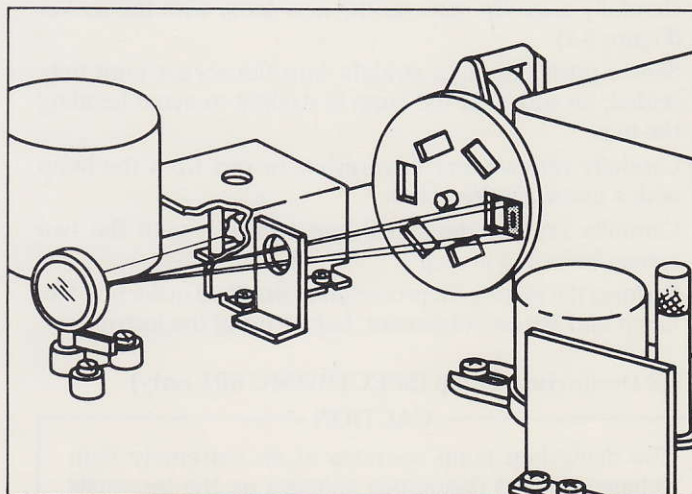


Figure 6-3a. Correct

Figure 6-3b. Incorrect

Figure 6-3. Light Hitting and Passing Through the Filter.

# SECTION 7. RS-232-C INTERFACE—INTRODUCTION

The RS-232-C Interface provides a 2-way communications link between the SPECTRONIC 501/601 spectrophotometer and an external electronic device, such as the Accessory Control Module, a computer, or a printer. The RS-232-C Interface consists of the following components:

a. A printed-circuit board, which is installed inside the spectrophotometer.

b. A cable assembly. An 11-pin MOLEX Connector internally connects the cable to the circuit board. The wires in the cable are connected to a DB-25P male connector, which is mounted on the rear panel of the spectrophotometer. This connector serves as the "serial port" for external communications.

c. A 25-pin RS-232-C cable, which is installed between the serial port and the external electronic device.

Output pin assignments are shown below.

| PIN | SIGNAL NAME | FUNCTION |
|---|---|---|
| 1 | PROTECTIVE GROUND | Grounds the chassis |
| 2 | TRANSMITTED DATA (TD) | Data output from the 501/601 |
| 3 | RECEIVED DATA (RD) | Data input from the external device |
| 4 | REQUEST TO SEND (RTS) | +12V from the 501/601 |
| 5 | CLEAR TO SEND (CTS) | Used for handshaking. Requires 3-25V from the external device (or CTS line may be left open). |
| 7 | SIGNAL GROUND | Return for Data & Control signals |
| 20 | DATA TERMINAL READY (DTR) | Used for handshaking. The 501/601 supplies +12V when power is on and the instrument is ready to accept data. |

# SECTION 8. FIRMWARE SETUP PROCEDURE

Before you can use the RS-232-C Interface you must first prepare it to communicate with an external device. Follow the steps below to enter a specification for each RS-232-C firmware function:

**Step 1:**
Enter 11, then press the <SECOND FUNCTION> and <DIAG> keys on the spectrophotometer keyboard. The RS-232-C firmware functions will appear sequentially on the display.

- To accept a displayed value and proceed to the next firmware function, press <YES> on the spectrophotometer keyboard.
- To refuse a displayed value and have another value displayed, press <NO>. Continue pressing <NO> until the required value is displayed.

When selecting the firmware functions and the various specifications presented below, be sure to check the user's guides and other documentation provided with the external device (or the software programs used with the device).

a. BAUD RATE: 110, 150, 300, 600, 1200, 2400, 4800, or 9600.

b. PARITY: ODD, EVEN, or OFF.
ODD or EVEN parity represents the checksum of the first 7 bits of each received or transmitted character. When parity is "OFF", the eighth bit of each received character will be ignored when it is received and will be transmitted as a space. If a parity error is detected on reception, the input buffer will be emptied, and the message "RS-232 Error" will appear on the spectrophotometer's display.

c. NUMBER OF STOP BITS:
ONE or TWO.

d. OUTPUT TERMINATOR:
CARRIAGE RETURN (CR), LINE FEED (LF), CARRIAGE RETURN immediately followed by a LINE FEED (CRLF), LINE FEED immediately followed by a CARRIAGE RETURN (LFCR).

e. CHARACTER ECHO:
ON or OFF. When set to ON, the CHARACTER ECHO function is activated, and the 501/601 transmits each character it receives back to the display of the external device.

(Exception: Control characters S, Q, R, T, W, G, C, and X are not echoed.)

f. FORMAT:
COMPUTER or PRINTER. This specification controls the format of the data output from the 501/601. (The computer and printer formats will be fully explained in Section 9.)

g. "CONTROL S"/"CONTROL Q":
ON or OFF. When this function is ON, the spectrophotometer will stop sending data when it receives a "CONTROL S" character. It will not start sending data again until it receives a "CONTROL Q" character. When this function is OFF, the spectrophotometer will ignore both control characters.

h. COMMAND COMPLETION ANSWERBACK:
ON or OFF. When set to ON, the COMMAND COMPLETION ANSWERBACK function is activated:

- If the spectrophotometer receives *and* executes a command properly, it will transmit the ASCII characters "OK" (followed by the programmed terminator) back to the external device.

- If the spectrophotometer receives an invalid command terminator, or a valid command which cannot be executed, it will transmit the ASCII characters "ER" (followed by the programmed terminator) back to the external device.

- If the spectrophotometer receives a command that requests data, it will transmit the following sequence back to the external device: the requested data, the programmed terminator, the ASCII characters "OK", and the programmed terminator again.

**Step 2:**
When you complete this routine, the RS-232-C Interface will be set up as you have specified. It will remain this way until you run the procedure again, or until you turn the instrument's power off.

**Step 3:**
To save this setup in the instrument's non-volatile memory, execute Diagnostic 4 (enter 14, <SECOND FUNCTION> <DIAG>). The option will then be properly set up whenever power is turned on.

## 9.1 MESSAGES FROM THE SPECTROPHOTOMETER TO AN EXTERNAL DEVICE

You may select either of two output formats: 'computer' or 'printer', depending upon the device connected to the RS-232-C port. (This format has already been selected if you have performed Diagnostic 1, the Firmware Setup Procedure described in Section 8.)

### 9.1.1 Printer Format

When you have specified "printer" format in the firmware setup procedure, a string (in the "printer format" shown below) is sent out the RS-232 port when you press the <SEND> key on the 501/601 (or in response to a remote "SND" command).

**Example:** CWWWNMbSD.DDDLMbXZ

**Explanation of Symbols:**

C = one of the following characters:

   R = indicates that a cartridge test is running.

   T = indicates that the temperature of the Thermoelectric Flowcell has not yet reached the preset value. The "T" designation has priority over the "R" designation.

   SPACE = neither an R or T is flashing in the display.

WWW = wavelength

NM = ASCII characters "NM", representing "nanometers"

b = a space

s = sign. (−) is transmitted for a negative value. A space is transmitted for a positive value.

D.DDD = datum value (with a floating decimal point).
   Data readings that exceed the range of the 501/601 (−0.1A to 2.999A) will cause error messages "UNFL" (data below −0.1A) or "OVFL" (data above 2.999A) to be printed.

L = high/low limit flag.
   If the current data value is not between the preset high and low limits, an asterisk (*) will be transmitted in this position. Otherwise, a space will be sent.

M = data mode: "T" (TRANSMITTANCE), "A" (ABSORBANCE) or "C" (CONCENTRATION)

X = lamp ON/OFF status: "D" = deuterium, "T" = tungsten, "B" = both.

Z = output terminator: CR, LF, CRLF, or LFCR—as specified by the firmware setup.

**Example of Printer Output:**

```
CWWWNMbSd.DDDLMbXZ
| | |  | |  | | | | | | |  | | |  | | | |
R 5 0  0 N M  0 . 0 2 9 * A  T  (CRLF)
```

**Explanation:** This printout indicates that a cartridge test (R) is running. For this test, the spectrophotometer was set to 500 nanometers and 0.029 absorbance (A) was measured. This data is not between the preset high and low limits (*). The Tungsten (T) lamp is turned on.

### 9.1.2 Computer Format

This format will be used by the instrument in response to a "SND" command (see section 9.2), or when the 501/601's SEND key is pressed and the firmware specifies the "computer" format. Data that exceeds the range of the instrument (−0.1A to 2.999A) will be sent as +9999 or −9999.

**Example:**

   bWWWbSD.DDDX

Where:

b = space

WWW = current wavelength

S = sign of data; "−" or space

D.DDD = current data. Location of decimal point depends on mode (T, A, or C) and data value.

X = programmed output terminator.

**Example:**

```
bWWWbSD.DDDX
| | | | | | | | | | | | |
 6 5 6 -0 .2 3 4  (CRLF)
```

Response to all other parameter queries: The spectrophotometer transmits information in either floating decimal point or integer format. Only one variable will be output on any one line.

**Example:** 1.234
          100
          −567.1

## 9.2 COMMAND ENTRY

Format of "execute" commands: CCCbDDDDDDDDZZ

   CCC = a three-character command field.

   b = a space, if data is to be sent.

DDDDDDDD = a 0- to 8-character data field.

   ZZ = command terminator (either a CR, LF, CR and LF, or LF and CR). Any of these are acceptable; the terminator selected in the setup procedure is for output only.

1. Some commands do not have a data field. They merely consist of a three-character command, followed by a command terminator. This type of command may either:
   • Ask the spectrophotometer to transmit a current data value, or
   • Set a specific operation.

2. Commands that include a data field may initiate one of three possible functions:
   • Turn a specific spectrophotometer function on or off (such as LSV 1, which turns the LAMP SAVE function on).
   • Enter a numerical value for a specific instrument parameter. In this type of command, 1-8 data characters may be entered. These characters can include a decimal point and, if applicable, the negative (−) sign. As previously stated, if no sign is entered in the command, the value is assumed to be positive.
   • Set a specific analytical mode of operation *and* enter a numerical value for that mode.

## 9.3 COMMAND TABLE

All of the valid commands are listed in this section. Some of the 3-character commands are followed by an "n", which represents a variable data field.

| TYPE OF COMMAND | COMMAND | ACTION CAUSED BY THIS COMMAND |
|---|---|---|
| DATA MODE | ABS | Sets the ABSORBANCE mode |
| | ABS n | Sets the ABSORBANCE mode and ABSORBANCE value n. (n = 0 to 2.999) |
| | CON | Sets the CONCENTRATION mode. |
| | CON n | Sets the CONCENTRATION mode and CONCENTRATION value n by calculating a FACTOR (n = 0 to ± 9999) |
| | TRN | Sets the TRANSMITTANCE Mode. (No numerical data permitted). |
| DATA CONTROL | ZER | Sets the following (zero) values: ABSORBANCE = 0, CONCENTRATION = 0, or TRANSMITTANCE = 100%. |
| | FAC | Outputs the current FACTOR value. |
| | FAC n | Sets the FACTOR to n. Sign and decimal point may be included. (n = 0 to ± 9999) |
| | LOL | Outputs the current LOW LIMIT value. |
| | LOL N | Sets the LOW LIMIT to n. Sign and decimal point may be included (n = 0 to ± 9999). |
| | HIL | Outputs the current HIGH LIMIT value. |
| | HIL n | Sets the HIGH LIMIT to n. Sign and decimal point may be included. (n = 0 to ± 9999) |
| | SIG | Outputs the current SIGNAL AVERAGE value. |
| | SIG n | Sets the SIGNAL AVERAGE to n. [n values may be only 0 (fast), 1 (medium), or 2 (slow).] |

| TYPE OF COMMAND | COMMAND | ACTION CAUSED BY THIS COMMAND |
|---|---|---|
| COMMUNICATIONS | SND | Outputs current wavelength, data mode, and data value per selected format (computer or printer). |
| | BEP | An audible device in the 501/601 "beeps" for about one-half second. |
| | CHP | Causes 501/601 to "chirp" for about one twentieth of a second. |
| | KLK n | Turns the "KEYBOARD LOCK" mode ON (n = 1) or OFF (n = 0). When set to ON, the 501/601 will not execute keyboard commands, but each key closure will generate an ASCII character corresponding to the key pressed (see Appendix C). |
| | DMD | Enters the "DISPLAY" mode. All uppercase letters, all numbers, and the following punctuation marks can be sent to the display: " $ % & ' ( ) * + - . / = ? ] [ @ and _ . An ASCII "CR" will blank the display between the last character sent and the end of the display, and the next character will be displayed in position 1. An ASCII "LF" will blank the entire display, and the next character will be displayed in position 1. Lowercase letters "a" through "p" will position the internal cursor so that the next displayable character will be displayed in positions 1-16, respectively (numbered left to right). All control characters will be recognized during the DMD mode. |

NOTE:

A single period "." does NOT increment the cursor position.

A lowercase "z" will exit the display mode.

| TYPE OF COMMAND | COMMAND | ACTION CAUSED BY THIS COMMAND |
|---|---|---|
| MONOCHROMATOR CONTROL | GTO n | Causes 501/601 to "go to" wavelength n. (n = 195 to 999 for SPECTRONIC 601, n = 325 to 999 for SPECTRONIC 501). |
| LAMP | DEU n | Turns the DEUTERIUM LAMP ON (n = 1) or OFF (n = 0) (601 only). |
| | TUN n | Turns the TUNGSTEN LAMP ON (n = 1) or OFF (n = 0) (601 only). |
| | LCH | Outputs the current LAMP CHANGE wavelength (601 only). |
| | LCH n | Sets the LAMP CHANGE wavelength to n nanometers (320 to 380 nm) (601 only). |
| | LSV n | Turns the LAMP SAVE mode ON (n = 1) or OFF (n = 0). |
| UTILITY | HDG | Outputs the current HARDWARE ANALOG GAIN value. |
| | HDG n | Sets the HARDWARE ANALOG GAIN to n. The data field *must* consist of two characters in hexadecimal format. (range: n = 00–0F). This value is used by the 501/601 to establish zero A/100% T levels. The HDG and ZRR commands permit multiple wavelength testing. (see Appendix B for examples). |

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| | | |
|---|---|---|
| FLF | | Empties the data filter. (Data characters are ignored.) |
| ECH n | | Turns the CHARACTER ECHO mode ON (n = 1) or OFF (n = 0). |
| CCM n | | Turns the COMMAND COMPLETION ANSWERBACK mode ON (n = 1) or OFF (n = 0). |
| FLR n | | Turns the FLASHING "R" function ON (n = 1) or OFF (n = 0). When set to "ON", an "R" character will flash on the display. |
| FLT n | | Turns the FLASHING "T" function ON (n = 1) or OFF (n = 0). When set to "ON", a flashing "T" character will appear on the display. |
| RST | | Executes a POWER-ON RESET. |
| DIA n | | Executes a diagnostic test (number = n, refer to Section 6.4 of the SPECTRONIC 501/601 Operator's manual). |

NOTE

Not all diagnostics are designed to work with the serial ports.

| | | |
|---|---|---|
| ZRR | | Outputs the data currently residing in the zero register in 8-character hexadecimal format. |
| ZRR n | | Sets the zero register to n. (The data field must consist of 8 characters in hexadecimal format.) |

In ZRR format, ASCII characters for hexadecimal values 0 through F are entered in the following manner:

IIIIFFFF

where:

IIII—Whole integer value contained in the zero register.

FFFF—Fraction integer values contained in the zero register.

$$\text{ZERO REGISTER VALUE} = IIII + \frac{FFFF}{65536}$$

This data is used by the spectrophotometer in establishing the zero A or 100% T level. The ZRR and HDG commands permit multiple wavelength tests. See Appendix B for examples.

## 9.4 "IMMEDIATE" COMMANDS (FROM THE COMPUTER TO THE SPECTROPHOTOMETER)

| COMMAND | DECIMAL EQUIVALENT | RESULTING ACTIVITY |
|---|---|---|
| CONTROL-C* | 3 | Executes a POWER-ON RESET. |
| CONTROL-R | 18 | Executes a SND operation. |
| CONTROL-X* | 24 | Similar to a "reset", and used primarily to purge buffers. The serial input command interpreter is reset to an idle state. This command does *not* terminate a command execution that is already in progress. |
| CONTROL-T* | 20 | The 501/601 exits the DISPLAY (DMD) mode. |
| CONTROL-G | 7 | The 501/601 interprets this code as a BEP (BEEP) command. |
| CONTROL-W | 23 | The 501/601 interprets this code as a CHP (CHIRP) command. |
| CONTROL-K* | 11 | "Read Keyboard Immediate" operation. Displays an asterisk "*" when no keys have been pressed, otherwise displays ASCII character of the key pressed. Refer to Appendix C. |

* = No answerback

# APPENDIX A. ALPHABETICAL LIST OF COMMANDS

| | |
|---|---|
| ABS | Sets the ABSORBANCE mode |
| ABS n | Sets the ABSORBANCE mode and ABSORBANCE value = n. |
| BEP | An audible device in the 501/601 "beeps" for about one-half second. |
| CCM n | Turns the COMMAND COMPLETION ANSWERBACK mode ON (n = 1) or OFF (n = 0). |
| CHP | Causes 501/601 to "chirp" for about one-twentieth of a second. |
| CON | Sets the CONCENTRATION mode. |
| CON n | Sets the CONCENTRATION mode and CONCENTRATION value. |
| CTL-C | Executes a POWER-ON RESET. |
| CTL-G | The 501/601 interprets this code as a BEP (BEEP) command. |
| CTL-K | "Read Keyboard Immediate" operation. |
| CTL-R | Executes a SND operation. |
| CTL-T | The 501/601 exits the DISPLAY (DMD) mode. |
| CTL-X | Similar to a "reset", and used primarily to purge buffers. |
| CTL-W | The 501/601 interprets this code as a CHP (CHIRP) command. |
| DEU n | Turns the DEUTERIUM LAMP ON (n = 1) or OFF (n = 0) (601 only). |
| DIA n | Executes a diagnostic test. |
| DMD | Enters the "DISPLAY" mode. |
| ECH n | Turns the CHARACTER ECHO mode ON (n = 1) or OFF (n = 0). |
| FAC | Outputs the current FACTOR value. |
| FAC n | Sets the FACTOR. |
| FLF | Empties the data filter. |
| FLR n | Turns the FLASHING "R" function ON (n = 1) or OFF (n = 0). |
| FLT n | Turns the FLASHING "T" function ON (n = 1) or OFF (n = 0). |
| GTO n | Causes 501/601 to "go to" wavelength n. |
| HDG | Outputs the current HARDWARE ANALOG GAIN value. |
| HDG n | Sets the HARDWARE ANALOG GAIN to n. |
| HIL | Outputs the current HIGH LIMIT. |
| HIL n | Sets the HIGH LIMIT. |
| KLK n | Turns the "KEYBOARD LOCK" mode ON (n = 1) or OFF (n = 0). |
| LCH | Outputs the current LAMP CHANGE wavelength. |
| LCH n | Sets the LAMP CHANGE wavelength. |
| LOL | Outputs the current LOW LIMIT. |
| LOL n | Sets the LOW LIMIT. |
| LSV n | Turns the LAMP SAVE mode ON (n = 1) or OFF (n = 0). |
| RST | Executes a POWER ON RESET. |
| SIG | Outputs the current SIGNAL AVERAGE value. |
| SIG n | Sets the SIGNAL AVERAGE. |
| SND | Outputs current wavelength, data mode, and data value per selected format. |
| TRN | Sets the TRANSMITTANCE Mode. |
| TUN n | Turns the TUNGSTEN LAMP ON (n = 1) or OFF (n = 0) (601 only). |
| ZER | Sets ABSORBANCE = 0, CONCENTRATION = 0, or TRANSMITTANCE = 100% |
| ZRR | Outputs the data currently residing in the zero register in 8-character hexadecimal format. |
| ZRR n | Sets the zero register to n. |

# APPENDIX B. SAMPLE PROGRAMS

1. Obtain wavelength and absorbance data (referenced to air) of a sample at 775 nm.

```
            FORMAT = COMP
            ANS BACK = ON
```
___

```
10 PRINT #5, "ABS"        :REM SET X01 TO ABSORBANCE MODE
20 PRINT #5, "HIL .75"    :REM DISPLAY FLAG (*) IS A > 0.75
30 PRINT #5, "LOL .70"    :REM DISPLAY FLAG (*) IS A < 0.70
40 PRINT #5, "GTO775"     :REM CAUSE X01 TO "GOTO" 775 NM
50 INPUT #5, A$           :REM WAIT FOR MESSAGE "OK" WHEN THE X01 IS AT 775 nm
60 PRINT #5, "ZER"        :REM SET ABS TO ZERO WITH AIR IN THE SAMPLE BEAM
70 PRINT #5, "SND"        :REM CAUSE THE X01 TO OUTPUT THE DATUM OF THE SAMPLE IN THE SAMPLE BEAM
80 INPUT #5, "D$"         :REM INPUT THE DATUM FROM THE X01
90 PRINT D$               :REM PRINT THE DATUM ON THE CRT
```

2. Obtain wavelength and absorbance data (referenced to air) of a sample from 900 to 800 nm at 2-nm intervals. Correct the sample data for background absorbance.

```
            FORMAT = COMP
            ANS BACK = ON
```
___

```
10 DIM Z$(11), H$(11), D$(11)
20 LET X = 1
100 REM FIRST GOTO EACH WAVELENGTH, SET ZERO ABS, AND RECORD ZRR AND HDG
110 FOR WV = 900 TO 800 STEP − 10
120 PRINT #5, "GTO";WV    :REM GOTO THE DESIRED WAVELENGTH
130 INPUT #5, A$          :REM WAIT FOR "OK" WHEN THE GOTO IS DONE
140 PRINT #5, "ZER"       :REM SET ZERO ABSORBANCE
150 INPUT #5, A$          :REM WAIT FOR COMPLETION
160 PRINT #5, "HDG"       :REM ASK FOR THE HDG VALUE
170 INPUT #5, H$(X)       :REM READ IN THE HDG VALUE
180 INPUT #5, A$          :REM GET THE "OK"
190 PRINT #5, "ZRR"       :REM ASK FOR ZRR VALUE
200 INPUT #5, Z$(X)       :REM READ IN THE ZRR VALUE
210 INPUT #5, A$          :REM GET THE "OK"
220 LET X = X + 1
230 NEXT WV               :REM DO THE NEXT WAVELENGTH
300 REM   AT THIS POINT, THE PROGRAM SHOULD PAUSE AND PROMPT
310 REM   THE OPERATOR TO LOAD THE SAMPLE COMPARTMENT WITH THE
320 REM   MATERIAL TO BE MEASURED.
400 REM   NOW COLLECT THE DATA
410 LET X = 1
420 FOR WV = 900 TO 800 STEP − 10
430 PRINT #5, "HDG" :H$(X)    :REM LOAD THE HDG VALUE
440 INPUT #5, A$
450 PRINT #5, "ZRR":Z$(X)     :REM LOAD THE ZRR VALUE
460 INPUT #5, A$
470 PRINT #5, "GTO":WV        :REM GOTO THE WAVELENGTH
480 INPUT #5, A$
490 REM   AT THIS POINT, A WAIT LOOP IS NEEDED FOR SETTLING OF
500 REM   THE DATA READING. THIS WILL DEPEND ON DATA VALUES
510 REM   EXPECTED AND SIGNAL AVERAGING SPEED.
520 PRINT #5,"SND"        :REM ASK FOR THE DATA
530 INPUT #5, D$(X)       :REM GET THE DATA...
540 INPUT #5, A$          :REM ...AND WAIT FOR THE "OK"
550 PRINT D$(X)           :REM OUTPUT THE DATA HERE
560 LET X = X + 1
570 NEXT WV1              :REM DO THE NEXT WAVELENGTH
```

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# APPENDIX C. KEYBOARD LOCK MODE (KLK):
## TABLE OF ASCII CHARACTERS PRODUCED BY
## SPECTRONIC 501/601 KEYSTROKES

(CHARACTERS WILL ALSO BE PRODUCED FOLLOWING A **CTL-K**)

| KEY | ASCII CHARACTER |
| --- | --- |
| 0–9 | 0–9 |
| + – | + |
| < CLEAR > | C |
| < SEND > | S |
| < SECOND FUNCTION > | N |
| < DOWN > | D |
| < UP > | U |
| < %T/A/C > | T |

## INSIDE MAINTENANCE COVER

20. Lamp Interchange Mirror
21. Deuterium Lamp Adjustment Screw (SPEC 601)
22. Tungsten-Halogen Lamp Adjustment Screw
23. Thumbscrew (Deuterium Lamp; removable)
24. Deuterium Lamp (SPEC 601)
25. Deuterium Lamp Connector Wires (SPEC 601)
26. Deuterium Lamp Assembly Screw, fixed (SPEC 601)

27. Monochromator Entry Slit (not visible in drawing)
28. Tungsten-Halogen Lamp Socket
29. Tungsten-Halogen Lamp Shield
30. Tungsten-Halogen Lamp Vertical Adjustment Screw
31. Tungsten-Halogen Lamp
32. Tungsten-Halogen Lamp Shield Screw (2)

## TECHNICAL DATA

| | |
|---|---|
| Light sources | Tungsten-Halogen (325 to 999nm) Deuterium (195 to 380nm) (SP 601 only) |
| Monochromator | Modified Czerny-Turner with holographic grating (1200 lines per millimeter) |
| Detector | Single silicon photodiode |
| Wavelength range | 501: 325-999nm, 601: 195-999nm |
| Wavelength accuracy | $\pm 1.0$nm |
| Wavelength precision | Better than 0.5nm |
| Spectral slitwidth | $\leq 5$nm |
| Stray radiant energy | $\leq 0.05\%$ T at 220nm and 340nm |
| Photometric accuracy | $\pm 0.005$ A near 1.0A |
| Photometric stability | $\pm 0.003$ A per hour near 0 A |
| Noise | Less than 0.004 A near 2A nm Less than 0.0015 A near 0A |

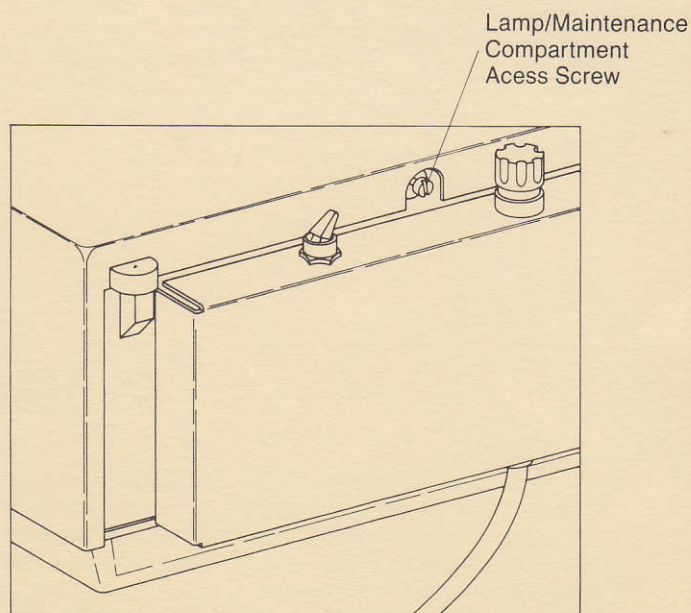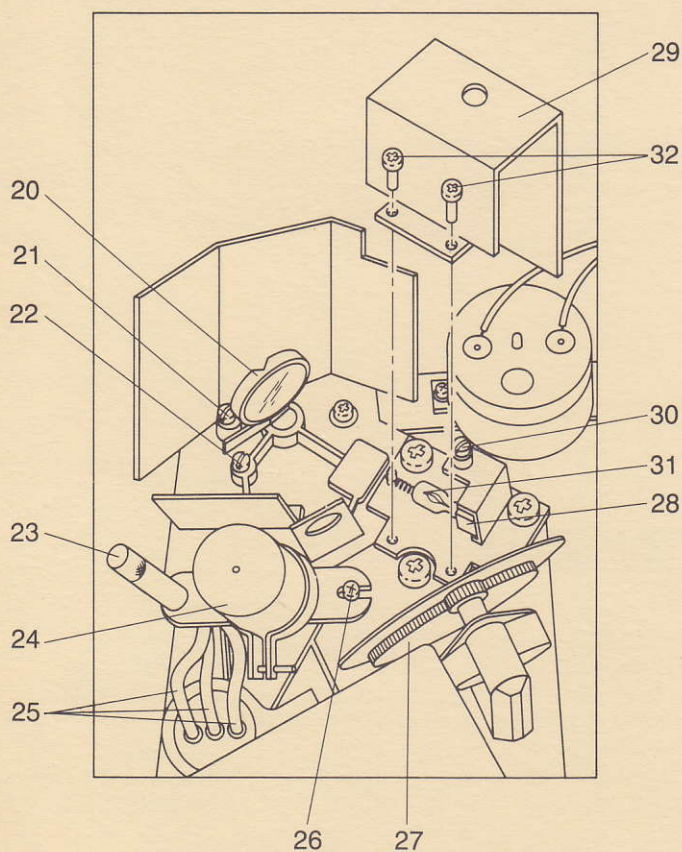| | |
|---|---|
| Photometric Ranges | Absorbance: $-0.1$ to 3.0 A Transmittance: 0.0 to 125% T concentration: $-9999$ to $+9999$ |
| Sample compartment dimensions | 10.2 cm (4 in) High x 10.6 cm (4.2 in) Wide x 17.1 cm (6.5 in) Deep |
| Power requirements | 100/115 and 220/240 V. $\pm 10\%$; 50/60 Hz, $\pm 2$ Hz; 2.0 A |
| Overall dimensions | 19.7 cm H x 44.5 cm W x 49 cm D; (7.75″ H x 17.5″ W x 14.3″ D). |
| Weight | 15 kg (35 lbs.) |
| Environment Operating | 50-105 F; 10-40.5 C. relative humidity 10-60%. |
| Storage | $-40$ to 105 F; $-40$ to 40.5 C; relative humidity not to exceed 60%. (Allow unit to adjust to room temperature for 24 hours when taking it out of storage.) |

# ⬯ MILTON ROY

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