

# UV/VIS SPECTROPHOTOMETER



## Instruction Manual



**Model : LUV-300**

Please read this manual carefully before using the instrument

**Labnics Equipment**

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## Chapter1 Principles of Operation

The general principles of spectrophotometer is based on the Beer's Law, which tells us that the concentration of a substance in solution is directly proportional to the 'absorbance', A, of the solution by the expression.

$$A = \log I_0/I = \log 1/T = kcL$$

Where,

T: transmittance,

$I_0$ : intensity of incident light,

I: intensity of transmitted light,

L: radiation path length through the solution, c: concentration of the substance,

k: extinction coefficient.

## Chapter 2 Environmental Requirements

### 2.1 Requirements for transportation and storage

During transportation, the instrument should be taken care to prevent rain, intensive sunshine and severe strike.

The instrument should be stored in the warehouse with shelter, avoiding acidic gas, alkali and other corrosive substances. The temperature of the warehouse should be in the range of  $-25^{\circ}\text{C}\sim 40^{\circ}\text{C}$ , humidity no more than 85%.

### 2.2 Site Requirements

The instrument should be installed in a place that satisfies the following requirements:

- (1) Avoid direct sunlight and ensure adequate ventilation.
- (2) Do not install the instrument where there may be corrosive gas or excessive dust.
- (3) Avoid placement where strong and sustained vibrations occur.
- (4) Keep away from devices that generate magnetic or Electric fields, or emit high frequency electromagnetic waves.
- (5) The instrument should be placed on a stable horizontal weight-bearable workbench. The back of the instrument should be at least 15cm away from the wall to ensure effective ventilation.
- (6) Keep away from high-temperature and high-humidity environments Operating temperature:  $5\sim 40^{\circ}\text{C}$   
Operating humidity: 85%
- (7) Power supply: AC voltage  $220\text{V}\pm 22\text{V}$  ( $110\text{V}\pm 10\text{V}$ );  
Frequency  $50\text{Hz}\pm 1\text{Hz}$  ( $60\text{Hz}\pm 1\text{Hz}$ );  
Total power consumption: 100W.
- (8) Power supply system required by the instrument should be a three-phase and four-line zeroing protection system.
- (9) To ensure the normal and reliable operation of the instrument, it is better to use a purified regulated power supply.

## Chapter3 Installation

### 3.1 Unpacking

When unpacking, please check the packing list to confirm that all items are included and in good condition. Should any parts be missing or damaged, contact the manufacturer immediately.

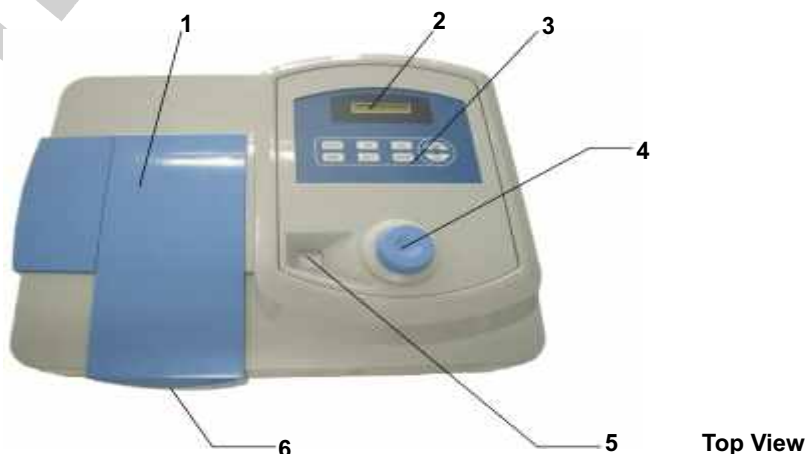
### 3.2 Installation

1. If a printer is used, connect the cable between the spectrophotometer and the printer. Then plug in the power cords of the printer and the Spectrophotometer.
2. Check the sample-holder by pulling its handle and feeling its different positions.
3. Close the sample compartment door.
4. Turn on the power switch of the spectrophotometer and then the printer. The spectrophotometer will enter measurement mode automatically.
5. Warm up the spectrophotometer for 15 minutes before starting measurements.

## Chapter 4

- |     |                            |   |   |
|-----|----------------------------|---|---|
| 1)  | Wavelength Range           | : | 190~1100nm<br>(D2 lamp: 190nm-350nm, tungsten lamp: 350nm-1100nm) |
| 2)  | Wavelength Accuracy        | : | ±2nm  |
| 3)  | Wavelength Reproducibility | : | =1nm  |
| 4)  | Photometric Accuracy       | : | ±0.5%T  |
| 5)  | Photometric Repeatability  | : | =0.3%T  |
| 6)  | Spectral Bandwidth         | : | 2nm   |
| 7)  | Photometric Range          | : | 0~200 %T, -0.300~3.000 A  |
| 8)  | Stability                  | : | 100%T: 0.5 %T/3min.<br>0%T: 0.3% T/3min.                          |
| 9)  | Optical System             | : | Plane grating as the dispersing element, 1200 L/mm                |
| 10) | Dimensions                 | : | 527×435×215 mm  |
| 11) | Weight                     | : | 17 kg   |

## Chapter 5 Instrument Descriptions:



**1) Sample compartment door**

Open the sample compartment door to put the sample cell into the cell holder. Measurements can only be made when the door is closed.

**2) LCD display**

Display different operation modes and measurement results. The transmittance (T%), absorbance (ABS) and concentration (CONC) values can be displayed on LCD as required.

**3) Operating keyboard**

Measurements and instrument functions can be realized via the keyboard.

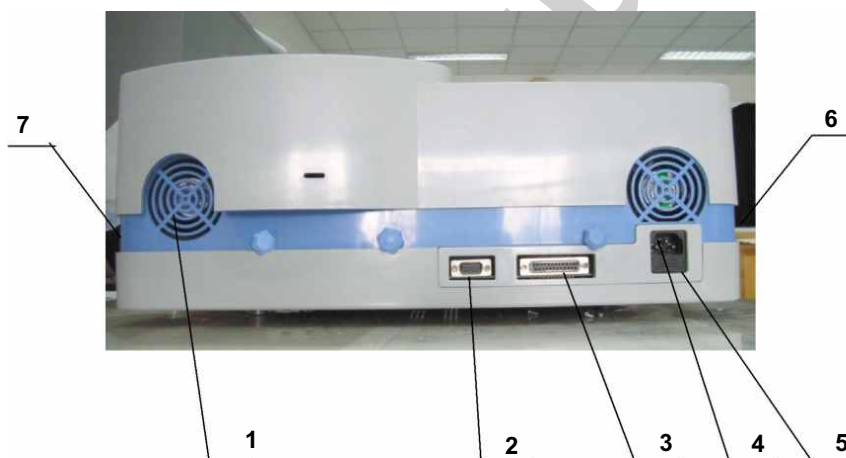
**4) Wavelength hand wheel**

Rotate the wavelength hand wheel to adjust wavelength. The wavelength indication is changed accordingly.

**5) Wavelength indication window** Indicate the current wavelength value.

**6) Pull-handle of sample cell-holder**

Pull the handle back and forth to change the position of the 4-cell sample holder.



**Back View**

1) Ventilating fan

2) RS-232 interface

3) Printer port

4) AC power outlet

5) Fuse

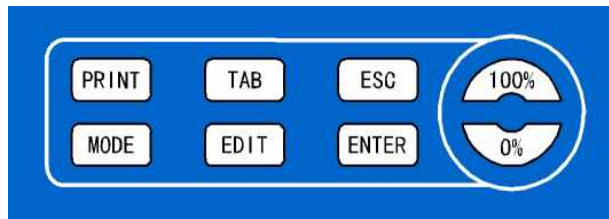
6) Deuterium lamp switch

Switch on the D2 lamp for UV range measurement. If the measurement range is in 350-1100nm, D2 lamp can be turned off to save D2 lamp lifetime. Warm up the D2 lamp for 15 minutes before UV range measurement is performed.

7) Power switch

## Chapter 6 Instrument Operation:-

### 6.1 Keyboard



The functions of the keys on the keyboard in different mode are described as follows:

#### **MODE key:**

Switch between MEASUREMENT MODE and CURVE MODE.

#### **EDIT key:**

- 1) In CURVE MODE, edit K and B values of current curve in Pre-view state under EDIT function.
- 2) In POINT EDIT MODE, edit A and C values of the blank or the existing standard points.

#### **100% key:**

- 1) In MEASUREMENT MODE, adjust T 100% and ABS 0;
- 2) In CURVE MODE, move the cursor to choose different functions;
- 3) In CURVE PRE-VIEW MODE, move the cursor to choose different curves;
- 4) As an arrow key [↑] to scroll up available data when inputting data.

#### **0% key:**

- 1) Adjust T to zero in MEASUREMENT MODE;
- 2) In CURVE MODE, move the cursor to choose different functions;
- 3) In CURVE PRE-VIEW MODE, move the cursor to choose different curves;
- 4) As an arrow key [↓] to scroll down available data when inputting data.

#### **ENTER key:**

- 1) Confirm current operation and come to next step;
- 2) In Pre-view state under LOAD function in CURVE MODE, load current curve and enter concentration measurement mode;
- 3) In Pre-view state under NEW function in CURVE MODE, set up a new curve at current curve position and enter POINT EDIT state; If there is already a curve in current curve position, system will ask whether to overwrite the original curve.
- 4) In Pre-view state under EDIT function in CURVE MODE, enter POINT EDIT state for current curve;
- 5) In POINT EDIT state, ask user if he wants to delete the existing standard point or not.

**ESC key:**

- 1) Quit current operation and return to previous operation.
- 2) Switch between CONCENTRATION MEASUREMENT MODE and STANDARD MEASUREMENT MODE.

**TAB key:**

- 1) In MEASUREMENT MODE, print a blank report head on the printer;
- 2) In CURVE MODE, switch among different functions and choose current function;
- 3) In CURVE PRE-VIEW state, switch between K and B display, and N and R display;
- 4) When inputting data, change cursor positions.

**PRINT key:**

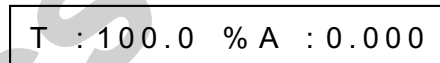
- 1) In MEASUREMENT MODE, print current measured results: transmittance, absorbance and concentration value;
- 2) In CURVE PRE-VIEW state, print parameter N, R, K, and B values of current curve;
- 3) In POINT EDIT state, print absorbance and concentration values of all the standard samples of current curve.

## 6.2 Display

The display of this spectrophotometer is a 16 characters X 2 lines LCD.

### 1. Standard measurement mode

The instrument enters this mode automatically after turning on, to display current transmittance (T) and absorbance (A) values, as shown in Fig. 1.

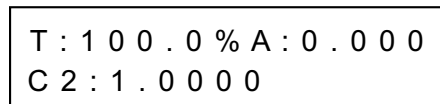


T : 100.0 % A : 0.000

Fig. 1

### 2. Concentration measurement mode

After loading standard curve correctly, the spectrophotometer enters this mode. In this mode, transmittance (T), absorbance (A) and concentration (C) values will be displayed. Letter "C" on the second line shows that concentration measurement is running. "2" following "C" as shown in Fig. 2 tells that the second standard curve is being used for concentration measurement.



T : 100.0 % A : 0.000  
C 2 : 1.0000

Fig. 2

### 3. Curve mode

Up to 10 standard curves numbered 0~9 can be stored and 10 standards numbered 0-9 can be used to set up a standard curve.

In Fig. 3, symbol "C>" shows that current mode is standard curve mode; "LOAD" means loading an existing curve for concentration measurement; "NEW" is for setting up a new standard curve with standard samples; "EDIT" is for editing K, B parameters of the curve and A, C values of the standards. Press "100%", "0%" or "TAB" key to locate the cursor at the item you want to choose, then press "ENTER" key to enter CURVE PRE-VIEW state of the corresponding function.

```
C > | L O A D   N E W   E D I T
```

Fig. 3

### 4. Curve Pre-view state

As shown in Fig. 4, "C>" shows that current mode is standard curve mode; the following "L>" means current function is LOAD (loading an existing curve). If "N>" follows "C>", the current function will be NEW (setting up a new curve with standards). If "E>" follows "C>", the current function will be EDIT (editing the curve). The numbers in the first line represent different curves. The blinking "0" tells that "0" curve is the current curve. Press "100%" and "0%" key to choose other curves. The second line displays the K and B values of the current curve. Press "TAB" key to switch between them. If there isn't any data for current curve, a prompt "Empty" will be displayed, as shown in Fig.5.

```
C > L >      0 1 2 3 4 5 6 7 8 9  
K : 1 . 0      B : 0 . 2
```

Fig.4

```
C > L >      0 1 2 3 4 5 6 7 8 9  
E m p t y
```

Fig. 5

Note: K is the slope of the curve; B is the intercept of the curve; N is the number of standards for establishing the curve; R is the relative coefficient of the curve. The equation of the curve is expressed as:  $A=KC+B$ , among them, A is the absorbance and C is the concentration.

### 5. Point Pre-view state

As shown in Fig.6, the meaning of the first two letters is the same with that in curve pre-view state. "2>" shows the current curve being edited is Curve No.2. The numbers following represent the standard sample points of the curve. For each curve, up to 10 standard points (numbered 0~9) can be stored. The blinking "1" tell you that No.1 point is being edited. Press "100%" and "0%" key to choose the other standards. The A and C displayed in the second line are the absorbance and concentration of the current standard sample. If there is no point for current curve, "Empty" will be displayed.

```
C > E > 2 > 0 1
A : 1 . 0           C : 0 . 2
```

Fig.6

## 6.3 Measurement

### 1. Adjustment before measurement

- 1) Turn on the spectrophotometer power switch. The instrument enters standard measurement mode automatically. Warm up the instrument for 15 minutes before measurement.
- 2) Rotate the wavelength hand wheel until the required wavelength value is indicated in the wavelength indication window.
- 3) Put the blank solution and the light block into the sample cell holder. Close the sample compartment door.
- 4) Pull the blank solution into the optical path. Press "100%" key until T value on LCD displayed 100% to adjust 100% T.
- 5) Pull the light block into the optical path to see if T value displayed is "0" or not. If not, press "0%" key to adjust zero.
- 6) Pull the blank solution into the optical path again to observe if T is 100% or not. If not, press "100%" key again to adjust 100% T. Repeat the procedure if necessary until 100% T and zero obtained with blank solution and light block respectively.

**Note:** If measurement is needed at another wavelength, go through the above procedure from step 2) for 100% T and zero adjustment. It's no need to warm up again.

### 2. Transmittance and absorbance measurement

After above instrument adjustment, put the sample into the sample holder and pull it into the optical path. The transmittance (T) and Absorbance (A) will be displayed on LCD.

**Important:** During measurement, if you find the transmittance for light block is not 0; the transmittance for blank solution is not 100%; and the drift is not in the permitted range, re-adjust the instrument as described above.

### 3. Concentration measurement

An existing standard curve should be loaded for concentration measurement. Please refer to Section 4 of this chapter for curve establishment. After instrument adjustment, put the sample into the sample holder and pull it into the optical path. To load a standard

- 1) Press "MODE" key to enter CURVE mode.
- 2) Choose "LOAD" function.
- 3) In CURVE PRE-VIEW state, move the cursor onto the curve number to be loaded and press "ENTER" key.

After a curve is loaded, system will return to concentration measurement mode automatically. As shown in the following figure, the value after C2 is the measured concentration value of the sample. "2" after "C" tells that No.2 curve is being loaded.

```
T : 1 0 0 . 0 %  A : 0 . 0 0 0
C 2 : 1 . 0 0 0 0
```

#### 4. Standard curve establishment

There are three ways to establish a standard curve:

- 1) Measuring the absorbance of standard samples;
- 2) Inputting concentration and absorbance of standard samples;
- 3) Inputting factor K and B of the curve.

##### 1) Measuring standard samples to establish standard curve

After instrument adjustment, put the standard samples into the sample holder. Press "MODE" key to enter "CURVE MODE". Press "100%", "0%" or "TAB" key to move the cursor to NEW function as shown in Fig.7. Then press "ENTER" key. The system enters CURVE PRE-VIEW state of NEW function.

```
C > L O A D | N E W E D I T
```

Fig. 7

In CURVE VIEW state, press "100%" or "0%" key to move the cursor onto the number at which you want to establish a curve. In Fig.8, No. 0 curve will be established. Fig.7

```
C > N > 0 1 2 3 4 5 6 7 8 9  
Empty
```

Fig. 8

Press "ENTER" key. If there has already been a curve at the position, system will display a prompt "Clr Curve?" to ask if you want to delete the current curve. Press "ENTER" key again to delete the original curve and enter POINT EDIT state as shown in Fig.9. If you don't want to delete the original curve, press "ESC" key to return.

```
C > E > 0 > |  
Empty
```

Fig.9

Press "EDIT" key to edit current standard point. Place the standard sample into the optical path. The system measures and displays the absorbance value automatically, as shown in Fig. 10.

```
C > E > 0 > |  
A : 1 . 2 3 4 5 C :
```

Fig.10

Press "ENTER" key to confirm the current absorbance value. The cursor will jump next to "C:" and the system will prompt to input the concentration value. Input the corresponding concentration value by using "100%", "0%" and "TAB" key. Press "ENTER" to confirm. Thus one standard point is established. System will give a

number to this established point automatically and move the cursor to the next standard number position to the right, as show in Fig. 11.

```
C > E > 0 > 0 |  
Empty
```

Fig. 11

Repeat the above procedure until all the standard points are established. Press “ESC” key to return to CURVE PRE-VIEW state. The system will calculate K, B, R and N value of the curve automatically and display them on the screen. Till now a standard curve is established.

- 2) Inputting absorbance and concentration of standards to establish a standard curve In CURVE MODE, press “100%”, “0%” or “TAB” key to move the cursor to the front of EDIT as shown in Fig. 12.

```
C > L O A D N E W | E D I T
```

Fig. 12

Press “ENTER” key to get into CURVE PRE-VIEW state under EDIT function. Press “100%” or “0%” key to move the cursor onto the number at which you want to establish a curve. As in Fig.13, No. 0 curve will be established.

```
C > E > 0 1 2 3 4 5 6 7 8 9  
Empty
```

Fig. 13

Press “ENTER” key to get into POINT EDIT state for establishing No.0 curve, as shown in Fig. 14.

```
C > E > 0 > |  
Empty
```

Fig. 14

Press “EDIT” key to input the absorbance value and concentration value as shown in Fig. 15. Press “100%”, “0%” or “TAB” key to input absorbance value and then press “ENTER” key to confirm. The cursor will jump to “C:” and the system will prompt to input the concentration value. Input the corresponding concentration value by using “100%”, “0%” and “TAB” key. Press “ENTER” to confirm. Thus one standard point is established. Then the cursor will blink at the next standard point position as shown in Fig. 16. Repeat the above procedure to input all standard points. After finishing, press “ESC” key. The system will calculate K, B, R and N value of the curve automatically and display them on the screen. Till now a standard curve is established.

```
C > E > 0 > 0  
A : 0 C : 0
```

Fig. 15

```
C > E > 0 > 0 |  
E m p t y
```

Fig. 16

3) Inputting K and B to establish standard curve.

In CURVE MODE, press “100%”, “0%” or “TAB” key to move the cursor to the front of EDIT as shown in Fig. 17.

```
C > L O A D N E W | E D I T
```

Fig. 17

Press “ENTER” key to get into CURVE PRE-VIEW state under EDIT function. Press “100%” or “0%” key to move the cursor onto the number at which you want to establish a curve. As in Fig.18, No. 0 curve will be established.

```
C > E > 0 1 2 3 4 5 6 7 8 9  
E m p t y
```

Fig.18

Press “EDIT” key to show Fig. 19. The cursor will blink behind “K=”, prompting you to input the slope of the curve.

```
C > E > 0 1 2 3 4 5 6 7 8 9  
K = | B =
```

Fig. 19

Press “100%”, “0%” or “TAB” key to input the slope value and then press “ENTER” key to confirm. The cursor will then blink behind “B:”, prompting you to input the intercept value of the curve as shown in Fig.20. Input the value by pressing “100%”, “0%” and “TAB” key. Then press “ENTER” key to confirm. Thus a standard curve is established.

```
C > E > 0 1 2 3 4 5 6 7 8 9  
K : 1 . 0 B : |
```

Fig. 20

## 5. Standard curve editing

The existing standard curve can be edited (modified) by changing its K and B factors or standard points. Please refer to Section 6.3.4 2) and 3) for standard points and K, B factor modifications.

## 6.4 Printing

It is recommended to use EPSON LQ-300K printer. All parallel printers compatible of ESC/PK command set can be used. Usually these printers support MS-DOS command. You can find if it has the function in the printer manual.

### 1. Printing the head of the report

In MEASUREMENT MODE, press "TAB" key to print the head of the report.

### 2. Printing measured data

In MEASUREMENT MODE, press "PRINT" key to print current measured result.

### 3. Printing curve factors

In CURVE PRE-VIEW state, press "PRINT" key to print the N, R, K, and B factors of the current if N and R factors are not available, it will only print out K and B factors.

### 4. Printing standard points of the curve

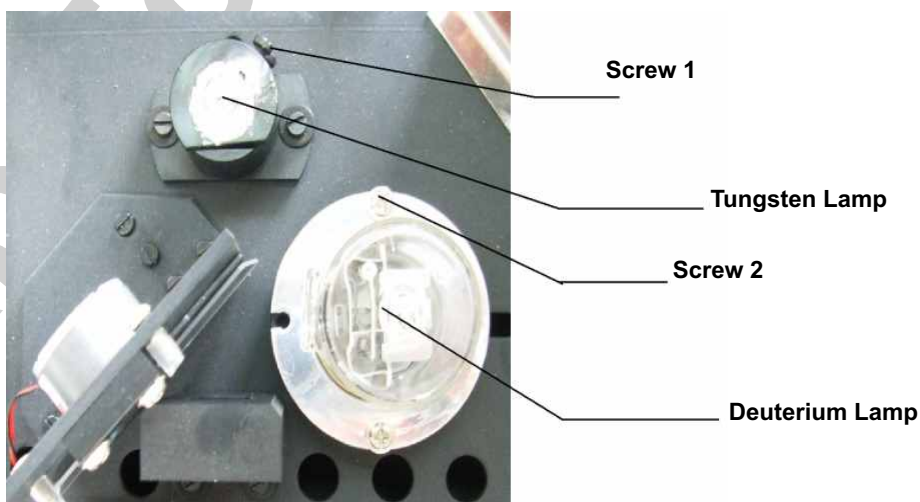
In POINT EDIT mode, press "PRINT" key to print the absorbance and concentration values of all the standard points of current curve.

## Chapter 7 Adjustments and Calibration

The replacement and adjustments of the light source and the calibration of wavelength shift can be made by the users according to the following procedures:

### 7.1 Replacement and adjustment of the light source

Replace or adjust the light sources according to the following procedures when needed:



Light source housing

### 1. Replacement of the deuterium lamp:

- 1) Switch off the instrument.
- 2) Loosen and remove the three locking screws at the back of the instrument and remove the wavelength hand-wheel. Lift the instrument cover from behind. Detach the light source housing cover. You will see the light source housing as shown in the above figure. Pay attention not to damage the connecting wires on the instrument.
- 3) Find the lead-wire connection board for deuterium lamp and tungsten lamp. The two green wires on the connector are corresponding to the tungsten lamp lead wires; the red wire and two black wires on the connector are corresponding to those of the deuterium lamp.
- 4) Loosen the three screws holding the D2 lamp lead-wires and remove the three lead-wires from the connection board.
- 5) Unscrew the two holding screws (as shown in the above figure, screw 2) on the deuterium lamp holder. Remove the deuterium lamp by pulling upwards from its holder.
- 6) Insert a new lamp into the lamp holder with care. Thread the three lead-wires out from the bottom of the lamp holder to the position on the connection board.
- 7) Screw down the two holding screws of the D2 lamp.
- 8) Connect the three lead-wires to the connection board securely and tighten the connection screws.

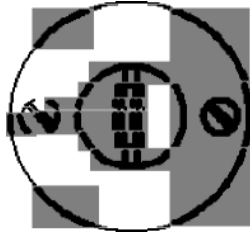
Note: Pay special attention to the color of the three lead-wires. The three lead-wires should be connected to the corresponding positions on the connection board (Red to red, and black to black).

### 2. Replacement of the tungsten lamp:

- 1) Switch off the instrument.
- 2) Loosen and remove the three locking screws at the back of the instrument and remove the wavelength hand-wheel. Lift the instrument cover from behind. Detach the light source housing cover. You will see the light source housing as shown in the above figure. Pay attention not to damage the connecting wires on the instrument.
- 3) Find the lead-wire connection board for deuterium lamp and tungsten lamp. The two green wires on the connector are corresponding to the tungsten lamp lead wires; the red wire and two black wires on the connector are corresponding to those of the deuterium lamp.
- 4) Loosen the two screws holding the tungsten lamp lead-wires and remove the two lead-wires from the connection board.
- 5) Loosen the holding screw (as shown in the above figure, screw 1) on the tungsten lamp holder. Remove the lamp upwards from the holder.
- 6) Insert a new lamp into the lamp holder with care. Thread the two lead-wires out from the bottom of the lamp holder to the position on the connection board.
- 7) Tighten screw 1.
- 8) Connect the two lead-wires to the connection board securely and tighten the connection screws.

### 3. Adjustment of the tungsten lamp

- 1) Connect the power cord of the instrument. Turn on the instrument power.
- 2) Set the wavelength between 350-1100nm.
- 3) Observe the beam spot of the tungsten lamp on the slit to see if the spot falls onto the center of the slit as shown in the below figure.
- 4) If it is not in the center, loosen screws 1, adjust the vertical position of the tungsten lamp so that the beam spot is located on the center of the slit. Then tighten screw 1.



## 7.2 Calibration of wavelength shift

### 1. Finding out wavelength shift

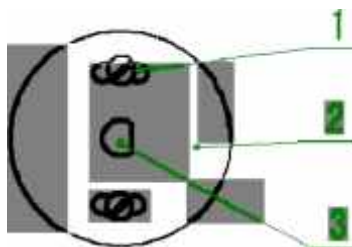
The value of wavelength calibration is based on the two peaks of didymium calibration filter 529.8nm and 807.7nm, and the difference between the two peaks  $277.9 \pm 2\text{nm}$ .

- 0) Adjust 100%T with blank.
- 1) Set the didymium calibration filter into the optical path.
- 2) Turn the wavelength hand wheel slowly and repeatedly around 529.8nm. The value (transmittance) on display will be changed from big to small, then from small to big. Stop the wavelength hand wheel when the minimum value is shown on the display. Record the wavelength value A at this point.
- 3) Turn the wavelength hand wheel to around 807.7nm and repeat procedure 3) to record the wavelength value B at this point.
- 4) If wavelength A and B are not exactly 529.8nm and 807.7nm, but their difference B-A is within  $277.9 \pm 2\text{nm}$ , a wavelength shift happens.

### 2. Wavelength shift calibration

If a wavelength shift is found out, the users can do the wavelength calibration according to the following procedures:

- 1) Turn off the power of the instrument.
- 2) Remove the three screws on the back of the instrument and the wavelength hand wheel. Lift and remove the instrument cover from behind. The screws as shown in the following figure can be seen.
- 3) Turn on the instrument. Rotate the wavelength adjusting shaft 3 slowly and repeatedly near 529.8nm until the minimum transmittance value is displayed.
- 4) Loosen screw (1). Adjust the wavelength dial 2 to set it at 529.8 nm. Then tighten the screw.
- 5) Rotate the wavelength adjusting shaft 3 to around 807.7nm and obtain the minimum display on the screen. Observe the wavelength display to see if the wavelength at that point is  $807.7\text{nm} \pm 2\text{nm}$  or not. If it is, the wavelength shift calibration is finished. If it is not, repeat the above procedure several times.



## Chapter 8 Trouble Shooting

SYMPTOM	POSSIBLE CAUSE	SOLUTION
There is no display after switching on and the lamp is not Lit. The display is on, but the lamp is not lit. Measuring results are not accurate.	Power cord isn't properly Connected or the fuse is blown.  Lamp is damaged.  a) Wavelength dial is loose. b) The sample cell holder blocks the light. c) The light source is unstable.	Connect the power cord securely Or replace a new fuse.  Replace a new one.  a) Calibrate the wavelength shift. b) Check the power supply of the Light source.
Data display is unstable	a) Light may be blocked in the Sample compartment. b) Ambient humidity is too high. c) The lamp is damaged.  d) There is suspension in the Sample to be measured. e) The power supply is unstable.	a) Take away the light block. b) Operate under dry Circumstance. c) Open the light source chamber and observe the lamp. If it blinks, replace a new one. d) Replace a new sample solution. e) Check the power supply.
Error Message is displayed: " E-0 T Overflow "	a) Sample compartment door is open;	a) Close the sampler compartment door;
Transmittance value is out of Range.	b) Another wavelength has been set after 100%T adjustment; c) Transmittance value is more than 200%.	b) Re-adjust 100%T; c) Check the sample and Operation procedure.
Error Message is displayed: "E-2 Energy Low" Light intensity is too low for 100%T adjustment.	a) Adjust 100%T when light is blocked ; b) Adjust 100%T using a substance with very high absorbance as the reference; c) Light source energy is too weak; d) Problem in light source or Optical system.	a) Check to make sure the current sample doesn't block the light; b) Make sure the analytical method used is correct; c) Contact a service engineer.
Error Message is displayed: "E-3 Energy High" Light intensity is too high for 0%T adjustment.	a) After adjusting 100%T using a substance with low transmittance, then adjust 0% T.	a) Adjust 100%T using blank, and then adjust 0%T using a light block.

Preheat the instrument for 30 minutes after it has been turned on.

**1. Wavelength Accuracy**

Put the didymium filter into the cell-holder and pull it into the optical path. Rotate the wavelength hand wheel in one direction to around 529.8nm. And find out the minimum display (transmittance). Record the wavelength value corresponding to the minimum display. This value should be in the range of  $529.8\text{nm} \pm 2\text{nm}$ . Then turn the wavelength hand wheel in one direction to around 807.7nm and get the wavelength value corresponding to the minimum display. The value should be in the range of  $807.7 \pm 2\text{nm}$ .

**2. 100%T stability: drift = 0.5%T in 3 minutes.**

After preheating, press "100%" key at 260nm (with D2 lamp on) and 500nm (with W lamp on) to adjust 100%T. Observe the transmittance change for 3 minutes. The drift should meet the requirement.

**3. 0%T stability: drift = 0.3%T in 3 minutes.**

After preheating, place a light block into the optical path to block the light. Press "0%" key to adjust the 0%T. Observe the transmittance change for 3 minutes. The drift should meet the requirement.