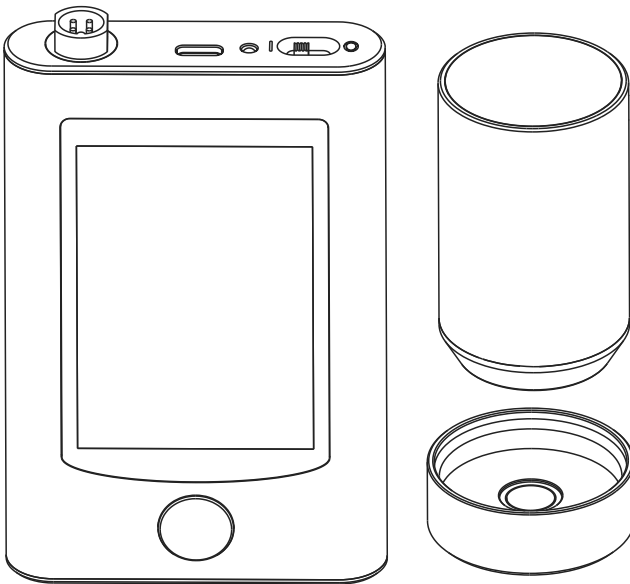


# MICRO-APERTURE SPECTROPHOTOMETER

OPERATION MANUAL



V1.0

Thank you for purchasing our products! Please read this manual carefully before use.  
After use, please keep it properly for the next use.

# Safety Instructions

This instrument is a very safe device; however, to ensure your correct and safe use, please carefully read and strictly adhere to the following terms to avoid accidental injury or harm. Losses incurred due to failure to follow the operating instructions in this manual are not the responsibility of our company.

<b>Battery</b>	<ol style="list-style-type: none"><li>1. This device has a built-in battery. Please use the original battery and do not replace it with other batteries to prevent damage to the instrument or other malfunctions.</li><li>2. Do not disassemble, squeeze, strike, or heat the battery. Do not place the battery in fire or high-temperature environments, otherwise it may cause the battery to explode and cause a fire.</li><li>3. After the instrument is fully charged, the external power supply should be disconnected when it is not in use to prevent electric shock or damage to the instrument.</li><li>4. If the instrument is not used for a long period of time, it should be charged once every two weeks. Otherwise, the internal battery may be damaged, making the instrument unusable.</li><li>5. For the first few charges, it's best to fully charge the battery and then use it until it's completely depleted, repeating this cycle three times to ensure the battery reaches its optimal condition for future use.</li></ol>
<b>External power supply</b>	<ol style="list-style-type: none"><li>1. When an external power source is required, please use the power adapter that comes standard with this instrument. Do not use other power adapters that do not meet the technical specifications, otherwise it may shorten the battery life or even cause electric shock, damage the instrument, or cause a fire.</li><li>2. If the instrument is not used for an extended period, the external power supply should be disconnected to prevent damage to the instrument or a fire.</li></ol>
<b>Instrument</b>	<ol style="list-style-type: none"><li>1. Do not use this instrument in the presence of flammable or combustible gases (such as gasoline), as this may cause a fire.</li><li>2. Do not disassemble the instrument yourself, otherwise it will be damaged. Dust or metal foreign objects may enter the instrument, which may cause a short circuit, electric shock, damage to the instrument, or even a fire.</li><li>3. If the instrument emits a burning or other unusual odor during use, stop using it immediately and send it to a repair shop for inspection and repair.</li></ol>

**Please keep this manual safe for future reference.**

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## Overview

This spectrophotometer is a high-precision spectrophotometer independently developed by our company with complete proprietary intellectual property rights. It is suitable for precise color transfer and quality control in industries such as plastics and electronics, chemical coatings, inks and printing, textile printing and dyeing, automotive electronics, medical analysis, cosmetics, and food analysis. It also has wide applications in research institutions and laboratories.

Under D/8° geometric optical illumination, this instrument provides accurate and stable color measurements, boasts a large storage capacity, is equipped with both USB and Bluetooth communication modes, and features powerful expansion capabilities in its PC-based color management software. It can accurately measure and describe various color difference formulas and color indices across multiple color spaces. The instrument's PC-based color management software also offers robust expansion capabilities.

## Note

- (1) This instrument is a precision optical measuring instrument. During measurement, drastic changes in the external environment should be avoided, such as flickering ambient light or rapid temperature changes.
- (2) During measurement, the instrument should be kept stable, the object being measured should be in close contact with the probe, and shaking or displacement should be avoided.
- (3) This instrument is not waterproof and should not be used in high humidity or water mist environments.
- (4) Keep the instrument clean and prevent liquids, powders, or solid foreign objects such as water and dust from entering the integrating sphere and the instrument. Avoid impacts and collisions to the instrument.
- (5) The standard board should be cleaned regularly with a wiping cloth to ensure that the working surface of the standard board is clean. The standard board should be stored in a dark, dry and cool environment.

(6) After use, the power should be turned off, and the instrument and standard plate should be placed in the instrument case and stored in a dry, cool environment.

(7) Users are prohibited from making any unauthorized modifications to this instrument. Any unauthorized modifications may affect the accuracy of the instrument or even cause irreversible damage.

## I .External structure and description

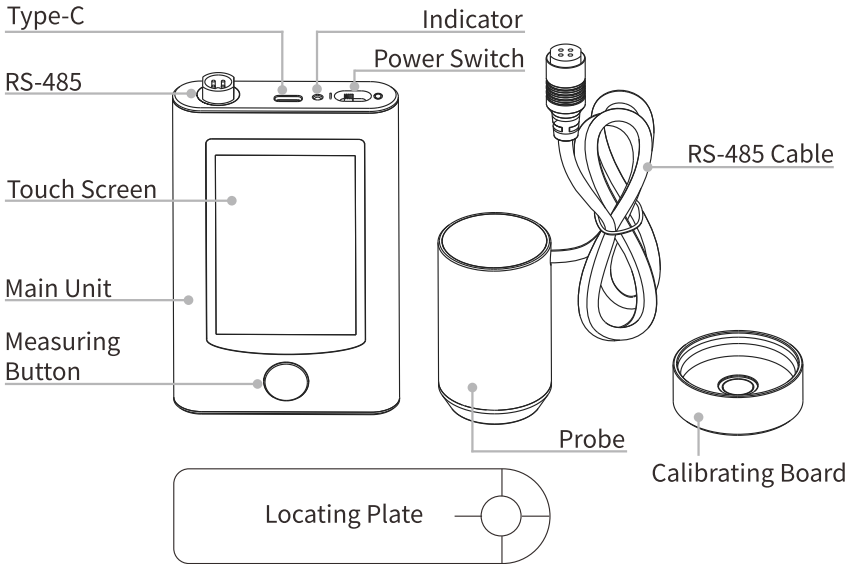


Figure 1 Schematic diagram of the instrument structure

**Power switch** : When the switch is turned to "1", the instrument is powered on; when the switch is turned to "0", the instrument is powered off and powered on. This switch is used for hard power-on/off.

**Type-C interface** : Used for connecting and communicating with a PC and charging the instrument. The external power supply charger is rated at 5V==2A.

**Test button** : Press briefly to wake the instrument in sleep mode, press briefly to measure in normal mode.

**LED indicator lights**: LEDs have two indicator colors, green and red, which are used to indicate the working status of the instrument.

When the device is powered on and charging, a green light will illuminate when the charge level is above 90%, and a red light will illuminate when the charge level is below 90%.

During normal startup, the instrument is in normal condition (power adapter not connected, black and white calibration within the validity period, battery level greater than 10%, instrument without faults). The green indicator light will be on for 10 seconds, flash during measurement, and turn off when measurement is complete.

When the instrument is in working mode, the red light will flash when the instrument's battery level is less than 10%.

**Touchscreen display**: The instrument can be interacted with directly by touch.

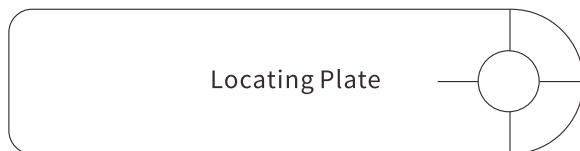
**Main unit**: Analyzes and displays the data measured by the probe.

**Positioning plate**: Used to fix the measurement position of the sample.

**Probe** : Used to collect spectral data of the sample to be tested.

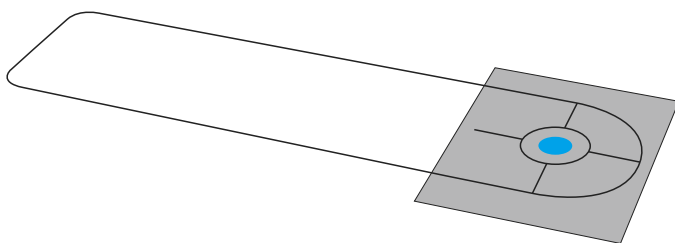
**RS-485 cable**: connects the probe and the host.

**Whiteboard box**: Contains a whiteboard, which is used during white calibration. Please refer to the black and white calibration section for details.

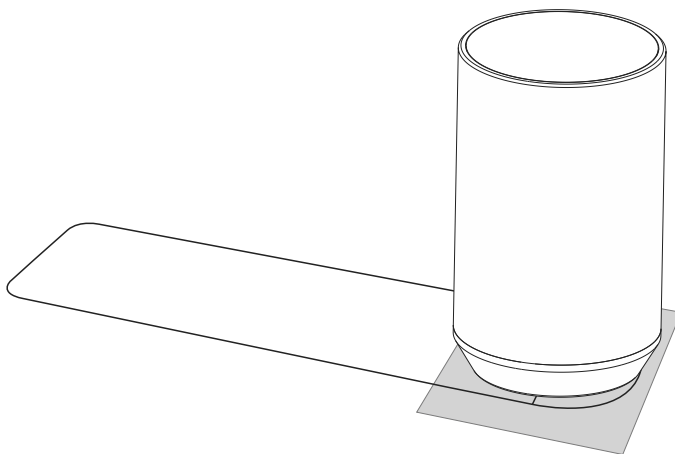


## Positioning plate usage

Step 1: Place the center of the positioning plate hole above the color to be tested.



Step 2: Insert the test probe into the hole in the positioning plate to take the measurement.






## II. Operating Instructions

### 2.1 Power on/off

As shown in Figure 1, when the power 1/0 switch is tossed to '1', the instrument is powered on and automatically enters the startup screen, and the instrument starts up. When the power 1/0 switch is tossed to '0', the instrument is powered off.

If the instrument remains inactive for an extended period while powered on, it will automatically enter sleep mode. To wake the instrument, briefly press the "Measurement" button or tap the LCD screen.

### 2.2 Black and White Calibration

Press the main menu button (  ) on the measurement interface to enter the main menu. On other interfaces, you can enter the main menu by clicking the confirmation button (  ) or the return button (  ) at the bottom , as shown in Figure 2.

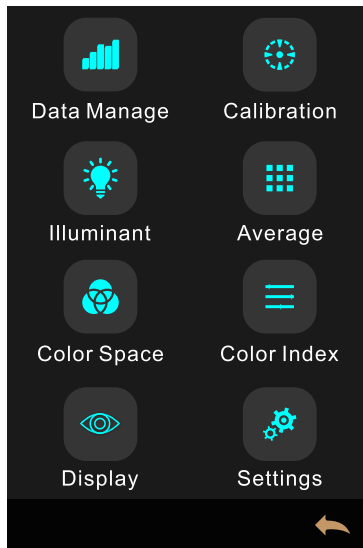


Figure 2 Main Menu

Click "Black and White Calibration" in the main menu to enter the "Black and White Calibration" interface, as shown in Figure 3. The interface will display whether the calibration is currently effective and the remaining effective calibration time.

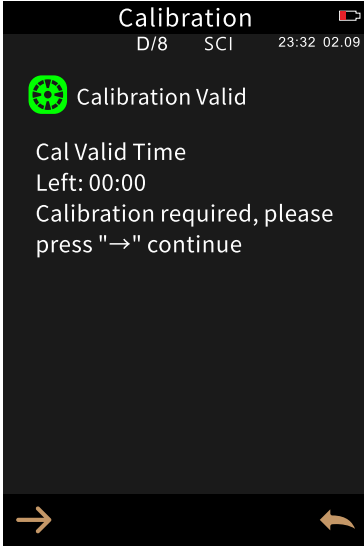


Figure 3 Black and white Calibration

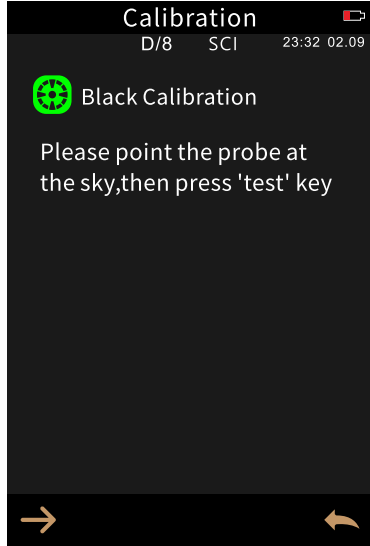


Figure 4 Black Calibration

Click “ → ” to continue the operation and enter the reflection black calibration interface shown in Figure 4. Follow the prompts to point the probe at an open and dark environment , then click the “Measure” button to perform black calibration. You can click the “Back” button ( ← ) to cancel the calibration.

When the black reflection calibration is complete, the white reflection calibration interface will be entered. According to the prompts, ensure that the measurement whiteboard number and probe connection are correct, attach the instrument probe to the whiteboard, and then click the "Measure" button to perform white calibration. If necessary, click the return button ( ← ) to cancel the calibration.

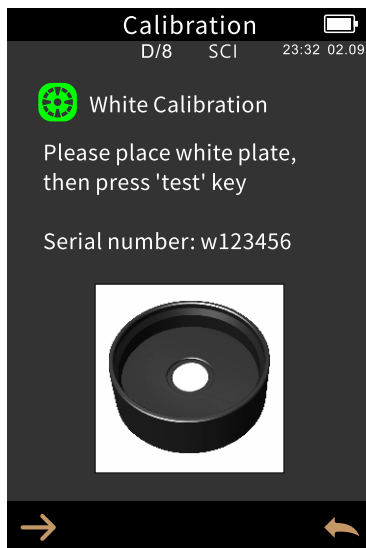


Figure 5 White Calibration

After the reflection white calibration is completed, the remaining calibration time will be displayed. Perform the corresponding operations as needed, and click the back button “ ← ” to return to the standard sample measurement interface.

## 2.3 Measurement Interface Description

As shown in Figures 6, 7, and 8, the upper part of the measurement interface is the working status area, where the instrument's measurement mode, Bluetooth status, and other settings are displayed in real time. The bottom of the test interface is the quick display area, where corresponding shortcut keys can be clicked to quickly switch test data. The middle part of the test interface is the data display area, where the instrument displays the corresponding colorimetric data according to the current user's settings. The bottom of the test interface is the operation button area, where clicking the corresponding operation buttons allows for operation of the current data. Figures 7 and 8 show the spectrum display area and color index display area, respectively, which can be quickly switched by clicking the down arrow key( ▼ ).

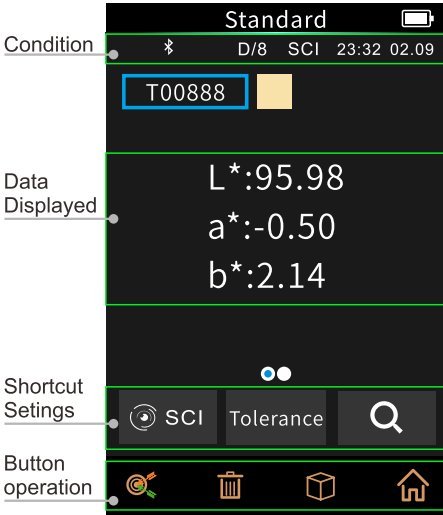


Figure 6 Colorimetric measurement interface

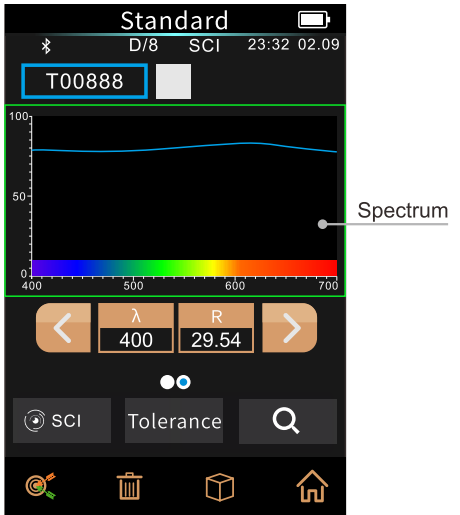


Figure 7 Spectral measurement interface

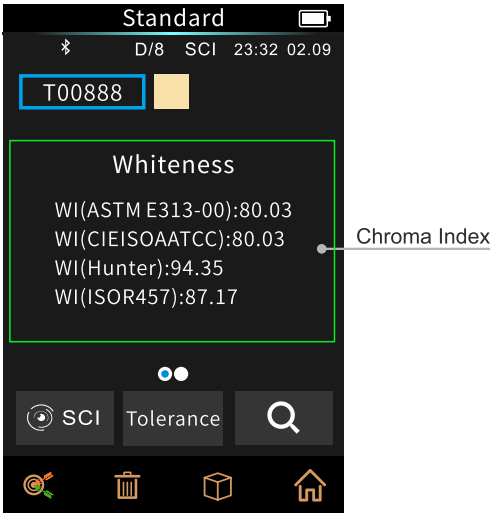



Figure 8 Color Index Measurement Interface

## 2.4 Measurement

Measurements are divided into standard sample measurements and specimen measurements.



Standard measurement is generally used to measure the colorimetric data of the target sample, while sample measurement is used to measure the color difference or contrast colorimetric data between the sample and the target sample.

After the instrument is powered on and the correct black and white plate calibration is completed, standard sample and specimen measurements can be performed. (Customers can set the corresponding color space and color index in the main menu interface as needed (see Chapter 3 for details). The system's default color space is CIE lab, the color difference formula is  $\Delta E^*ab$ , and the color index is empty.) If you are not currently on the measurement interface, you can click the return button on the interface(  )several times or press the "Measurement" button to return to the measurement interface.

### 2.4.1 Standard Sample Measurement

On the standard sample measurement interface, align the instrument probe with the sample to be tested and press it firmly. A buzzer will sound once, accompanied by the LED indicator flashing and then going out. The buzzer will then sound again, indicating the test is complete. The interface after the sample test is complete is shown in Figures 9 and 10. The standard sample interface will be explained in detail below.

- 1) Interface title : Indicates that you are currently in the standard sample measurement interface.
- 2) Status bar : Displays system settings information, such as lighting mode, Bluetooth icon, measurement mode, as well as current time, date, and battery level. If Bluetooth is enabled, the Bluetooth icon will be displayed in the status bar; otherwise, it will not be displayed.

- 3) Standard sample number : The current standard sample number, starting with "T" followed by the number, which is generated by the system to uniquely identify the standard sample.
- 4) Standard Sample Name : Displays the name of the currently tested sample. You can click to quickly modify it. The default is "No name".
- 5) Display mode: Displays the measurement mode for the current measurement data. This instrument only has the SCI measurement mode.
- 6) If the current test data does not support the mode selected by the customer or the measurement parameters are set incorrectly , the corresponding display may be "-".
- 7) Tolerance settings : Click to set the tolerance of the current standard sample.
- 8) Color search function: Click  the button to enter the color search interface and search for the color of the current standard sample.
- 9) Switch to sample measurement : Click to switch to sample measurement.
- 10) Delete/Save : When automatic measurement saving is enabled, click to delete the current measurement data. When automatic measurement saving is disabled, a save button will appear; clicking it will save the current test data.
- 11) Main Menu Button: Clicking the main menu button will take you to the main interface of the instrument's functions.
- 12) Page turning: Swiping left and right allows you to quickly switch between the data display area, the spectrum display area, and the color indicator display area (color index has been set) .
- 13) Wavelength switching button : As  shown in Figure 10, clicking the button will switch the wavelength and reflectivity of the current test sample at 10nm intervals.

# Spectrophotometer

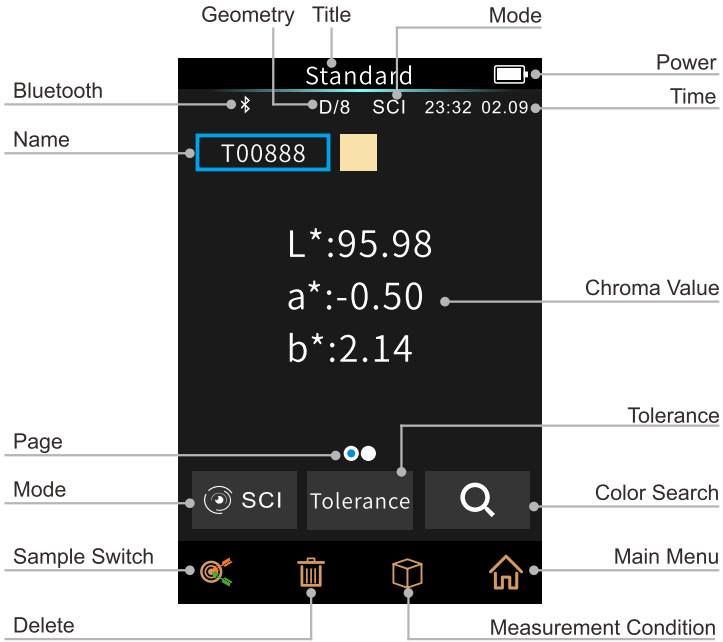


Figure 9 Standard Sample Measurement Interface

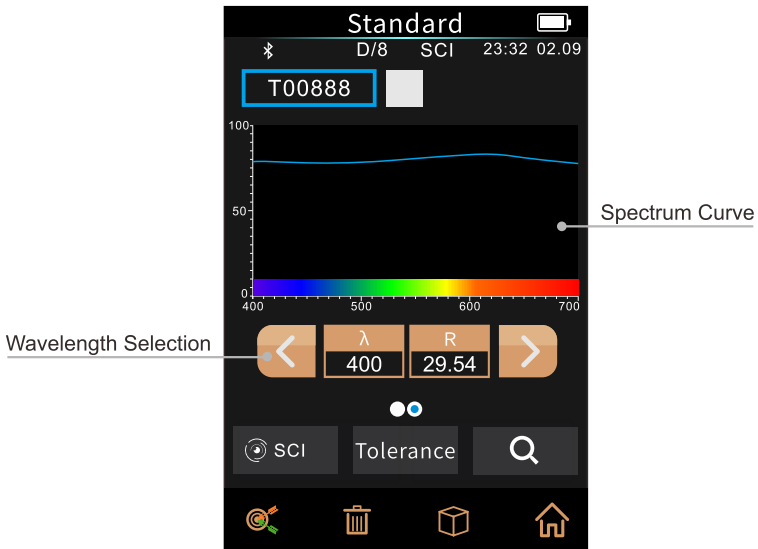


Figure 10 Standard sample measurement spectrum display interface

## 2.4.2 Sample Measurement


In the standard sample measurement interface, click "Sample Measurement" to switch to the sample measurement interface. Align the instrument probe with the sample to be tested and press the measurement button gently. The buzzer will beep once, accompanied by the LED indicator flashing and then going out. The buzzer will beep again, indicating that the measurement is complete. The interface after the sample measurement is complete is shown in Figures 11 and 12. The sample measurement interface is similar to the standard sample measurement interface, except that it displays the difference between the current sample and the current standard sample colorimetric data.



The following is a detailed explanation of the sample measurement.

- 1) Interface title : Indicates that you are currently in the sample measurement interface.
- 2) Standard sample number : The current standard sample number, starting with "T". All color difference values of the current sample are based on the current standard sample.
- 3) Sample number : The current sample number, starting with S followed by numbers, is generated by the system to uniquely identify the current sample.
- 4) Sample Name : Displays the name of the current test sample. Click to quickly modify it. The default is No name.
- 5) Display mode: Displays the measurement mode of the current measurement data. This instrument only has the SCI measurement mode.
- 6) Sample colorimetric value: Displays the colorimetric data of the sample in the current display mode.
- 7) Color difference value: Displays the difference between the color value of the sample and the color value of the standard sample in the current display mode.
- 8) Measurement Results : Displays the test results of the current sample, determined by the tolerance of the standard sample and the specified color difference formula. If the color difference value exceeds the tolerance, it will be displayed in red as "Unqualified"; otherwise, it will be displayed in green as "Qualified". This will only be displayed if "Display Measurement Results" is

enabled in the system settings.

9) Color Bias : The color bias of the current sample compared to the standard. This will only be displayed if color bias is enabled in the system settings.

10) Color search function: Click  the button to enter the color search interface and search for the current sample.

11) Wavelength switching button :   As shown in Figure 12, Click the button to switch between the current measurement of the sample wavelength, sample reflectance, and the difference in reflectance between the sample and the standard sample at 10nm intervals.

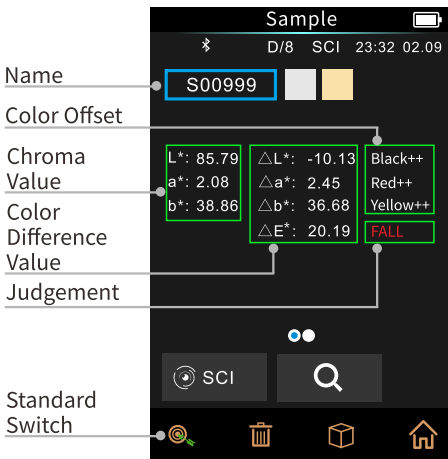


Figure 11 Sample measurement interface

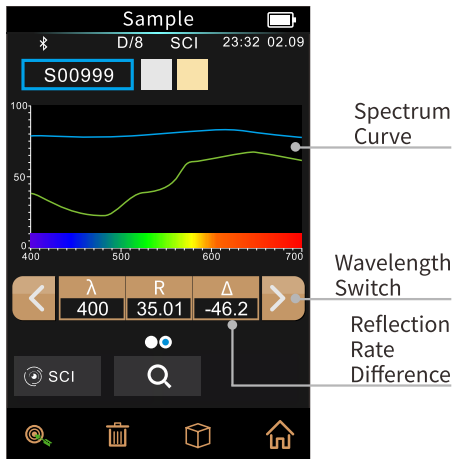


Figure 12 Standard sample measurement spectrum display interface

### 2.4.3 Average Measurement

When the sample being tested is relatively large or not very uniform, by measuring multiple representative test points to obtain the average reflectance at multiple points, the calculated colorimetric data can better represent the true colorimetric value of the sample being tested. This instrument can achieve an average measurement of 2 to 99.

On the main menu, click "Average Measurement" to enter the average measurement interface, then enter the number of average measurements and click "✓" to Confirm.

If the average number of inputs is 1, the measurement will be performed in the normal manner; if it is greater than 1, the measurement result will be calculated and output after averaging the set number of measurements when measuring the standard sample/sample.



Figure 13 Average number of measurements

## 2.5 Color Search Function

### 2.5.1 Color Search

The color matching interface displays the current target color (i.e., the currently selected standard/sample data). It automatically matches similar colors from color charts ( **eight color charts are available** ). Two data points are displayed per page, as shown in Figure 14. Pages can be scrolled up and down using the " ▲ " and " ▼ " buttons, with a maximum of six data points displayed. The color difference error range is within 10. If the error exceeds this range or no similar color chart data is found, the page will be empty, as shown in Figure 15. To filter different color charts using the color matching function, see Figure 16.

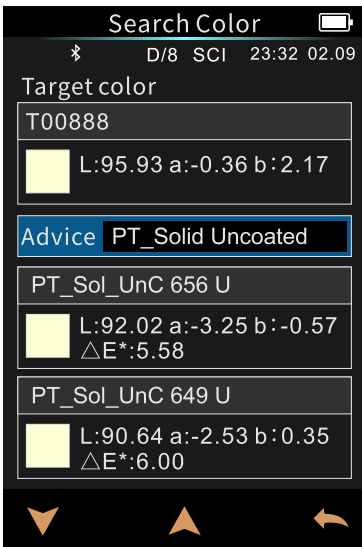


Figure 14 Color search function interface -1

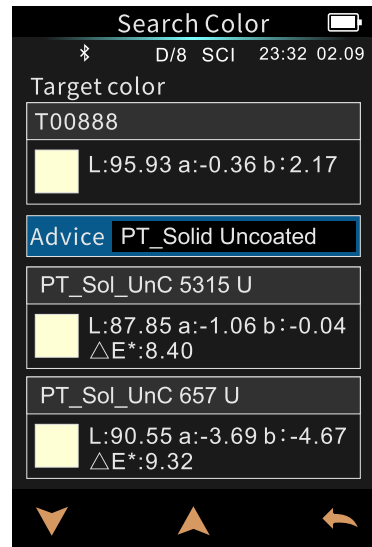


Figure 15 Color Search Function Interface - 2



Figure 16 Selecting a Color Chart



Figure 17 Color matching hint interface

## 2.5.2 Color Search - Filtering Criteria

To access the color search interface, the measurement mode must be set to SCI mode, the standard light source to D65, the observer angle to 10°, and the measurement data must not be empty. **All of these conditions are mandatory**. If any one of these conditions is not met, you will not be able to access the color search interface and use the color search function. The prompt message is shown in Figure 17 below.

## 2.6 Communication with PC

The PC software offers robust functionality expansion, enabling more colorimetric data analysis. The main unit of this instrument series can communicate with the PC software via USB data cable and Bluetooth module (only models equipped with Bluetooth module are supported). The probe can be connected to the PC software independently via RS-485 cable.

## 2.6.1 Communication with PC via USB

With the client software installed on the PC, connect the instrument to the PC using a USB cable. The connection will be automatically recognized; if successful, the instrument's measurement interface will display a USB connection icon; otherwise, it will not. Once connected, the software allows for comprehensive control of the terminal instrument and the testing and analysis of relevant samples.


## 2.6.2 Communicating with PC via Bluetooth

For instrument models equipped with a Bluetooth module, communication with a PC can be achieved via Bluetooth.

With the client program installed on the PC, enable Bluetooth in the instrument's "System Settings" and pair the computer with the Bluetooth device. After successful pairing, the software will connect via Bluetooth. A Bluetooth icon will appear in the lower right corner of the software, indicating a successful Bluetooth connection. The software then allows for comprehensive control of the terminal instrument and the testing and analysis of relevant samples.

## 2.7 Print

Mini printers are non-standard accessories and need to be purchased separately.

Users can first perform colorimetric data testing on the sample, save the sample record to be printed, connect the mini printer to the instrument via USB, find the sample record to be printed in the standard sample record or sample record, as shown in Figure 18, click  to bring up a dialog box, as shown in Figure 19, select "Print Data" in the pop-up menu, the instrument sends the data of the current record in the current mode to the printer, and the printer completes the printing work.

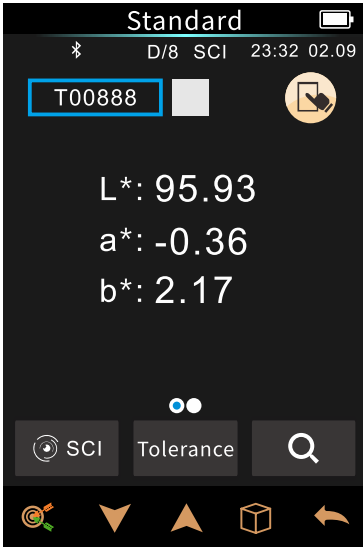


Figure 18 Printing Operation

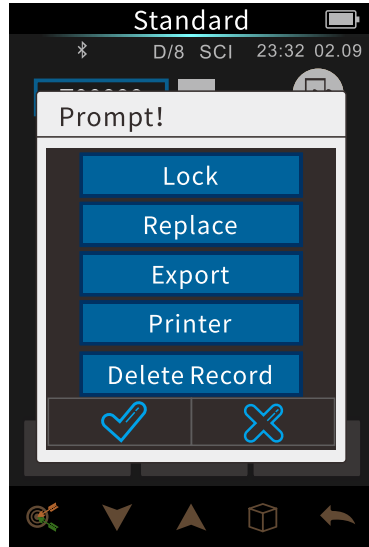




Figure 19 Printing Operation Interface

### III. System Function Description

On the measurement interface, click the main menu button (  ) to enter the main menu. On other interfaces, you can enter the main menu by clicking the back button (  ). From the main menu, you can access the sub-menus to realize all system function settings.

#### 3.1 Data Management

Click "Data Management" in the main menu to enter the data management interface, as shown in Figure 20. Data management mainly allows you to view and manipulate the measured records.

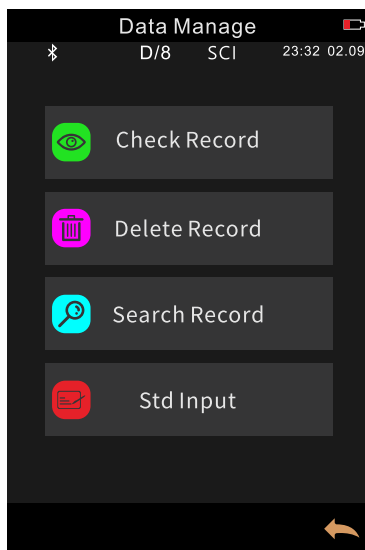


Figure 20 Data Management Interface

### 3.1.1 View Records

#### 1) Review the standard sample record

Click "View Records" in the data management interface to enter the "Standard Sample Records" interface, as shown in Figure 21. The measurement conditions display the illumination method and measurement mode used for the standard sample, while the measurement time and measurement date indicate the time and date when the standard sample was measured.

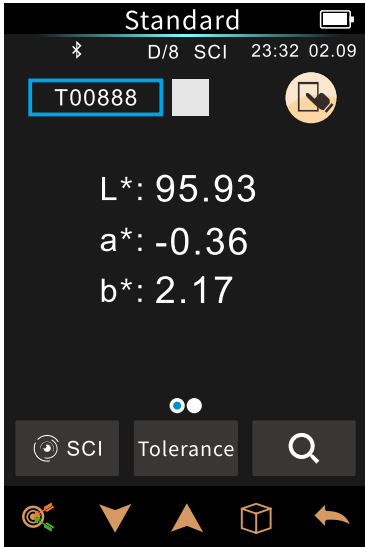


Figure 21 Standard Record Interface

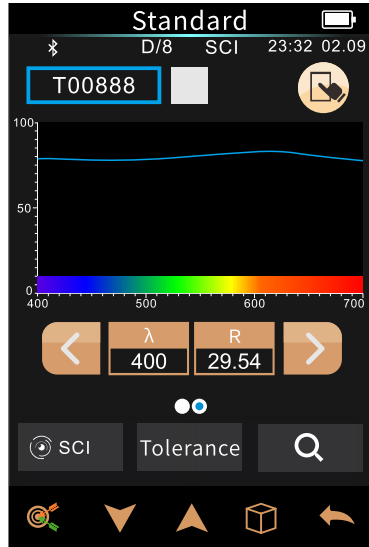


Figure 22 Reflectance Spectrum of standard sample record

Click ▼ to view the next record, click ▲ to view the previous record. By swiping left and right with your finger, you can switch between the chromaticity data interface, the reflectance display interface, and the color index interface, as shown in Figures 21 and 22.

Click on the specimen name to edit it (as shown in Figures 23). Enter a new name (note that the name can only contain a maximum of 8 characters), and then click ✓ OK. To cancel, click ↶.

Clicking 🗑️ allows you to delete records, print data, import standards, reset standards, and lock standards, as shown in Figure 24.

To delete a record: Click "Delete Record" to enter the record deletion interface, then click "Confirm" to complete the deletion; or click "Cancel Deletion" to return to the operation menu.

Print Data: Click "Print Data". If you connect a mini printer (optional, to be purchased separately), you can print out the current sample data.

Importing Standard Samples: Clicking "Importing Standard Samples" will set the currently viewed standard sample as the current standard sample, as shown in Figure 25 . Then, clicking "Sample Measurement" will allow you to perform sample measurement under that standard sample.

Standard Reset: By clicking "Standard Reset", users can replace the current standard with a new standard. The samples under the current standard will not be affected.

Standard Sample Lock: Clicking "Standard Sample Lock" allows users to lock the current standard sample, preventing accidental operations. While locked, the sample cannot be deleted or its name edited. To operate on a locked standard sample, it must first be unlocked.

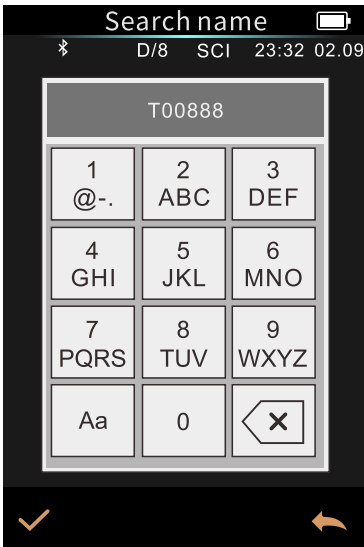


Figure 23 Name Editing Interface

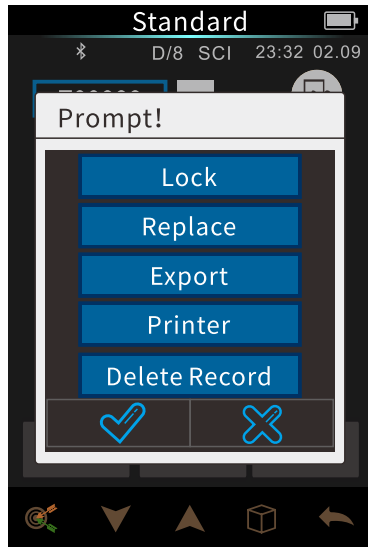


Figure 24 Standard Sample Record Operation Menu

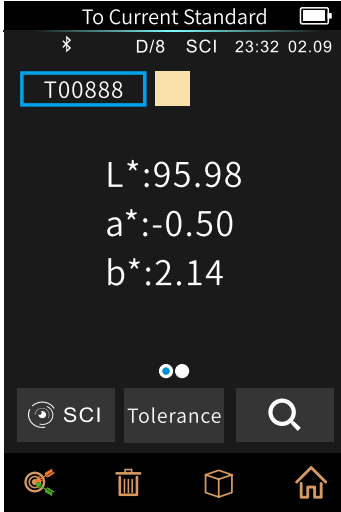


Figure 25 Standard Loading Interface

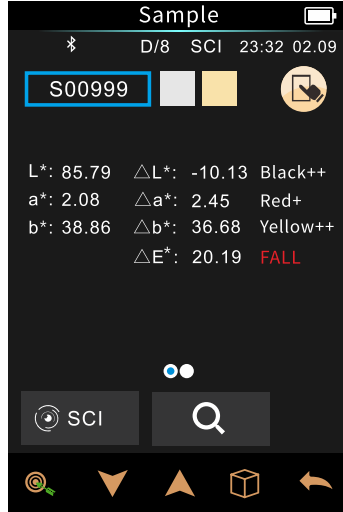


Figure 26 Sample record interface

## 2) Review the sample record

Click "Sample" in the standard sample record interface to view the sample record under the standard sample, as shown in Figure 26 .

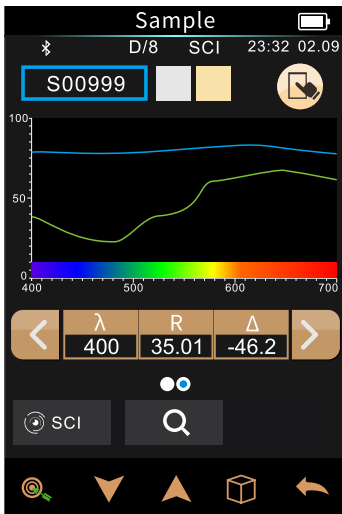




Figure 27 Reflectance Spectrum of sample records

Click  to view the next record, click  to view the previous record.

Swipe left or right with your finger to switch between the chromaticity data interface, reflectance display interface, and color index interface, as shown in Figures 26 and 27 .

Click on the sample name to edit the sample name (as shown in Figure 23 ). Enter a new name (note that the name can only contain a maximum of 8 characters), and then click  ; to cancel, click  .



Clicking  allows you to delete records, print data, and import standards .

The options for deleting records and printing data are the same as those for standard record operations.

Import Standard Sample: Clicking "Import Standard Sample" will set the currently viewed sample record as the new current standard sample. Then, clicking "Sample Measurement" will allow you to perform sample measurement under this standard sample.

### 3.1.2 Deleting Records

In the data management interface, click "Delete Record" to enter the delete record menu interface, as shown in Figure 28. Delete records are divided into "Delete All Samples" and "Delete All Records".

Clicking the corresponding option will first take you to the deletion warning interface. Clicking  on the warning interface will delete all records or all data in the corresponding area; to cancel, click  , as shown in Figure 29.

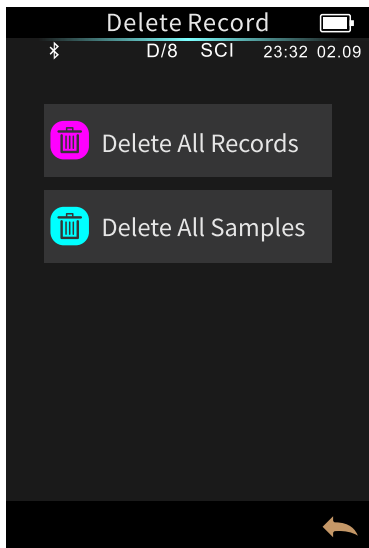


Figure 28 Delete Record Menu Interface

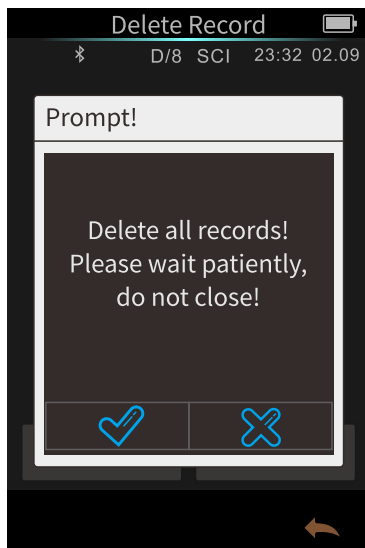


Figure 29 All records deletion prompt warning interface

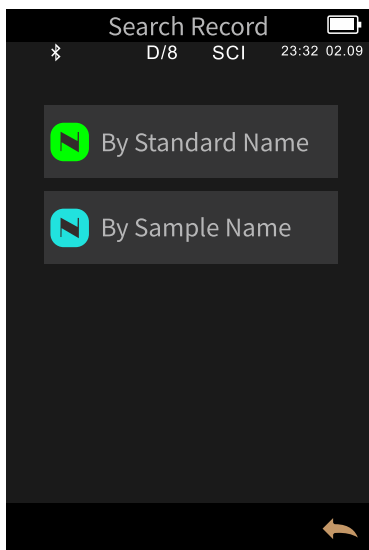





Figure 30 Search menu interface

### 3.1.3 Search History

In the data management interface, click "Search Records" to enter the search menu, as shown in Figure 30. You can choose "Search by Standard Name" or "Search by Sample Name".

#### Search by name

Click "Search by Name for Standard Samples" and a search name input interface will pop up, as shown in Figure 31. Enter the name to search for or characters contained in the name, and then click "  " to confirm. The instrument will automatically perform a search in all standard sample records and list the standard sample records that meet the criteria, as shown in Figure 32. Click (  ) and (  ) to view all records that meet the filter criteria. If no matching record is found, it will prompt "This record does not exist" and return to the search record menu (as shown in Figure 33).

#### Search by name /style

The operation steps are the same as "Search by Name ". After starting the search, it will search all patterns. It takes a long time to wait. The search results are the same as the standard pattern search. Only five data will be listed.



Figure 31 Window for entering search names

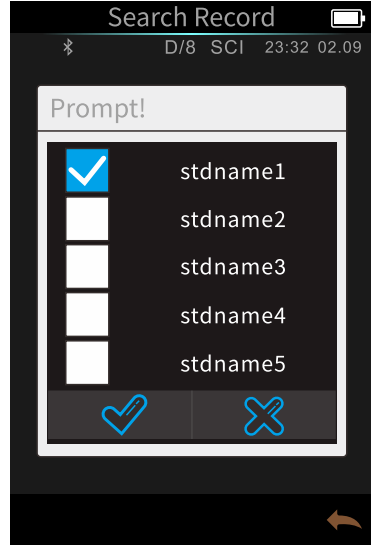


Figure 32 shows the standard sample found.



Figure 33 shows the message "No record found".

### 3.1.4 Standard Sample Input

Click "Standard Input" in the data management interface to enter the standard input interface, as shown in Figure 34.

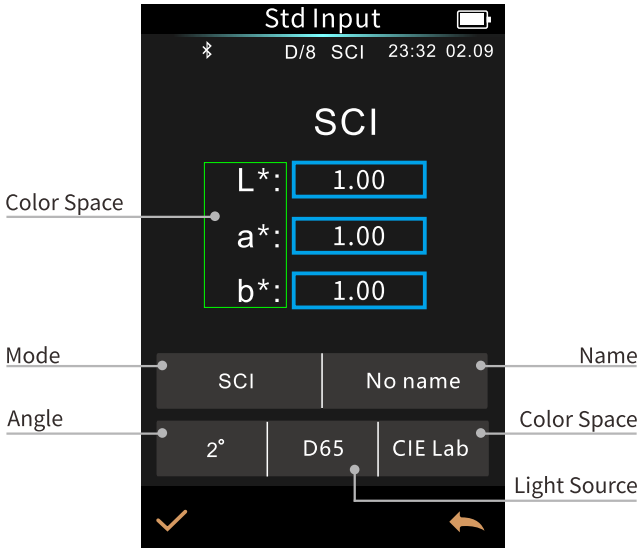


Figure 34 Standard Sample Input

Clicking on the name field allows you to edit the name of the currently entered sample; the default is "No Name".

Click on the measurement mode setting to input the standard sample measurement mode, which is divided into SCI, SCE, and SCI+SCE. This instrument currently only supports SCI mode.

Click on the standard light source to set the lighting source for the input standard sample.

Click on the color space and select the color space to input. Currently, only color values from the CIELAB and CIEXYZ color spaces are supported.

Click on Observer Angle to set the observer angle for the input standard sample.

Click on the corresponding chromaticity coordinates, enter the chromaticity value at the corresponding coordinates, as shown in Figure 35 . Click on the L coordinate, and the L input window will be displayed. Enter the corresponding L value and confirm.

After entering all the information for the standard sample and clicking " ✓ " to confirm, the standard sample will be stored in the standard sample record list, and its sample number will be incremented sequentially.

Note: Manual input of standard samples on the instrument only supports CIE Lab/XYZ chromaticity coordinates. To input the reflectance of the standard samples, it must be done through the host computer software and then downloaded to the instrument. The input standard sample data is matched with specific observer angles, illumination sources, and viewer angles. To view the input standard sample data, the corresponding conditions must be set correctly. In the standard sample record viewing interface, if the observer angle, test mode, or light source changes, the corresponding chromaticity data will be displayed as "- -".



Figure 35 shows the coordinates of input L.

## 3.2 Black and white Calibration

Black and white board calibration is the benchmark for colorimetric data measurement and must be performed accurately, otherwise the accuracy of the test data will be affected.

When the black and white plate calibration environment differs significantly from the current sample testing environment (e.g., drastic fluctuations in temperature and humidity) or when there are obvious anomalies in the data, it is necessary to perform black and white plate calibration on the instrument in a timely manner.

If the instrument has been used continuously for 8 hours or if the instrument has been turned on and off repeatedly, it is also recommended to perform a new blackboard calibration.

The whiteboard should be cleaned regularly, and the optical trap should be cleaned of dust periodically. The calibration tube should be properly stored in a light-proof, dust-proof, and dry environment.

For blackboard calibration methods, please refer to Section 2.2.

## 3.3 Light Source Setup

Customers set the appropriate light source according to the actual test conditions. The standard observer angle and standard light source type can be set in the light source settings interface. Click "Light Source Settings" in the main menu to enter the light source settings interface, as shown in Figure 36 .

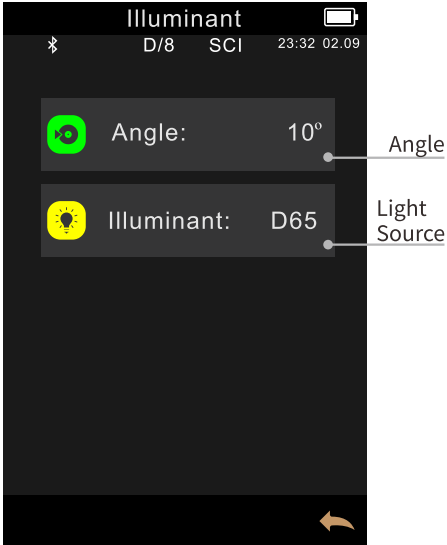


Figure 36 Light Source Settings Interface



Figure 37 Light Source Selection Window

Clicking on the observer's angle allows you to switch between 10° and 2°. 10° follows the CIE 1964 standard, while 2° follows the CIE 1931 standard.

Click on the light source, as shown in Figure 37. In the light source selection window, the customer can select from a variety of light sources, including: D65, A, B, C, D50, D55, D75, F1, F2 (CWF), F3, F4, F5, F6, F7 (DLF), F8, F9, F10 (TPL5), F11 (TL84), F12 (TL83/U30), U35, NBF, ID50, ID65, LED-B1, LED-B2, LED-B3, LED-B4, LED-B5, LED-BH1, LED-RGB1, LED-V1, LED-V2, etc.

### 3.4 Average Measurement

When the sample being tested is relatively large or not very uniform, by measuring multiple representative test points to obtain the average reflectance at multiple points, the calculated colorimetric data can better represent the true colorimetric value of the sample being tested. This instrument can achieve an average measurement of 2 to 99.

On the main menu, click "Average Measurement" to enter the average measurement interface, then enter the number of average measurements and click " ✓ "to confirm.

If the average number of inputs is 1, the measurement will be performed in the normal manner; if it is greater than 1, the measurement result will be generated by averaging after the specified number of measurements when measuring standard/sample.

### 3.5 Color Space

Click "Color Space" in the main menu to open the color space interface, as shown in Figure 38. Select the corresponding color space in the color space interface, and then click ✓ to complete the color space setting.



Figure 38 Color Space Interface

## 3.6 Color Index

The color index interface allows you to select the currently used color difference formula and color index, and also allows you to set the parameter factors for the color difference formula and metamerism index, as shown in Figure 39 .

### 3.6.1 Setting the color index

Click "Color Index" in the main menu to enter the Color Index window, as shown in Figure 39 .

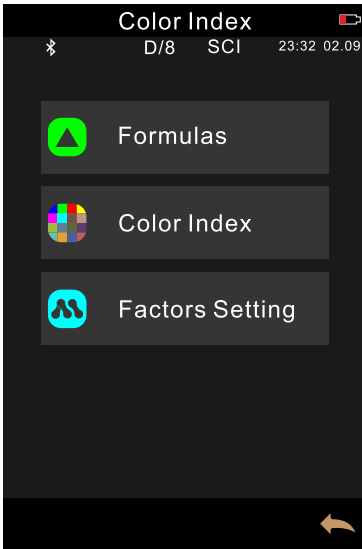


Figure 39 Color Index Window

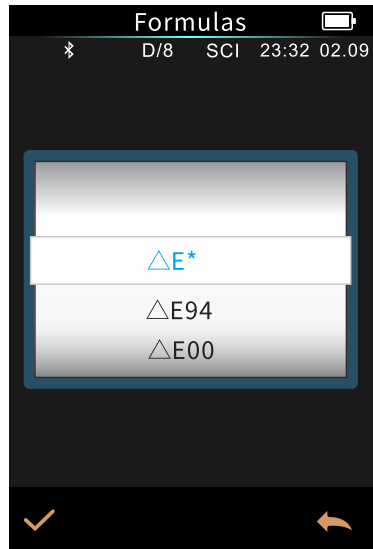


Figure 40 Color difference formula.

within "Color Difference Formula" to select the corresponding formula, then click " ✓ " to confirm.

The selected color difference formula will be used to calculate the color difference of the sample during sample measurement, as shown in Figure 41 .

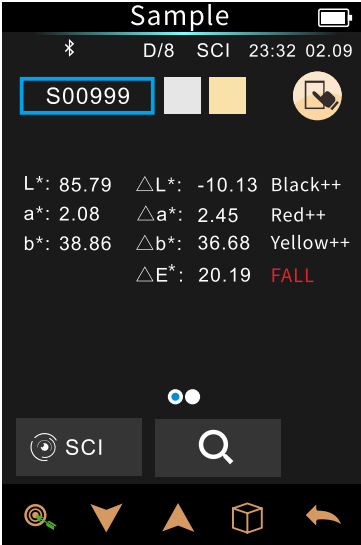


Figure 41 shows the calculation of color difference using  $\Delta E$  .



Figure 42 Selectable chromaticity index interface

Click on a color index within "Optional Colorimetric Indices" to select the corresponding color index , then click " ✓ " to confirm.

The selected color index will be displayed in the color index display area of the standard sample and the test sample (depending on the index, it may only be displayed in the test sample). You can turn to the color index display area by swiping left in the measurement interface or the record viewing interface , or swipe right to return to the color value interface , as shown in Figure 43 , which is the yellowness display interface.

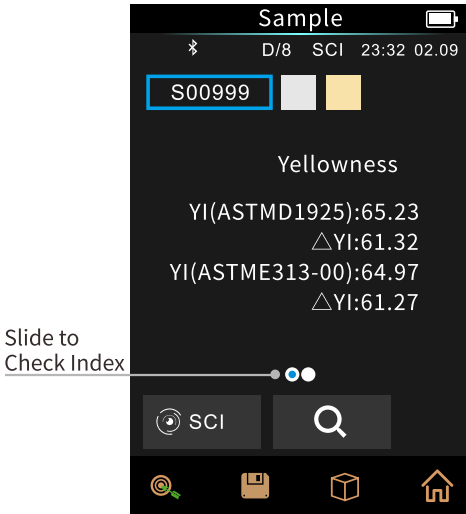


Figure 43 Yellowness index interface under sample measurement interface

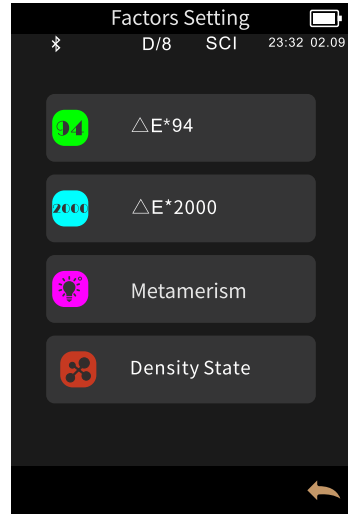


Figure 44 Parameter Factor Setting Interface

### 3.6.2 Color difference formula parameter factors, metamerism index settings, and density settings

Click "Parameter Factor Settings" in the Color Index interface to enter the parameter factor settings interface, as shown in Figure 44 .

#### 1) Set parameter factors

For the color difference formulas CIE DE2000 ( $\Delta E_{00}$ ) and CIE DE1994 ( $\Delta E_{94}$ ), users can set the parameter factors for L, C, and H. The following example illustrates the parameter factor setting of  $\Delta E_{94}$  .

Click “ $\Delta E_{94}$  Factor” to enter the  $\Delta E_{94}$  Factor settings interface (as shown in Figure 45)

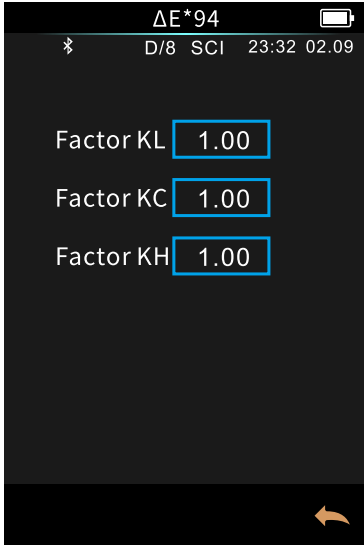
Figure 45  $\Delta E_{94}$  factor setting interface

Figure 46 Editing interface of factor KL

Click on the values of factors KL, KC, and KH to enter the editing interface (as shown in Figure 46), then enter the new values and click ✓ OK. Clicking ← again will cancel saving the settings.

## 2) Metamerism parameter settings

In the parameter factor setting interface, click "Metameric Setting" to enter the metameric setting interface, as shown in Figure 47. Set the reference light source 1 and the light source to be tested 2 respectively. After setting, click "✓" to confirm to save the settings, or "←" to cancel.

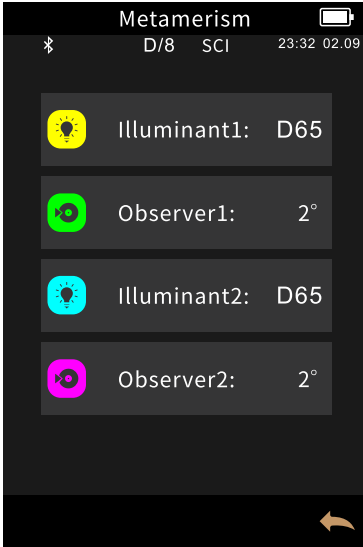


Figure 47 Metamerism settings interface

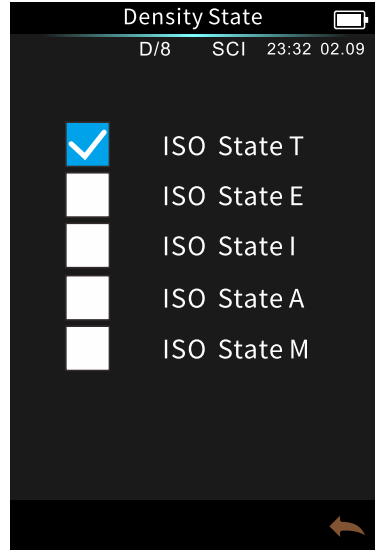


Figure 48 Density Settings

### 3) Density state settings

The density status interface allows you to select from five density states: T/E/I/A/M, as specified in the ISO density standard.

#### 3.7 Display Settings

Click "Display Settings" on the main menu to enter the display settings interface, as shown in Figure 49. In this interface, you can configure whether to enable color bias and test result display.

When the color bias is turned on, it will indicate the color bias of the sample compared with the standard sample during sample measurement, as shown in Figure 50. When it is turned off, there will be no indication.

If the test result prompt is enabled, during sample measurement, if the test result

exceeds the tolerance range set by the standard sample, a red prompt will indicate non-compliance; if the sample error is within the allowable tolerance range of the standard sample, a green prompt will indicate compliance, as shown in Figure 51 .

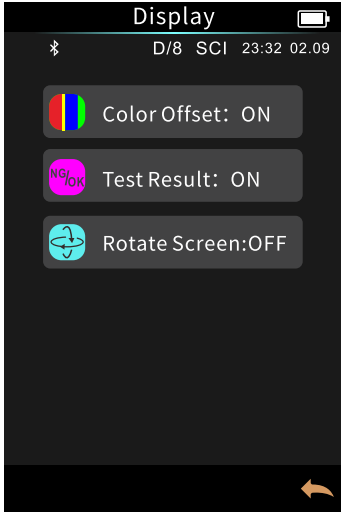


Figure 49 shows the settings interface.

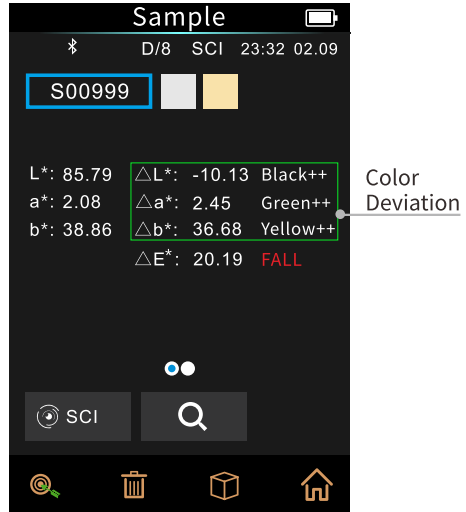


Figure 50 shows the sample measurement interface after color deviation is opened.

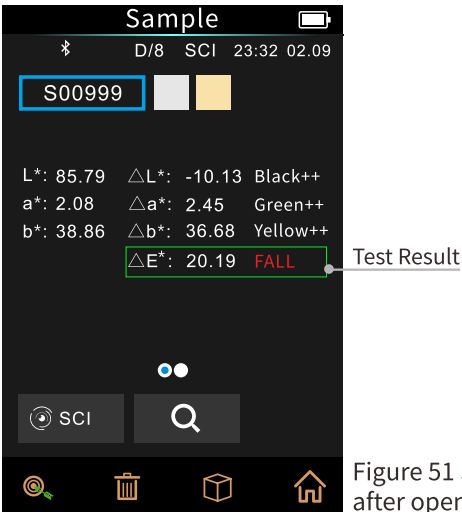


Figure 51 Sample measurement interface after opening the test result prompt.

### 3.8 System Settings

Click "System Settings" in the main menu to enter the system settings interface, as shown in Figures 52 , 53 , and 54 .

The system settings include automatic measurement saving, probe address , Bluetooth, buzzer, measurement mode, calibration validity period, measurement control method, language, time, screen backlight time, and screen backlight brightness. It also includes functions such as restoring factory settings, viewing software and hardware version numbers, and serial numbers.



Figure 52 System Settings Interface

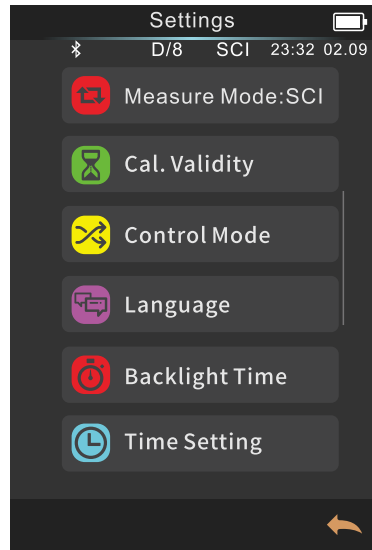


Figure 53 System settings interface

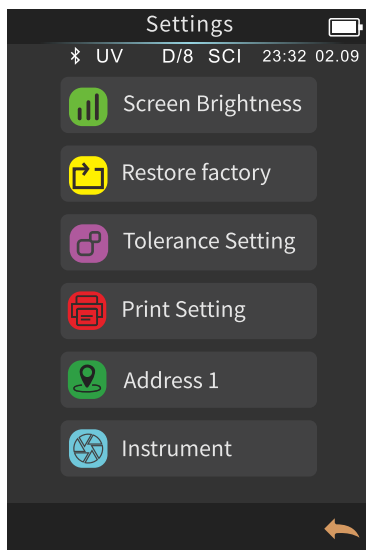



Figure 54 System settings interface

### 3.8.1 One-click mode

When the one-click mode function is turned on, the system will automatically switch to the sample measurement interface after measuring the standard sample, as shown in Figures 55 and 56. When the one-click mode function is turned off, the user can only manually switch to the sample measurement interface.

### 3.8.2 Measurements are automatically saved .

When the automatic saving function is enabled, each sample will be automatically saved to the instrument after testing . When the automatic saving function is not enabled, the record will not be saved automatically after the sample test is completed. You need to manually click the save icon  to save it , as shown in Figure 57.

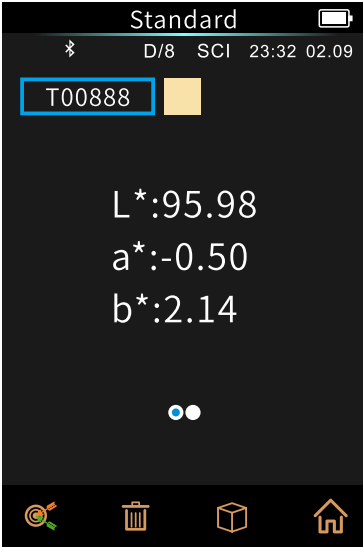


Figure 55 standard measurement interface under One-click mode

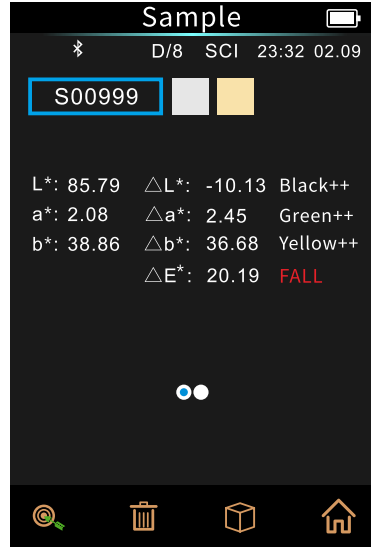


Figure 56 One-click mode automatically switches to the sample measurement interface

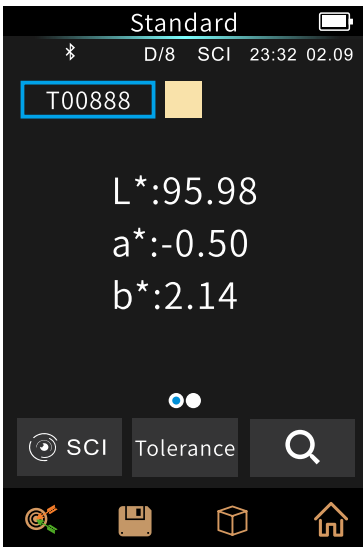


Figure 57 shows that measurement results need to be manually saved when automatic saving is turned off.

### **3.8.3 Measuring Diameter**

This series of instruments is equipped with a  $\Phi 1\text{mm}$  measuring probe, with a sample contact area of approximately  $8\text{cm}^2$ , and connects to the main unit via an RS-485 cable.

### **3.8.4 Bluetooth®**

For product models equipped with Bluetooth®, the instrument uses Bluetooth® 5.0 and can choose to communicate with PC software via Bluetooth®.

When Bluetooth® is enabled, the Bluetooth® icon will be displayed in the status bar of the measurement interface. With the client program installed on the PC, enable Bluetooth® in the instrument's "System Settings," pair the computer with the Bluetooth device, and once pairing is successful, the software will connect via Bluetooth. A notification will appear in the lower right corner of the software indicating a successful Bluetooth connection. This allows for comprehensive control of the terminal instrument and the testing and analysis of relevant samples through the software.

### **3.8.5 Buzzer**

The buzzer switch controls whether an alarm sound is emitted during measurement. When the buzzer is on, an alarm sound will sound after each measurement; otherwise, no alarm sound will be emitted during the test.

### **3.8.6 Measurement Mode**

SCI is a measurement mode that includes specular reflection light ; this instrument only supports this measurement mode.

### **3.8.7 Calibration validity period**

The instrument's "Calibration Validity Period" in the system settings manages the

validity period of black and white board calibration. As the benchmark for colorimetric data measurement, black and white board calibration must be performed accurately; otherwise, the accuracy of the test data will be affected.

When the black and white plate calibration environment differs significantly from the current sample testing environment (e.g., drastic fluctuations in temperature and humidity) or when there are obvious anomalies in the data, it is necessary to perform black and white plate calibration on the instrument in a timely manner.

If the instrument has been used continuously for 8 hours or if the instrument has been turned on and off repeatedly, it is also recommended to perform a new blackboard calibration.

In the system settings interface, click "Calibration Validity Period" to enter the calibration validity period selection interface, as shown in Figure 58. You can select power-on calibration, 4-hour calibration, 12-hour calibration, or 24-hour calibration.

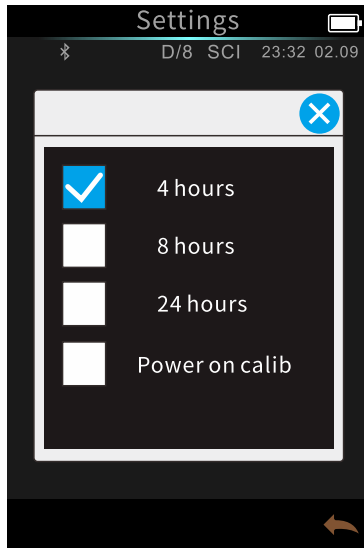


Figure 58 Calibration validity period selection interface

If you choose to perform calibration upon startup, you will automatically enter the black and white calibration interface every time you power on the device. If the black and white board calibration is not performed correctly, you will only be able to view the data, but you will not be able to complete the test.

If you select 4 hours, the instrument's black and white calibration validity period will expire 4 hours after each calibration. If it expires, you can only view the data but cannot complete the test. After recalibrating the black and white board, the calibration validity period will start again.

If you select 8 hours, the instrument's black and white calibration validity period will expire 12 hours after each calibration. If it expires, you can only view the data but cannot complete the test. After recalibrating the black and white board, the calibration validity period will start counting down again.

If you choose 24 hours, the instrument's black and white calibration validity period will expire 24 hours after each calibration. If it expires, you can only view the data but cannot complete the test. After recalibrating the black and white board, the calibration validity period will start again.

### **3.8.8 Measurement and Control Methods**

When the instrument communicates with the PC software, the customer can set a specific measurement control mode as needed. Click "Measurement Control Mode" in the system settings interface to open the measurement control mode selection interface ( as shown in Figure 59), select the appropriate mode, and then confirm.

**Button :** When this mode is selected, the instrument can only be used to perform measurements by pressing the instrument's test button when communicating with the PC software. The customer can then complete the data test by pressing the instrument's test button and upload the data to the PC software.

**PC software :** When this mode is selected, the instrument can only be measured by

clicking the test button on the PC software. The customer can complete the data test by clicking the test button on the PC software and upload the data to the PC software.

Buttons | PC Software : In this mode, customers can complete sample testing and upload data using either the instrument's test buttons or the PC software's test buttons. This is the instrument's default selection mode.

Note: The measurement control mode is only effective when the instrument is connected to the PC software. When not connected, only the measurement button can be used for measurement.

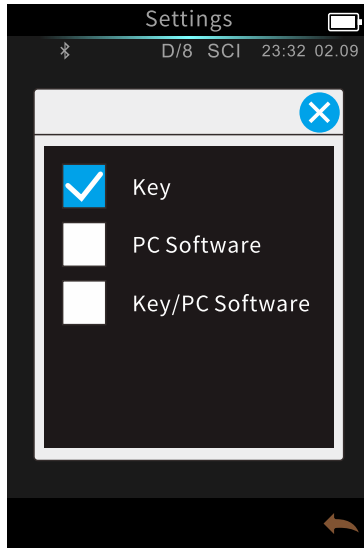


Figure 59 Measurement and control mode selection interface

### 3.8.9 Language Settings

The language settings are used to configure the language of the instrument interface. In the system settings interface, click "Language Settings," then select the desired language and confirm.

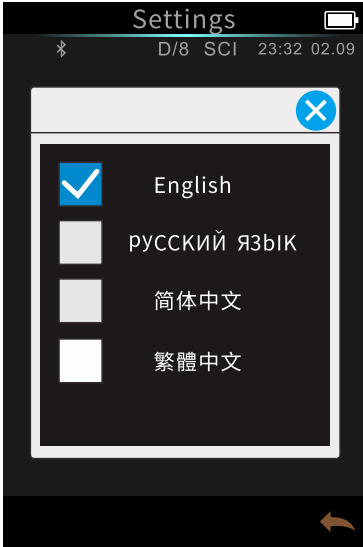


Figure 60 Language settings interface

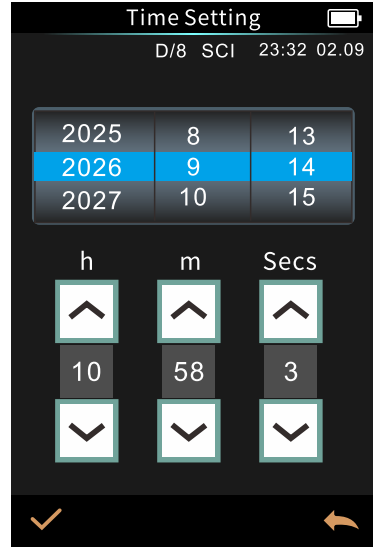


Figure 61 Time and Date Settings Interface

### 3.8.10 Time Settings

The instrument is usually synchronized with the manufacturer's local time when it leaves the factory, but customers can also set the instrument's time according to their actual needs. Click "Time Settings" in the system settings interface to enter the time settings interface shown in Figure 61 .

### 3.8.11 Screen backlight time

In the system settings interface, click " Screen Backlight Time " to enter the " Screen Backlight Time " selection interface.

Backlight duration options include: "Always On", " 1 Minute", " 5 Minutes ", " 10 Minutes ", and " 30 Minutes ". If "Always On" is selected, the screen will not automatically turn off or the device will not automatically shut down when there is

no operation. If set to "60 Seconds", the device will start timing from the last user operation, turn off the screen after 60 seconds, and automatically soft-shut down and enter power-saving mode after 3 minutes of screen-off time. The "5 Minutes", "30 Seconds", and "15 Seconds" settings have the same meaning.

During the screen-off period, the instrument can be illuminated by short-pressing the measurement button; when the instrument is soft-shutdown, it can be woken up by long-pressing the test button. For details on powering on and off, please refer to Section 2.1. The instrument's default screen backlight time is "60 seconds," putting it in power-saving mode.

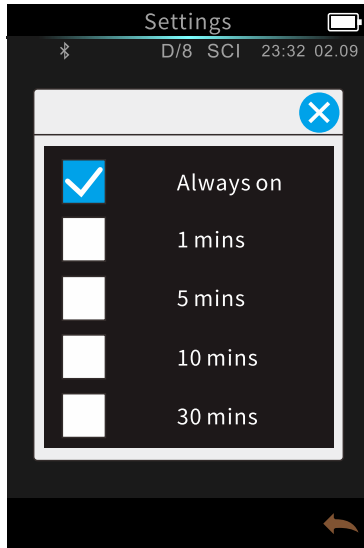


Figure 62 Screen Backlight Time Setting Interface

### 3.8.12 Screen backlight brightness

Click " Screen Backlight Brightness " in the system settings interface to enter the " Screen Backlight Brightness " interface, as shown in Figure 63.

Click "+" to increase screen brightness, and click "-" to decrease screen brightness. You can adjust according to the actual working conditions. After adjustment, click the confirmation button ( ✓ ) at the bottom to save the settings, and click the back button ( ← ) to cancel saving.

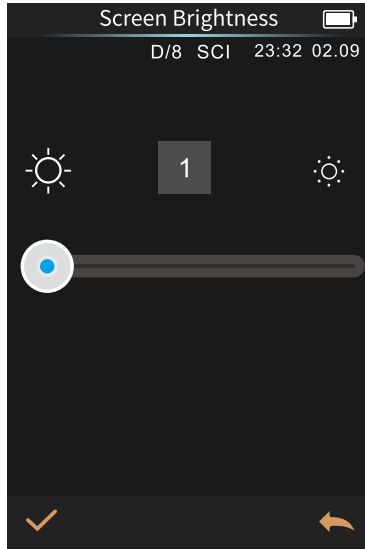


Figure 63 Screen backlight brightness adjustment interface

### 3.8.13 Restore factory settings

In the system settings interface, click "Restore Factory Settings" to enter the interface shown in Figure 64. Click the OK button ( ✓ ) to clear all measurement records and customer settings and restore the instrument to its factory state; click the Return button ( ← ) to cancel this operation.

Note: This operation will erase all data and user settings and restore the device to its factory settings. All data is unrecoverable. Please operate with caution.



Figure 64 Factory reset screen

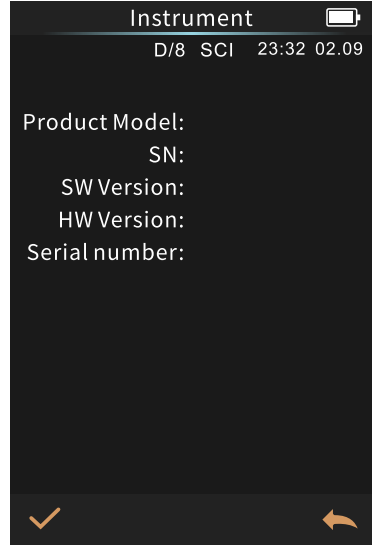


Figure 65 About the Instrument Interface

### 3.8.14 About the instrument

You can view the instrument model, software and hardware version information, serial number (SN) code, and whiteboard SN code, as shown in Figure 65.

### 3.8.15 Tolerance settings

Tolerance settings are configured as shown in Figure 66. When the  $\Delta E^*$  value exceeds the set tolerance value, "Unqualified" will be displayed; conversely, "Qualified" will be displayed on the sample interface (test result prompts will be enabled). The ranges  $\Delta L^*$ ,  $\Delta a^*$ , and  $\Delta b^*$  function similarly to  $\Delta E^*$ , controlling the display of test result prompts.

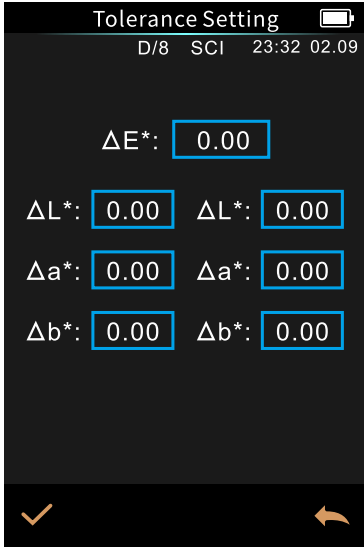


Figure 66 Tolerance Settings

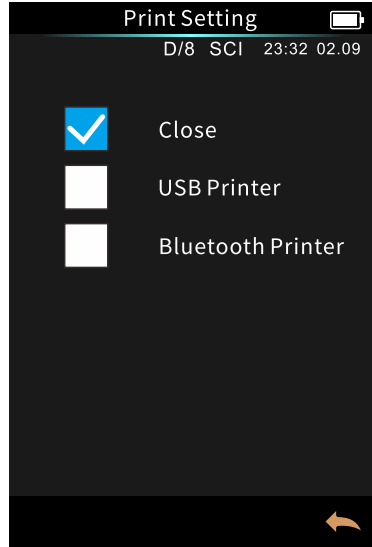


Figure 67 Printing Settings

### 3.8.16 Print settings

Enter the print settings interface, as shown in Figure 67. Select the corresponding method to connect the printer and start printing.

### 3.8.17 Probe address settings

After entering the probe address setting interface, directly input the probe address, which is the number on the probe. After successfully inputting the address, you need to restart the instrument to connect to the probe.



Figure 68 Probe Address Setting Interface

#### IV. Routine Maintenance and Repair of Instruments

1) This instrument is a precision optical instrument. Please handle and use it properly. Avoid using and storing the instrument in humid, strong electromagnetic interference, strong light, or dusty environments. It is recommended to use and store the instrument in a standard laboratory environment (temperature 20 degrees Celsius, 1 standard atmosphere, humidity 50~70%RH).

2) The standard plate is a precision optical component and must be properly stored and used. Avoid hitting the working surface with sharp objects, avoid soiling the working surface with dirt, and avoid exposing the standard plate to strong sunlight. Clean the working surface of the standard plate regularly with a cloth dampened with alcohol, and remove dust from the working surface promptly during calibration.

3) To ensure the validity of the test data, it is recommended that the colorimeter instrument and standard plate be subjected to metrological inspection by the manufacturer or a qualified metrology institute one year from the date of purchase.

4) This instrument is powered by a built-in lithium battery. If the instrument is not used for a long time, please charge it every two weeks to protect the performance of the lithium battery and extend its life.

5) Please do not disassemble or reassemble the instrument yourself. If you have any questions, please contact the relevant after-sales staff. Tearing off the easy-tear label will affect the instrument's after-sales maintenance service.

## V. Technical Parameters

### 5.1 Product Features

- 1) The beautiful appearance is perfectly combined with the ergonomic structural design.
- 2) D/8 geometric optical structure, conforming to standards CIE No.15, GB/T 3978, GB 2893, GB/T 18833, ISO7724-1, ASTM E1164, DIN5033 Teil7 .
- 3) Use a combination of high-lifetime and low-power LED light sources.
- 4)  $\Phi$ 1mm diameter, suitable for more test samples.
- 5) Dual-path optical system with an optical resolution of less than 10nm in the visible light range, enabling precise measurement of the SCI spectrum of samples.
- 6) The sample spectrum is measured. The Lab data is accurate and can be used for color matching and precise color transfer.
- 7) High hardware configuration: 3.5-inch TFT true color screen, capacitive touch screen, 1000-line blazed grating, silicon photodiode array detector, etc.
- 8) USB/Bluetooth dual communication modes, making it more adaptable.
- 9) Super dirt-resistant and stable standard whiteboard.
- 10) 2/10 standard observer angle, multiple light source modes, multiple color systems, conforming to multiple standard colorimetric indicators, meeting the color measurement needs of various customers.
- 11) Auxiliary positioning line measurement and positioning.
- 12) Large storage capacity, capable of storing over 10,000 test data entries.
- 13) PC software has powerful function extensions.

## 5.2 Technical Specifications

<b>Product Model</b>	PS102 Spectrophotometer
<b>Lighting method</b>	D/8 (diffuse illumination, 8° direction reception), SCI (including specular reflection), conforming to standards CIE No. 15, GB/T 3978, GB 2893, GB/T 18833, ISO 7724-1, ASTM E1164, DIN 5033 Teil 7
<b>characteristic</b>	Employing a dual-channel silicon photodiode array sensor with a built-in electronic color card, it is used for color difference quality control in industries such as plastics and electronics, paints and inks, textiles and apparel printing and dyeing, printing, and ceramics.
<b>Integrating sphere size</b>	Φ20mm
<b>Lighting source</b>	Combined full-spectrum LED light source
<b>Spectrophotometry</b>	Nanoscale integrated spectral devices
<b>Sensors</b>	Silicon photodiode array (dual-row, 32 groups)
<b>Measurement wavelength range</b>	400~700nm
<b>Wavelength spacing</b>	10nm
<b>Reflectivity measurement range</b>	0~200%
<b>Measuring Diameter</b>	1mm
<b>Light-containing methods</b>	SCI
<b>Color space</b>	CIE LAB,XYZ,Yxy,LCh,CIE LUV,s-RGB,HunterLab,βxy, DIN Lab99

## Spectrophotometer

<b>Color difference formula</b>	$\Delta E^*ab, \Delta E^*uv, \Delta E^*94, \Delta E^*cmc(2:1), \Delta E^*cmc(1:1), \Delta E^*00, \text{DIN}\Delta E99, \Delta E(\text{Hunter})$
<b>Other colorimetric indicators</b>	Spectral reflectance, WI (ASTM E313, CIE/ISO, ISO2470/R457, AATCC, Hunter, Taube, Berger, Stensby), YI (ASTM D1925, ASTM 313), Metamerism Index (MI), Staining fastness, Color change fastness, Power content, Opacity, 555 Hue Classification, Munsell (C/2), Blackness (My, dM), Color Density (CMYK), Tint (some functions are implemented through a host computer).
<b>Observer's perspective</b>	2°/10°
<b>Observation light source</b>	D65, A, B, C, D50, D55, D75, F1, F2 (CWF), F3, F4, F5, F6, F7 (DLF), F8, F9, F10 (TPL5), F11 (TL84), F12 (TL83/U30), U35, NBF, ID50, ID65, LED-B1, LED-B2, LED-B3, LED-B4, LED-B5, LED-BH1, LED-RGB1, LED-V1, LED-V2, Customizable Light Sources (41 types in total, some implemented via host computer/APP)
<b>show</b>	Spectrum/data, sample chromaticity values, color difference values/graphs, pass/fail results, color simulation, color bias
<b>Measurement time</b>	Approximately 1 second
<b>Repeatability</b>	Colorimetric value: Standard deviation $\Delta E^*ab$ within 0.02 (average value of 30 measurements taken on a white board at 5-second intervals after preheating calibration).  Spectrophotometric reflectance: MAV/SCI, standard deviation within 0.1% (400~700nm: within 0.2%)
<b>Inter-platform difference</b>	$\Delta E^*ab$ within 0.3 (average value measured from 12 color swatches of BCRA Series II)
<b>Measurement method</b>	Single measurement, average measurement (2~99 times)
<b>Positioning method</b>	Auxiliary positioning lines

## Spectrophotometer

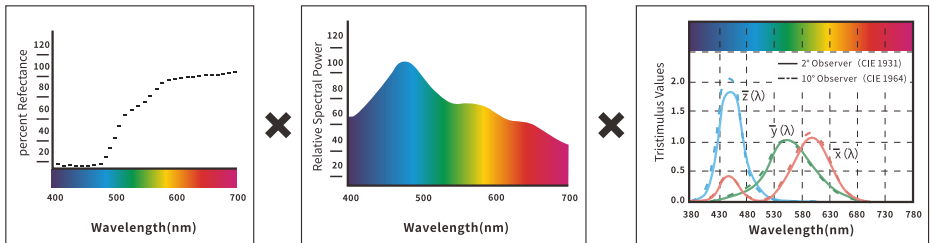
<b>size</b>	Main unit: 80*132*20; Probe: Φ43*73.5; Cable: 1.5m
<b>weight</b>	250g ; Probe (including calibration box): 200g
<b>Battery power</b>	Lithium battery, 3.7V, 3200mAh, 15,000 cycles in 9 hours , 2.15W power.
<b>Lifespan of lighting sources</b>	More than 3 million measurements in 10 years
<b>Display screen</b>	3.5-inch TFT true color capacitive touchscreen
<b>interface</b>	USB, Bluetooth, RS485 (probe)
<b>Store data</b>	500 standard samples, 10,000 test samples, massive storage via APP/PC
<b>Software support</b>	Android, iOS, Windows, WeChat Mini Programs, HarmonyOS
<b>language</b>	Simplified Chinese, English, Traditional Chinese, Russian
<b>Operating temperature range</b>	0~40°C, 0~85%RH (non-condensing), altitude: below 2000m
<b>Storage temperature range</b>	-20~50°C, 0~85%RH (non-condensing)
<b>Standard Annex</b>	Power adapter, data cable, instruction manual, quality management software (downloadable from the official website), white calibration box, positioning plate, Bluetooth adapter, RS485 adapter
<b>Optional accessories</b>	Mini printer
<b>Note</b>	Different product models may have slightly different configurations (color space, testing accuracy, colorimetric index, storage space, Bluetooth, standard accessories, etc.), please refer to the technical specifications of the corresponding product model.

## Appendix 1

### 1. Object color

There are three essential elements to color perception: the light source, the object, and the observer. Any change in any of these three will affect the observer's color perception. When the light source and the observer remain unchanged, the object will determine the observer's color perception.

The reason why objects can affect the final color perception is that the reflection spectrum (transmission spectrum) of the object modulates the spectrum of the light source. Different objects have different reflection spectra (transmission spectra). The light source spectrum is modulated by the reflection spectrum (transmission spectrum) of different objects to obtain different results. Since the observer remains the same, different colors are presented. The principle is shown in the figure below.



Reflectance spectra

Light source

Standard observer

=

$$L = 70.95$$

$$a = 69.72$$

$$b = 40.35$$

### 2. Color difference formula

The CIE 1976 color difference formula  $\Delta E^*_{ab}$  is shown below:

$$\Delta E_{ab}^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

$$\Delta L^* = L^*_1 - L^*_0$$

$$\Delta a^* = a^*_1 - a^*_0$$

$$\Delta b^* = b^*_1 - b^*_0$$

The CIE 2000 color difference formula  $\Delta E_{00}$  is shown below:

$$\Delta E_{00} = \left[ \left( \frac{\Delta L'}{K_L S_L} \right)^2 + \left( \frac{\Delta C'}{K_C S_C} \right)^2 + \left( \frac{\Delta H'}{K_H S_H} \right)^2 + R_T \left( \frac{\Delta C'}{K_C S_C} \right) \left( \frac{\Delta H'}{K_H S_H} \right) \right]^{1/2}$$

$$L' = L^*$$

$$a' = a^*(1+G)$$

$$b' = b^*$$

$$G = 0.5 \left( 1 - \sqrt{\frac{\bar{C}_{ab}^{*7}}{\bar{C}_{ab}^{*7} + 25^7}} \right)$$

The CIE 1994 color difference formula  $\Delta E^*_{94}$  is shown below:

$$\Delta E^*_{94} = \left[ \left( \frac{\Delta L^*}{K_L S_L} \right)^2 + \left( \frac{\Delta C^*_{ab}}{K_C S_C} \right)^2 + \left( \frac{\Delta H^*_{ab}}{K_H S_H} \right)^2 \right]^{1/2}$$

$$S_L = 1$$

$$S_C = 1 + 0.045 C^*_{ab}$$

$$S_H = 1 + 0.015 C^*_{ab}$$

### 3. Normal color difference tolerance range

The allowable range of normal color difference varies depending on the industry and application scenario. The following is an overview of the allowable color difference range for some major industries:

1. Electronic equipment industry

- Standard: Typically, the input E (color difference unit) is required to be less than 0.5 to ensure color accuracy in screen display, product appearance, etc.

2. Plastic Coating Industry

- Standard: Requires E to be below 1.0, applicable to color control of plastic products and coating products.

3. Textile industry

- General standard: An E value below 2.0 is considered acceptable, especially in textile color management.
- Specific standards: Some standards require that the color difference of a specific part be no less than level 4, which is equivalent to a color difference value between 0 and 2.0.

4. Printing industry


- Range: A color cast range of 1.5 to 3.0 is generally considered normal, but the specific value may vary depending on the product grade and customer requirements. The pursuits differ.
- Standards: Some standards stipulate that the color difference value should not exceed 6, whether for fine products or general products.

5. Railway signal flags

- Standard: Color difference less than or equal to 3.0 to ensure the clarity and recognizability of the signal flags.

**Color difference magnitude and visual perception:**

$\Delta E^*$ value	Human visual perception	$\Delta E^*$ value	Human visual perception
0-0.25	Very little or no color difference, ideal match	1.0-2.0	Moderate color difference, perceptible to the human eye, acceptable in specific applications.
0.25-0.5	Minor color variations are generally acceptable.	2.0-4.0	Significant color difference, acceptable under certain conditions.
0.5-1.0	Minor to moderate color variation, acceptable for some applications.	4.0 or above	The color difference is too great, unacceptable for most applications.



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