Multi-Angle Spectrophotometer

OPERATION MANUAL

V1.0

Content

Overview

Multi-angle spectrophotometer is a multi-angle color measuring instrument independently developed by the company with independent intellectual property rights. Multi-angle spectrophotometers provide accurate color measurement for metallic, pearlescent, and other complex special effect color products.

This instrument has the following features:

1)TFT True Color 3.5inch Capacitive Touch Screen, Full Viewing Angle Display;

2)A variety of measuring angles can be measured simultaneously;

3)PC-side quality management software has powerful extension functions;

4)Color camera preview positioning, so that the object to be measured more accurately aligned with the measurement caliber, improve the accuracy of the measurement data;

5)Built-in rechargeable lithium battery, can also be powered by an external DC power supply.

6)Through the measurement of 15° and 45°angles, the LAB value at different angles is distinguished and displayed, which enables more comprehensive measurement evaluation of the effect topcoat.

Precautions

1) The instrument belongs to the precision optical measuring instrument, in the measurement, should avoid drastic changes in the external environment of the instrument, such as in the measurement should avoid the flicker of the surrounding environment light, rapid changes in temperature, etc.;

2) The instrument should be kept stable during the measurement, and the measured object should be aligned with the measuring caliber to avoid moving;

3) This instrument is not waterproof and cannot be used in high humidity environment or water mist;

4) Keep the instrument clean and tidy, avoid water, dust and other liquids, powders or solid foreign matter into the integrating sphere and the inside of the instrument, and avoid impact and collision of the instrument;

5) After the instrument is used, the power supply should be cut off, and the instrument and accessories should be put into the instrument box and stored in a dry and cool environment;

6) The user shall not make any unauthorized changes to the instrument, and any unauthorized changes may affect the accuracy of the instrument and even irreversibly damage the instrument.

1, The Interface Button Description

LED Indicator

Display Screen

Measuring Button

Dust Cover

Calibration Plate

Black Cavity

Figure 1 Schematic diagram of the multi-angle
spectrophotometer key interface (front)

USB Port/Printing Port
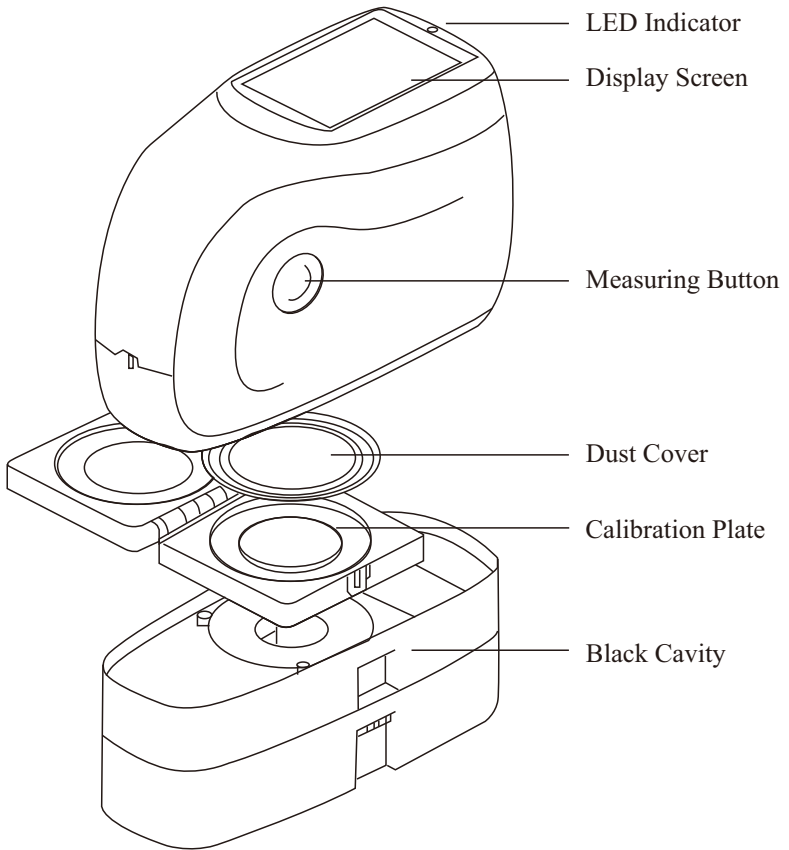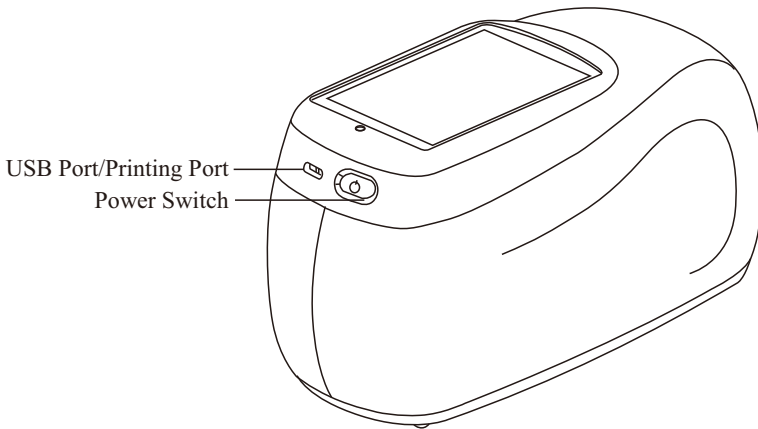Power Switch

Figure 2 Schematic diagram of the multi-angle
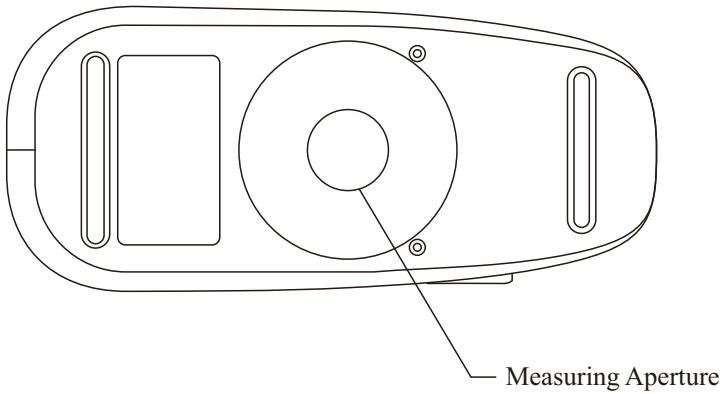spectrophotometer key interface (side)

Measuring Aperture

Figure 3 Schematic diagram of the multi-angle
spectrophotometer key interface (back)

Display: TFT True Color 3.5inch capacitive touch screen for displaying measurement data and instrument operation navigation.

Measurement button: Under Measurement Mode, press the Measurement key to open the measurement; Under Standby Mode, press the Measurement key to wake up the system.

LED indicator: The LED indicator color is green and red. Press the power switch (the instrument connection adapter or battery is fully charged), the green light flashes to power on; the green light flashes during the measurement, and the green light is always on when the measurement is completed. The red light is always on when the battery is low and charged; the red-light flashes when the instrument fails.

Power switch: Power on and off by pressing the power switch button.

USB interface / print interface: This interface is a common interface, and the instrument automatically determines the connection. The USB interface is used to communicate with a PC connection or to power the instrument via a power adapter that inputs AC (AC110V-240V) and outputs 5V/DC 2A. The print interface is connected to the printer using a dedicated cable.

Measuring Aperture: When measuring, this position is the placement area of the sample to be measured.

Correction Box: The correction box adopts a double-sided folding design, with a whiteboard on one side and a color board on the other side (some models have no color board). When making corrections, open the correction box and use the whiteboard and color board 180 degrees apart.

White board: When white Correction, align the whiteboard with the measuring aperture.

Black Cylinder: When black correction, align the black cylinder to the measuring caliber.

Dust Cover: When the instrument is turned off or in standby, the dust cover is placed on the measuring caliber to avoid dust from staining the inside of the instrument and protect the integrating ball. In addition, the black cylinder is also equipped with a dust cover, and the dust cover must be removed when the black cylinder is used, and the dust cover is covered when not in use.

2, The Operation Instructions

2.1 Switch on and off

Press the "Power Switch" and the indicator light will flash green and the LOGO interface will be displayed. After waiting a few seconds, the instrument will automatically enter the measurement interface, as shown in Figure 4.

In the power-on state, if no operation is carried out for a long time, the instrument will automatically enter the sleep state, at this time press the "measurement button" or touch the screen to wake up the instrument into a working state. After powering on the system, press and hold the "Power Switch" key for 3 seconds to shut down. Note: When the instrument is not in use for a long time, please cut off the power supply.

Angle	L*	a*	b*	RGB
-15°	99.80	4.27	15.93	
15°	93.13	3.86	18.35	
25°	87.51	4.06	19.88	
45°	83.09	4.16	21.71	
75°	85.40	4.07	20.65	
110°	82.57	4.02	20.60	

Figure 4 Measurement Interface (Standard Measurement)

2.2 Correction

Press (⌂) on the measurement interface to enter the main menu, and in other interfaces you can enter the main menu by clicking Confirm (✓) or Back (←) on the lower side, as shown in Figure 5.
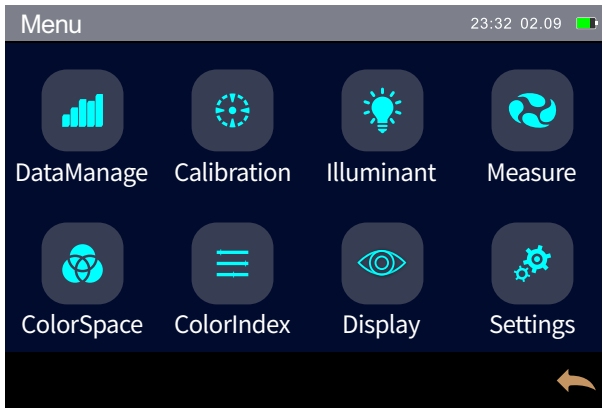
Figure 5 The Main Menu Interface

Click "Black and White Correction" in the main menu to enter the correction screen, as shown in Figure 6. Displays in the interface whether the current correction is valid and how long it remains.
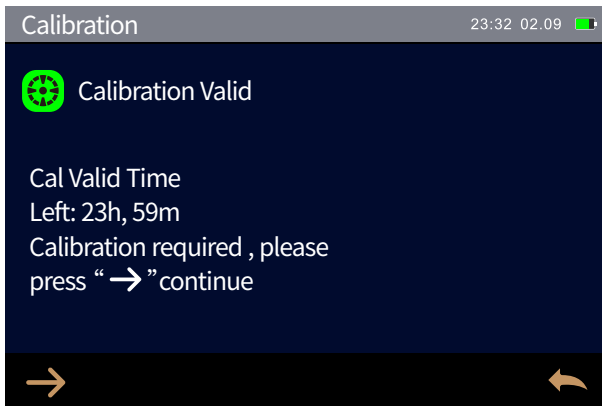
Figure 6 Correcting the valid time

Click (→) to enter the Reflected Black Proofing interface shown in Figure 7. According to the prompts, put the black cylinder face up, remove the black cylinder dust cover, and align the measurement caliber with the black cylinder, press the "measurement button" to carry out the black correction, click (→) to skip the reflective black school and enter the reflective white school.
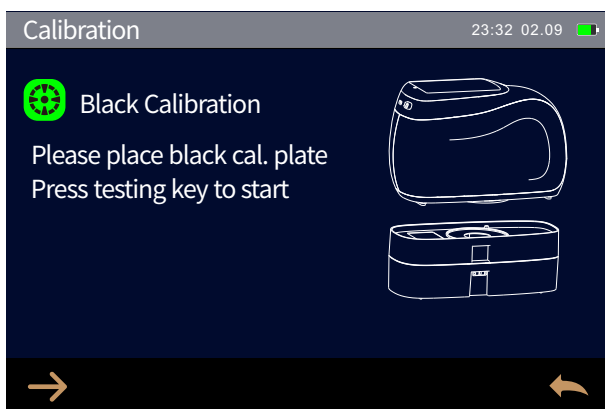
Figure 7 Reflecting the Black School

After the reflection black school is completed, it automatically jumps into the reflection white school interface, as shown in Figure 8. According to the prompts, align the measurement caliber with the whiteboard, press the "Measurement Button" to perform the reflective white correction, click (→) to skip the reflective white correction and enter the correction effective time interface.
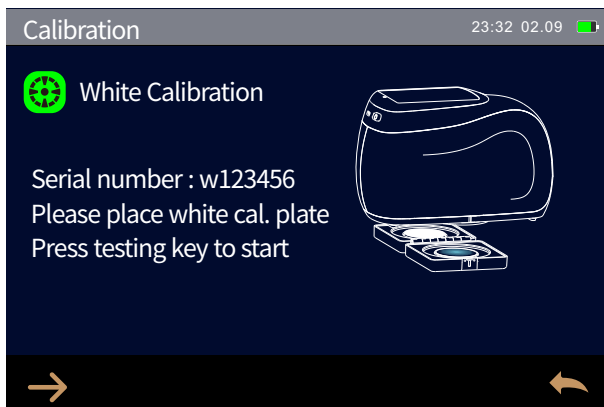
Figure 8 Reflects the White School

Note: 1. The whiteboard Number on the screen needs to match the whiteboard number provided with the instrument.

2. During white calibration, the marking line on the instrument must be aligned with the box before calibration can be performed. As shown in Figure 9.
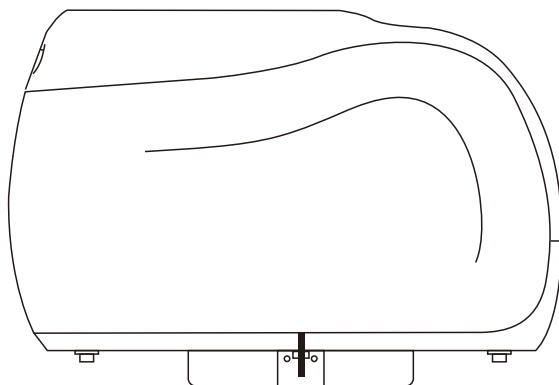
Figure 9 Schematic diagram of mark alignment during white calibration

After the calibration is complete, the instrument system retimes according to the calibration validity period set by the user, as shown in Figure 6. Users can also click (→) to re-make calibrations or click (←) to return to the main menu as needed.

2.3 Measurement Interface Description
2.3.1 Standard measurement interface

In the main menu interface, click Back (←) to enter the standard measurement interface, if in the other interface, you can click back (←) on the interface several times in a row to return to the measurement interface.

The upper part of the standard measurement interface includes: interface name, sample name, parameter setting area (tolerance, measurement angle, etc.), system time, battery level, framing positioning, etc.; the middle part is the data display area, displaying the measurement data of the current standard; the bottom is the operation button area. The operation of the current data is achieved by clicking the corresponding operation button. As shown in Figure 10. Scroll down to view standard reflectance plots, color plots, and chromaticity data. This is shown in Figures 11,12,13.

Tolerance, measurement angle, color space, light source

Interface Name

System time, battery level

Sample name

Camera

The data shows the zone

Angle	L*	a*	b*	RGB
-15°	99.80	4.27	15.93	
15°	93.13	3.86	18.35	
25°	87.51	4.06	19.88	
45°	83.09	4.16	21.71	
75°	85.40	4.07	20.65	
110°	82.57	4.02	20.60	

Standard · T00055 · Tol · ∀45° · CIE Lab · D65/10 · 23:32 02.09

Specimen switching

Delete

Scroll

Main menu
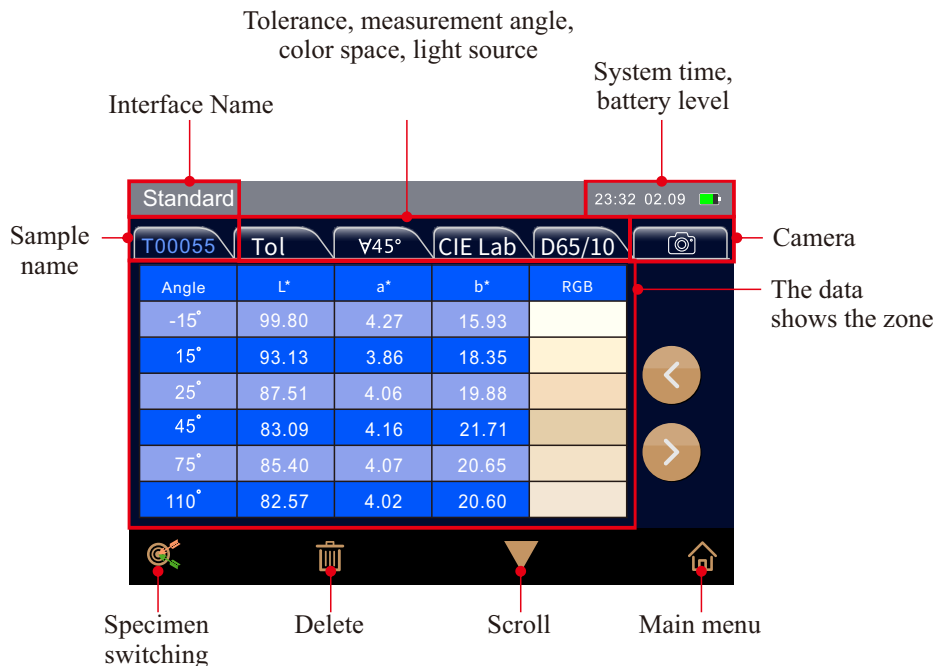
Figure 10 Standard measurement interface

Standard · T00027 · Tol · ∀45° · 23:32 02.09

Reflectance

Reflect · Chroma · -15° · 15° · 25° · 45° · 75° · 110° · R 400 67.58

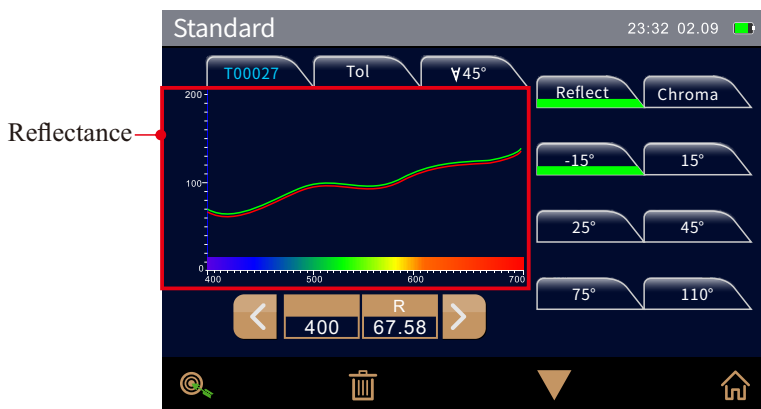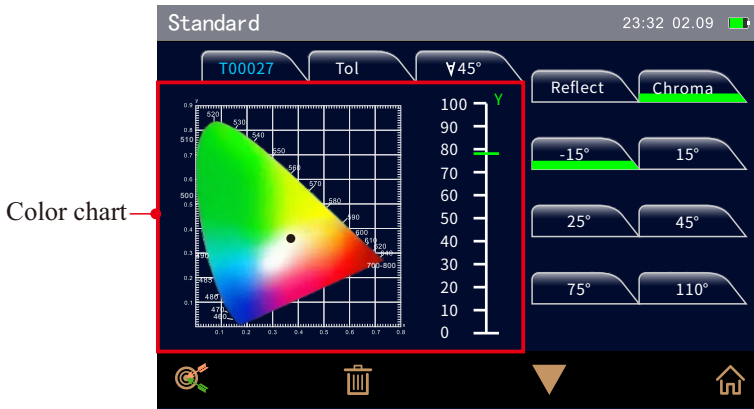Figure 11 Sample Reflectance Plot

Figure 12 Sample Color Rendering
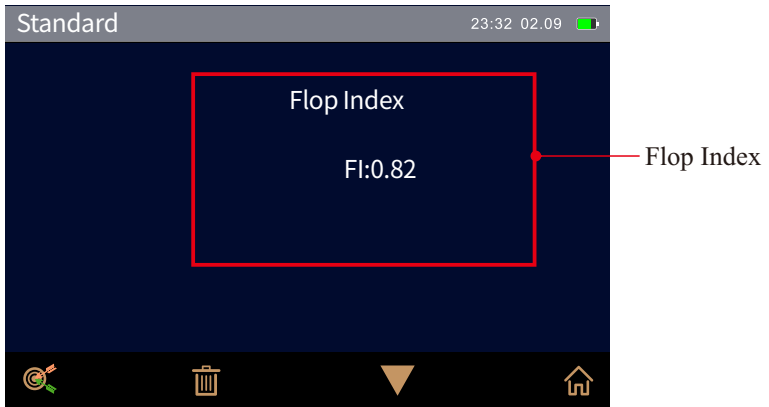
Figure 13 Flop Index Interface

Interface Name: Displays the current measurement interface name;
Sample name: When the sample is measured, the instrument automatically generates the sample name, which is named by default with the serial number starting from T00001, click to modify the sample name;

Tolerance: Click to set the tolerance for the current sample;

Measuring angle: Click to switch between 15°and 45°measurement angle (not supported on some models);

Color space: Click to set the color space;

Light source: Tap to set the observer angle and light source selection. The observer angle can be selected from 2°and 10°; the light source can be selected from D65, A, C, D50, D55, D75, F1, F2(CWF), F3, F4, F5,F6, F7(DLF), F8, F9, F10(TPL5), F11(TL84), F12(TL83/U30);
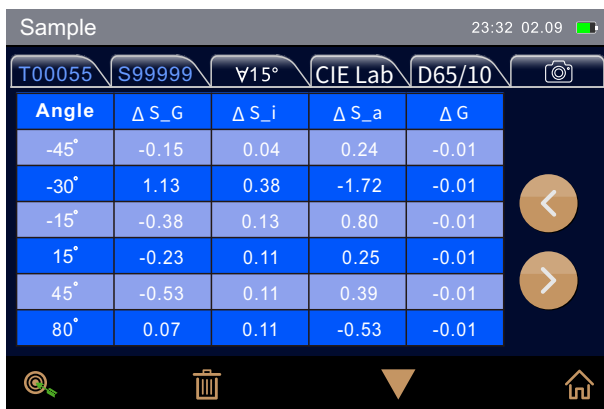
System Time: Displays the current time of the system;

Battery Level: Displays the current charge of the battery;

View Finder: Click to preview and position the measured items;

Wavelength Switching: Click the wavelength switching button below the Reflectance graph to reduce or increase the current wavelength at (◀▶) 10nm intervals to switch the transmittance. You can also directly click on the wavelength to select a specified wavelength;

Page Turn: Click the Left and Right Page Button on the right side of the data display area (◀ ▶) to view other page data, such as roughness and other data, as shown in Figure 14.

Figure 14 Data such as flicker area and roughness

Sample switching: Click to switch to the sample measurement interface;

Delete: Click to delete the current measurement data. If "Measure Auto Save" is not selected in the system settings, the delete button will become a save button, and click the save button to save the current measurement (💾) data;

Scroll down: Click to view the color map and reflection data of the current standard;

Main Menu: Tap to return to the main menu;

Data display area: the standard measurement interface displays the standard measurement data, and the sample measurement interface displays the sample measurement data and the difference between the sample and the standard;

Reflectance Graph: Click "Reflect" on the measurement interface to display the light wavelength and reflectance curve graph. The sample measurement interface also displays the difference from the sample;

Color map: Click "Chroma" in the measurement interface to display the color map;

Chromaticity Index: Displays the corresponding chrominance data based on the set chromaticity index.

2.3.2 Sample measurement interface

The sample measurement interface is basically the same as the standard measurement interface. The difference is that the sample measurement interface displays the measurement data of the current sample as well as the difference to the sample and the measurement result hints, as shown in Figure 15. Flip down is similar to the standard, as shown in Figures 16, 17, 18.

Sample Name

Standard Name

Standard Name

Measurement results

Figure 15 Sample Measurement Interface 1

Figure 16 Sample Measurement Interface 2
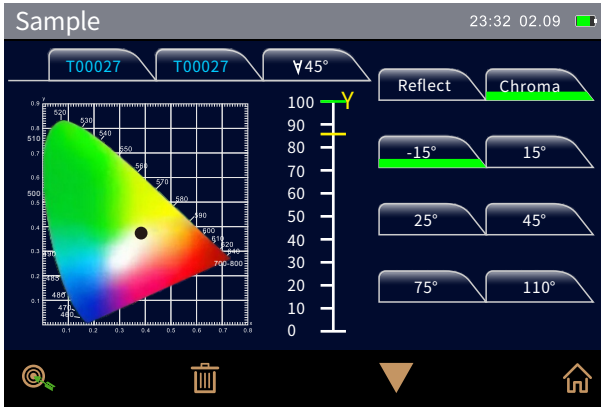
Figure 17 Sample Measurement Interface 3
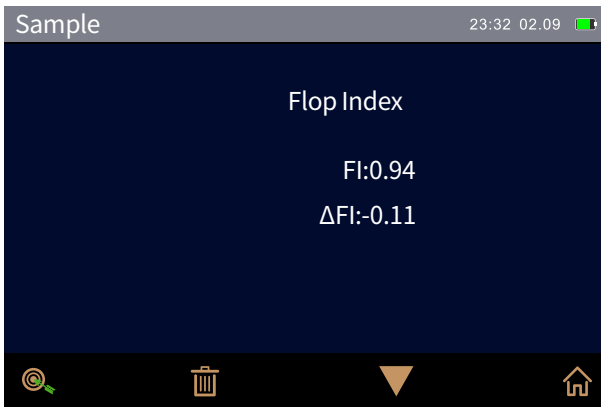
Figure 18 Sample Measurement Interface 4

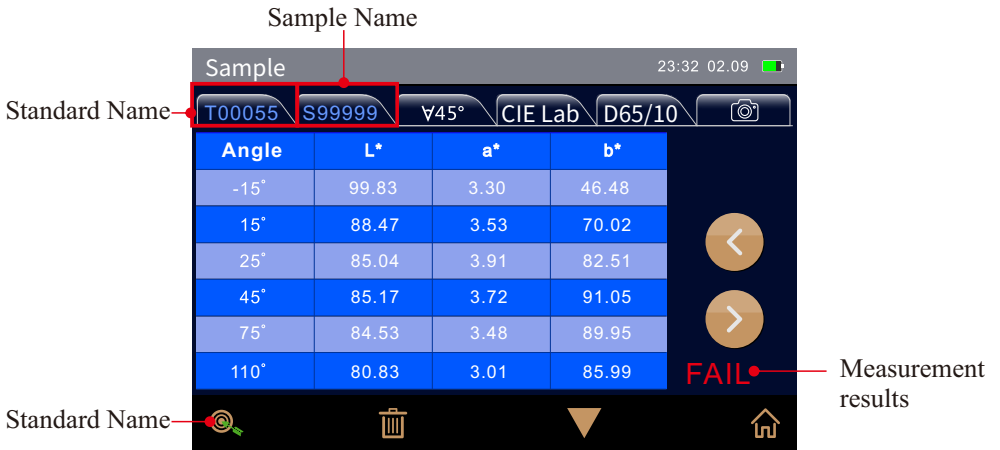**Sample Name:** When a sample is measured, the instrument automatically generates a sample name, which is named by default with the serial number starting with S00001. Click on the sample name to modify the name.

Sample Switching: On the Sample Measurement interface, click Switch to the Sample Measurement Interface ( ) associated with the sample.

Measurement result prompt: In the system settings, turn on "Show measurement results", by the standard tolerance and the specified chromatic aberration formula (increase the effect of the effect color, some models do not support) to determine the sample measurement results, the color difference between the sample and the standard if within the tolerance range will display the green font "qualified", if beyond the tolerance range will display the red font "unqualified".

2.4 Measurement

After the correction is completed at power-on, the measurement can be taken. If you are not currently in the measurement interface, you can click back (←) on the interface several times in a row to return to the measurement area. Multi-angle spectrophotometers, angle selection and tolerance settings corresponding to each angle are essential for measurements.

2.4.1 Angle selection

In the system settings interface, click "Angle Selection" to enter the angle selection screen, as shown in Figure 19. Measuring angles are available in 45°and 15°, and one or more measuring angles can be selected. 45° can choose

45as-15, 45as15, 45as25, 45as45, 45as75, 45as110;

15° can choose 15as-45, 15as-30, 15as-15, 15as15, 15as45, 15as80.

Figure 19 The Angle Selection Interface

Check "User-defined" and the user can choose the desired angle, as shown in Figure 20.

Figure 20 User-Defined Angle Selection Interface

Note: Some models have a measuring angle of only 45°, and the measuring angles that can be selected for different models of instruments are also different.

2.4.2 Standard tolerance settings

On the Standard Measurement screen, click "Tolerance" to enter the Standard Tolerance Settings screen, as shown in Figure 21. Click to (█45°◣) display the measuring angle corresponding to 45°, and click to display (█15◣) the measuring angle corresponding to 15°.   After selecting a measurement angle, click the Tolerance Value box for the Chromatic aberration formula (see Section 3.6.1 for the setting of the Chromatic aberration formula) and pop up the corresponding box Tolerance Value Editing interface, as shown in Figure 21, click Confirm (✓) to save after setting, that is, this tolerance is used The tolerance of the selected measurement angle for this sample.

In the tolerance setting, the upper tolerance limit on the right side must be greater than the lower limit on the left tolerance.

Figure 21 Standard Tolerance Settings

Figure 22 System Tolerances Value Editing Interface

Note: If you do not modify the standard tolerance, the standard tolerance uses the system tolerance by default.

2.4.3 Standard measurement

In the main menu interface, click Back (←) to enter the standard measurement interface, as shown in Figure 23. At this point, the measurement aperture is aligned and closely aligned to the sample, and the object under test can also be accurately positioned by the framing camera. When the measured item is properly placed, gently press the "Measurement Button", the buzzer will emit a "Beep" sound, and the indicator light flashes to stop, indicating that the measurement is complete.

Figure 23 Standard Measurement Interface 1

Figure 24 Standard Measurement Interface 2
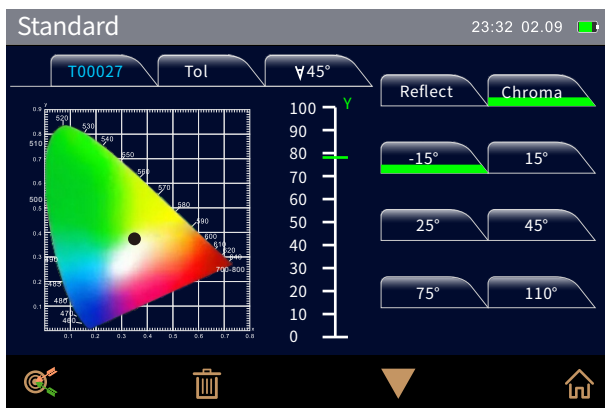
Figure 25 Sample Measurement Interface 3
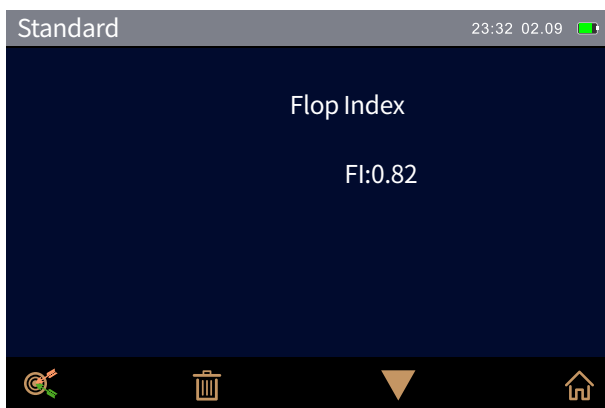
Figure 26 Sample Measurement Interface 4

If the measurement autosave function is enabled (for ways to turn on the measurement autosave function, please refer to 3 Section 8.1), the measurement results are automatically recorded every time the measurement is completed. Otherwise, manually click the Save button to save the measurement data. Once the standard measurement is complete, press the flip key to view the reflectivity, color map, and chromaticity data, as shown in Figures 24, 25, and 26 shown.

2.4.4 Sample measurement

In the standard measurement interface, click ( ) to switch to the sample measurement interface associated with the standard, the sample measurement method is the same as the standard measurement method. The measurement interface is shown in Figures 27, 28, 29, and 30.

The differences are:

1.If the system tolerance is not used, the tolerance of the current standard needs to be set before the sample measurement is performed. (Set the tolerances of the standard as detailed in Section 2.4.2).)

2.Check the different Chromatic aberration formula options to compare the measurement results with the sample. (The setting of the chromatic aberration formula is detailed in Section 3.6.1).

Turn on "Show Measurement Results" in the system settings, when the sample is measured, the color difference between the sample measurement result and the standard sample is determined by the standard tolerance and the specified chromatic aberration formula, and the green font "Pass" is displayed if it is within the tolerance range, and the red font "Fail" is displayed if the tolerance range is exceeded.

Angle	L*	a*	b*
-15˚	99.83	3.30	46.48
15˚	88.47	3.53	70.02
25˚	85.04	3.91	82.51
45˚	85.17	3.72	91.05
75˚	84.53	3.48	89.95
110˚	80.83	3.01	85.99

Figure 27 Sample Measurement Interface 1

Figure 28 Sample Measurement Interface 2
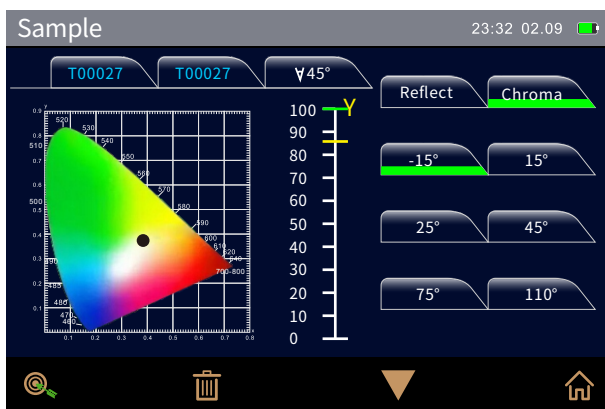
Figure 29 Sample Measurement Interface 3
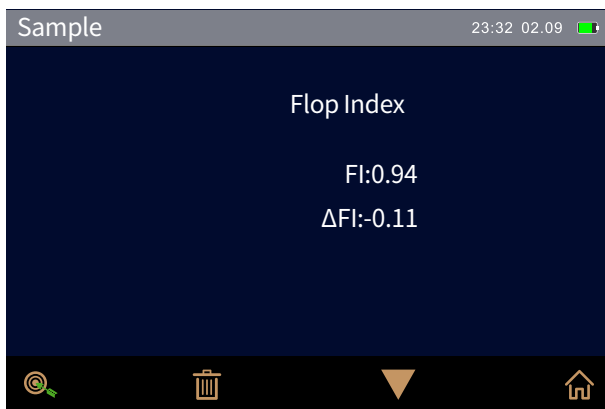
Figure 30 Sample Measurement Interface 4

2.5 Communication with the PC

The PC-side software has powerful extensions that enable more chromaticity data analysis. This series of instruments can be connected to the PC-side color management software via a USB cable or a Bluetooth module (only for product models equipped with a Bluetooth module).

2.5.1 Communicating with the PC via USB

Install the color management software on the PC side, connect the instrument with the PC with the USB data cable, the software will automatically connect with the instrument, the connection is successful, the status bar of the instrument will display the USB connection icon, and the software will achieve full control of the terminal instrument. And the relevant sample measurement and analysis is carried out.

2.5.2 Communicate with the PC via Bluetooth

For instruments equipped with a Bluetooth module, it is possible to communicate with the PC-side color management software via Bluetooth.
Install the color management software on the PC side and use the matching Bluetooth adapter, and the non-matching other Bluetooth adapter cannot be used,

at the same time turn on the Bluetooth function in the instrument "system settings", the status bar of the instrument will display the Bluetooth icon, the software will automatically connect with the instrument, Successful connection, full control of the terminal instrument via software, and related sample measurement and analysis.

2.6 Printers

There are two ways to print, one is that the instrument is connected to the PC-side color management software, and the printer is connected to the PC-side for printing (the use method refers to the color management software manual); the other is Printing is performed by connecting a miniature printer to the instrument, and the second method is described in detail below.

Micro printers are non-standard accessories and need to be purchased separately. Printing steps:

1. The user first measures the color data of the sample and saves the sample record to be printed;

2. Enter the "System Settings" menu and click "Print Settings" to open this feature;

3. Connect the micro-printer to the instrument via USB;

4. Enter "Data Management" for the main course list, view the records, and find the sample records to be printed (standard records or sample records) through (▲) or (▼);

5. Click (🖱), select "Print Data" in the pop-up menu, click "Confirm" and start printing the sample color data.

3, The System Function Description

In the measurement interface, press (🏠) to enter the main menu interface (as shown in Figure 5), and in other interfaces, you can enter the main menu by continuously clicking back (←), from the main menu you can enter each submenu to achieve all system function settings.

3.1 Data Management

Click "Data Management" in the main menu interface to enter the data management interface, as shown in Figure 31. Data management mainly enables viewing and manipulating measured records.
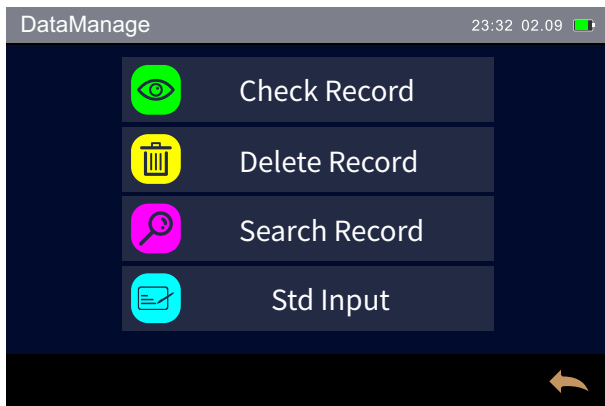
Figure 31 Data Management Interface

3.1.1 View Records

Click View Records on the data management interface to enter the Sample Records interface, as shown in Figures 32and33.

Click the (▼) button to view the data records such as reflectivity and chromaticity of the standard;

Click the (▼ , ▲) button to view the records of other samples;

Click the (🎯) button to switch to the sample record associated with the sample recording interface;

Other icons and settings of the sample recording and sample recording interfaces are defined the same as the standard measurement interface and the sample measurement interface.

Figure 32 Viewing the Sample Record

Figure 33 Viewing the sample record

3.1.2 Delete Records

Click "Delete Record" on the data management interface to enter the Delete Record screen, as shown in Figure 34. Click on the corresponding option, pop up the prompt interface, click "Confirm"

will delete all the corresponding records, if you do not want to delete click "Cancel", as shown in Figure 35.

Select Delete All Records to delete all sample and sample records.

Select Remove All Samples to delete all sample records and keep the sample records.
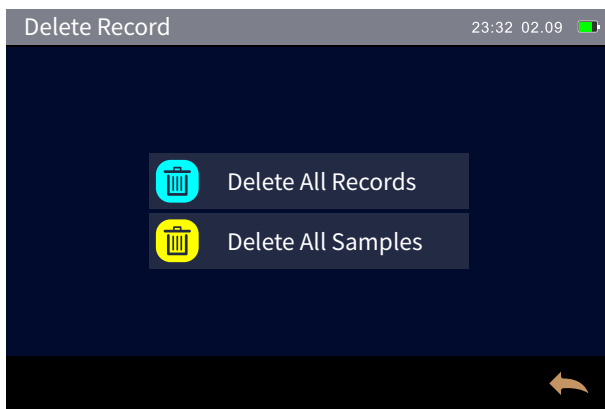
Figure 34 Deleting the Record Interface
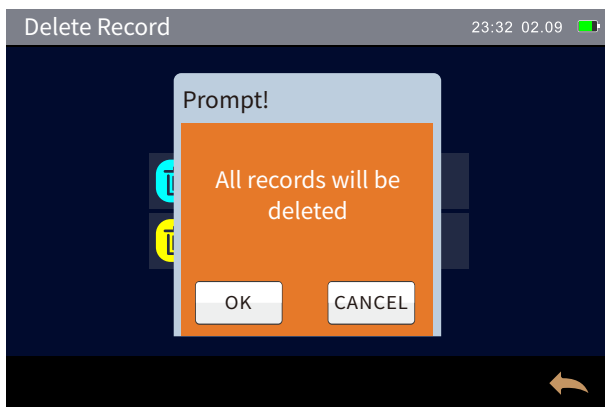
Figure 35 Prompt to delete all sample records

Note: After the record is deleted, you will not be able to recover the data, please be careful to prevent accidental deletion.

3.1.3 Search Records

Click "Search Records" in the data management interface to enter the search record interface, as shown in Figure 36. Select Search by Name or Search by Name Sample to bring up a name edit box, as shown in Figure 37.
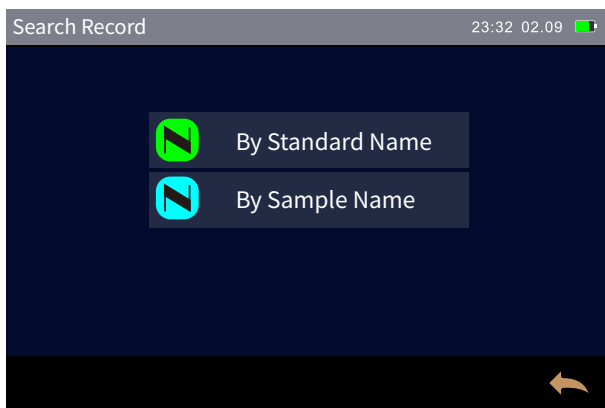
Figure 36 Search History

Figure 37 The Lookup Record Name Input Box

In the Edit Name field, enter the name you want to find, and list the records that contain the name in the sample or sample record. Users can also click (←) to return to cancel the lookup as needed.

3.1.4 Sample Input

Click "Import Sample" in the data management interface to enter the input sample interface, as shown in Figure 38. After all the parameters are edited, click Confirm (✓) in the figure, and the sample will be stored in the list of standard records.
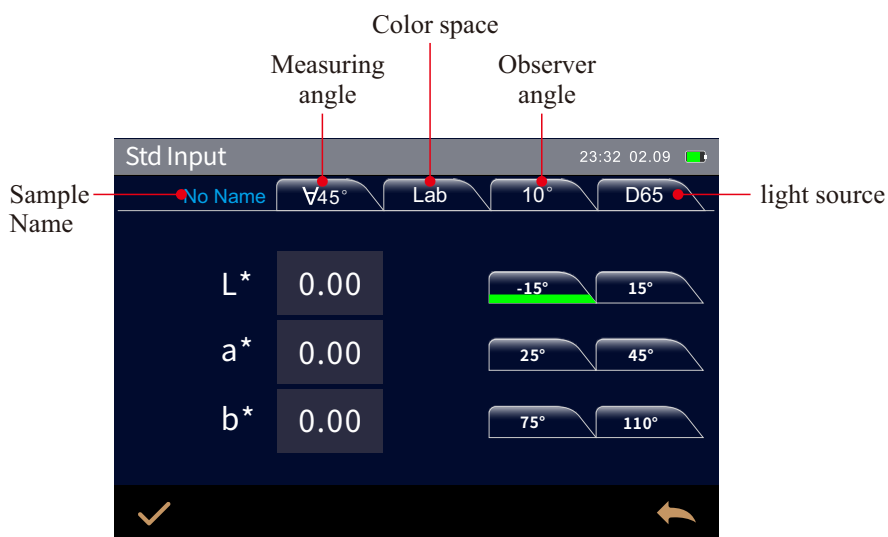
Figure 38 Entering the Sample Interface

In the sample input interface, you can set the sample name, measurement angle, color space, observer angle, light source, etc.

Sample Name: Click to edit the sample name;

Measurement Angle: In the Angle Selection section of the System Settings interface, select the single or multiple measurement angles that need to be the standard. Select Done, click (▬▬) or in the sample input interface (▬▬) to display the corresponding angle under the current measurement angle;

Color space: Tap to toggle the color space. Select a measurement angle, click on the corresponding edit bar on the right side of the color space parameter, enter the sample value, as shown in Figure 39, enter the completion click confirm (✓), the color space sample value of the angle is set;

Observer angle: click to switch the observer angle;

Light source: Click to select a light source.

Figure 39 Enter the color space sample value

3.2 Black and white correction

As a benchmark for measurements, correction must be carried out accurately, otherwise it will affect the validity of the measurement data. This series of instruments requires calibration in the following situations:

1) When the difference between the calibration environment and the current sample measurement environment is relatively large (such as violent temperature fluctuations), the instrument needs to be corrected in time;

2) The instrument has exceeded the validity period of the calibration, and it is also necessary to re-do a correction when measuring the sample;

3) When the instrument is reselected the measuring angle also needs to be re-corrected.

For the method of correction, please refer to Section 2.2.

3.3 Light source settings

In the main menu interface, click "Light Settings" to enter the Light Settings interface, as shown in Figure 40.

Figure 40 Light Source Setup Interface

Click on "Observer Angle" to switch between 2°and 10°;
Click "Light Source Selection" to select the light source parameters, select the corresponding light source in the Light Source Selection interface, and then click confirm (✓) to complete the Light Source setting. As shown in Figure 40:

Figure 41 Light Source Selection

3.4 Measurement mode

In the main menu interface click on "Measurement Mode" to open the
Measurement Mode Settings interface, as shown in Figure 42.
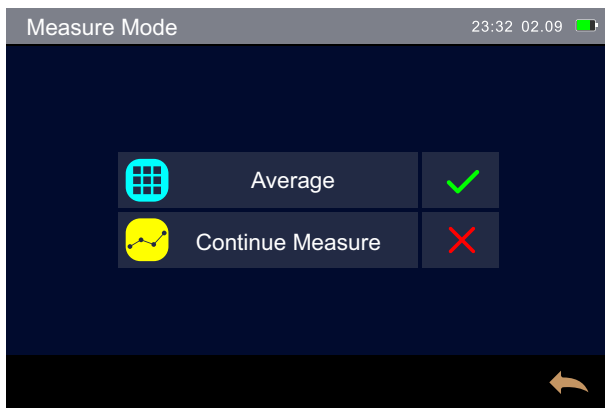
Figure 42 Measurement Mode Settings

The measurement mode is divided into average measurement and continuous
measurement, click on the control behind you can select the average measurement
mode or continuous measurement mode, and the green check mark is the selected
mode. When both the average and continuous measurements of both the standard
and the sample are "1", the instrument is in single-shot measurement mode. This
instrument defaults to a single measurement.

3.4.1 Average measurement

When the measured item is relatively large or relatively uneven, by measuring a
representative number of test points, the average value of multiple points is
obtained, and the calculated result can better represent the real situation of the
sample under test.

By clicking on "Average Measurement", the user can set the number of times the
standard and sample average measurements are as needed, as shown in Figure 43.
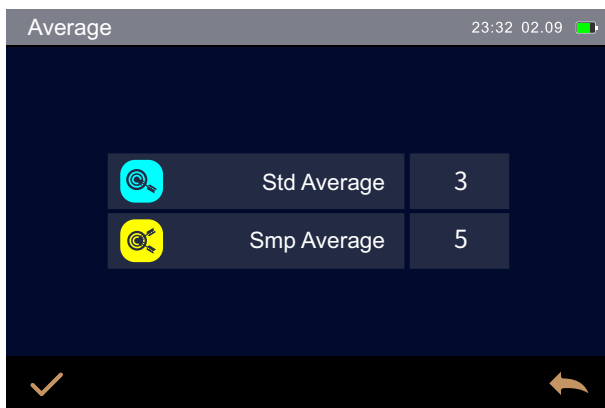
Figure 43 Average Measurement Setup

Average number of measurements can be set from 1 to99 times per group, and when the average number of measurements set is between "2-99", the instrument is in average measurement mode.

Click "Sample Average Measurement" and "Sample Average Measurement" to bring up the value settings interface, as shown in Figure 44. Setup complete Click Confirm (✓) Save.

Figure 44 Average Number of Times Settings

Instrument When making an average measurement, manually make multiple measurements according to the set average number of measurements until all the set measurements are complete. During the measurement process, the average measurement result is automatically updated every time the measurement is completed, and an average measurement result is obtained after the measurement is completed.

3.4.2 Continuous measurement

When the measurement conditions are fixed and the sample needs to be measured continuously (such as the assembly line automation operation process), the continuous measurement mode can be used, reducing the number of operations and saving measurement time.

The number of consecutive measurements of the standard and sample can be set from 1 to99 times per group, with an interval of 5-99 seconds each time, when the number of consecutive measurements is set to " Between 2-99", the instrument is in continuous measurement mode.

Click "Continuous Measurement" to enter the continuous measurement settings interface, where you can set the number of consecutive measurements of the standard and sample and the interval between the two measurements as needed, as shown in Figure 45. Click "Standards Interval Time", "Standards Consecutive Times" and "Sample Interval Time", "Sample Consecutive Times" and pop up the corresponding value setting interface, as shown in Figure 46. Setup complete Click Confirm (✓) Save.
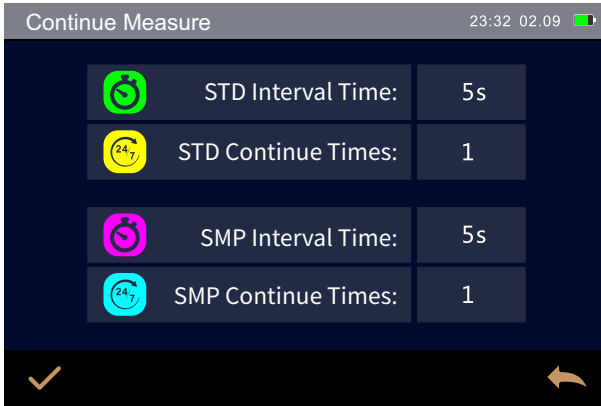
Figure 45 Continuous Measurement Setup

Figure 46 Interval Time Settings

When taking continuous measurements, the instrument will automatically perform multiple measurements according to the set number of continuous measurements and interval times, and the measurement results will be recorded once each time the measurement is completed (only when the measurement is automatically saved when the measurement is turned on) until the set number of measurements is completed. The measurement is completed and the result of each measurement is recorded.

3.5 Color Space

In the main menu interface, click "Color Space" to open the color space interface, as shown in Figure 47, select the corresponding color space in the color space interface, and then click Confirm (✓) to complete the color space setting.

Figure 47 The Color Space Setup Interface

3.6 Color index

Click "Color Index" in the main menu interface to enter the Color Index setting interface, as shown in Figure 48.
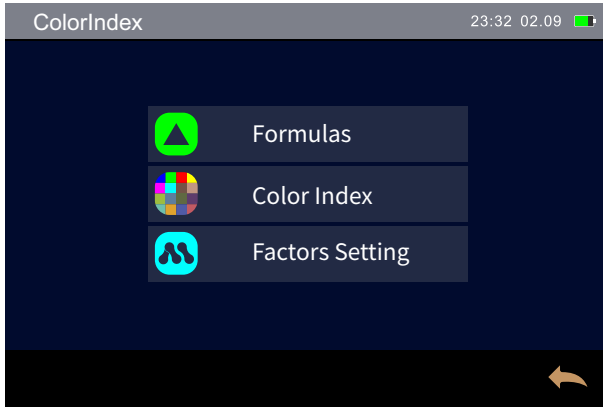
Figure 48 Color Index Settings Interface

3.6.1 Chromatic aberration formula

Click "Chromatic aberration formula" on the color index interface to enter the chromatic aberration formula selection interface, as shown in Figure 49.

Figure 49 Chromatic aberration formula settings

Click a chromatic aberration formula to select the appropriate chromatic aberration formula. Select Done and click ($\checkmark$) to confirm. The selected chromatic aberration formula is used to calculate the chromatic aberration of the sample when the sample is measured, e.g. $\triangle$E* is selected below to show the corresponding value at sample measurement, other chromatic aberrations and so on, as shown in Figure 49.

Figure 50 Color difference calculated using ΔE BMW

3.6.2 Optional chromaticity indicator

Click "Optional Chromaticity Indicator" on the Color Index interface to enter the Optional Chromaticity Indicator selection screen, as shown in Figure 51.
Click a chromaticity metric to select the appropriate chromaticity metric. The color index is optional, if you want to uncheck it, click the selected chroma indicator again. After selecting the Good Chromaticity Indicator, click ($\checkmark$) to confirm, and the selected Chromaticity Indicator will be displayed in the Color Index display area of the sample and the sample test (depending on the index, it may only be displayed in the sample), as shown in Figure 52 as the Flop Index interface.
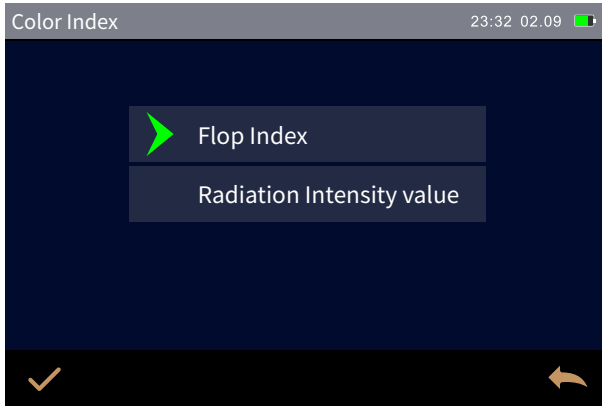
Figure 51 Optional Colorimetric Indicator Setup Interface
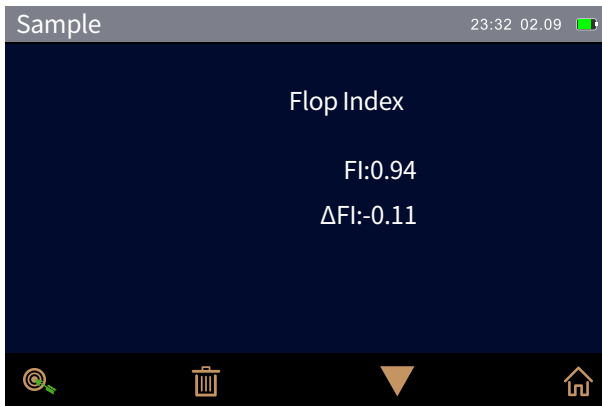
Figure 52 Flop Index Interface

3.6.3 Parameter factor settings

Click "Parameter Factor Settings" on the color index interface to enter the parameter factor settings interface, as shown in Figure 53.
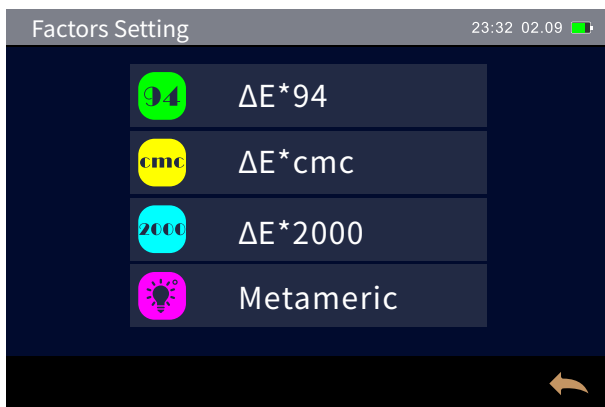
Figure 53 Parameter Factor Setup Interface

1) Parameter factor settings

For the chromatic aberration formula CIE DE1994 (ΔE_{94}), CMC ($\Delta E_{cmc(l:c)}$, CIE DE2000 (ΔE_{00}), the user can set KL, KC, K The parametric factor for H ($\Delta E_{cmc(l:c)}$ can only be set to KL and KC）。

The following takes the parametric factor setting of ΔE_{94} as an example:

Figure 54 ΔE94 Factor Setup Interface

Click "Δ E$_{94}$ Factor" to enter the ΔE_{94} Factor setting interface (as shown in Figure 54).

Click the values of factor KL, factor KC, and factor KH to enter the editing interface, as shown in Figure 55, then enter the new value, click (✓) to confirm Save.

Factor KL			23:32 02.09 🔋
	1.00		
1	2	3	BackSpace
4	5	6	
7	8	9	Enter
–	0	.	

Figure 55 The editing interface for factor KL

2) Isochromatic settings

Click "Isochromatic Settings" in the Parameter Factor Settings interface to enter the Isochromatic Settings interface, as shown in Figure 56, set the reference light source 1 and the light source to be measured 2 respectively, set it up, click (✓) to confirm, click (⬅) to cancel the save.

Figure 56 Homochromatic Heterospectral Setup interface

3.7 Display Settings

Click "Display Settings" in the main menu interface to enter the display settings interface, as shown in Figure 57.
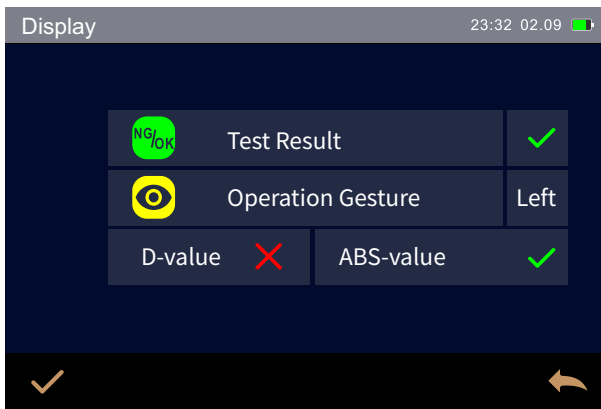
Figure 57 shows the setup interface

When "Test Result Prompt" is turned on, when the sample is measured, the color difference between the sample and the standard sample is displayed with a green font "Pass" if it is within the tolerance range, and a red font "Failed" is displayed if the tolerance range is exceeded.

Manipulation gestures: The user can set the left- or right-hand operation as needed.

Difference / Absolute Value: The user can set the difference or absolute value as needed.

3.8 System Settings

Click "System Settings" in the main menu to enter the system settings interface, as shown in Figures 58,59,60.
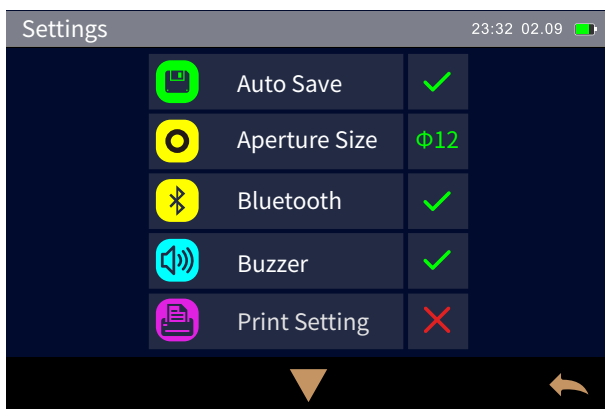
Figure 58 The System Setup Interface
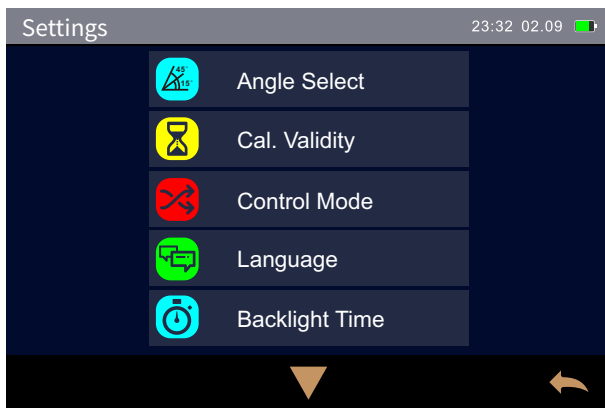
Figure 59 System Setup Interface
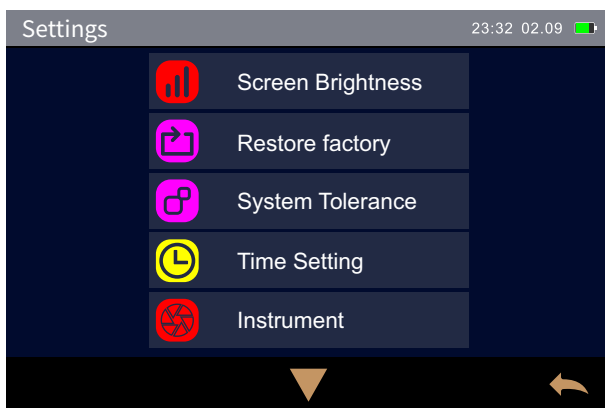
Figure 60 The System Setup Interface

3.8.1 Automatic saving of measurements

Measurement Auto Save When turned on, the measurement results are automatically stored in the instrument for each measurement. Otherwise, the sample measurement is over, the measurement record will not be automatically saved, and the current measurement data will be saved by manually clicking the Save (💾) button.

3.8.2 Measuring caliber

The measuring caliber of this series of instruments is Φ12mm.

3.8. 3 Bluetooth

For Bluetooth-equipped instruments, it is possible to communicate with the PC-side color management software via Bluetooth. For how to set up the instrument to communicate with the PC-side software via Bluetooth, please refer to Section 2.5.2.

3.8. 4 Buzzer

The buzzer switch controls whether a tone sounds when measuring. When the buzzer is turned on, a tone sounds for each measurement. Otherwise, there is no sound when measuring.

3.8. 5 Print Settings

Print Settings When open, the instrument is connected to a printer and can be set up for printing. When print settings are off, the instrument cannot print. For details, see Section 2.6.

3.8. 6 Angle selection

A variety of measuring angles are available in this series of instruments. For how to select angles, see Section 2.4.1.

3.8. 7 Correction validity period

In the System Settings interface, click "Correction Validity Period" to manage the validity period of the correction, as shown in Figure 61.
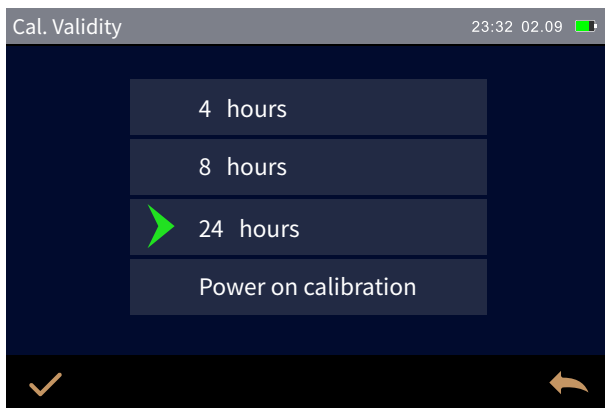
Figure 61 Correction Validity Period Selection Interface

The correction validity period can be selected as4 Hours,8 Hours,24 Hours, and Power On Correction.

Select 4 hours, the instrument's correction validity period will expire after each correction 4 hours, if it expires, you will only be able to view the data, but you will not be able to complete the measurement, after re-correction, the correction validity period will start timing again. 8 hours, 24 hours, Boot Correction Settings have the same meaning as above.

When the correction expires, in the measurement interface, pressing the "Measure Button" will pop up a prompt and will not measure normally. Measurements can only be made after correct correction.

3.8. 8 Measurement control mode

When the instrument communicates with the PC-side software, the user can set specific measurement control methods according to their needs. Click "Measurement Control Mode" in the system settings interface to open the measurement control interface, as shown in Figure 62, select the appropriate method, and then click Confirm (✓).
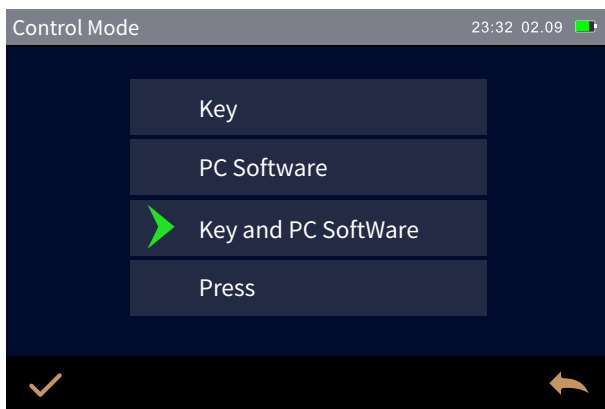
Figure 62 Measurement Control

Button: Select this mode, the instrument measurement can only be triggered by the instrument measurement button to complete the data test, and the data is uploaded to the PC software.

PC-side software: Select this mode, the instrument measurement can only be triggered into a data test by the PC-side software measurement button, and the data is uploaded to the   PC-side software.

Press the key | PC-side software: Select this mode, customers can complete the sample test through the instrument test button or the PC-side software measurement button, and upload the data. This mode is the default selection mode for the instrument.

Note: The measurement control method only works when the instrument is connected to the PC-side software, and in the case of no connection, only the measurement button can always be measured.

3.8. 9 Language settings

Language Settings Is used to set the language of the instrument interface. In the system settings interface, click "Language Settings" and select the corresponding language confirmation (✓).

3.8. 10 Screen Backlight Time

Click "Backlight Settings" in the system settings interface to enter the backlight setting selection interface. You can select screen brightness and backlight time, as shown in Figure 63.

Move the brightness adjuster around the Brightness settings bar to adjust the screen brightness.

The backlight time is divided into: "Solid On","1 Minute","5 Minutes","10 Minutes", "30 Minutes". If You select Solid On, the screen is not automatically screened when there is no action. If set to"1 Minute", the instrument will time out from the last operation, andafter1 minute, it will pause and enter power saving mode. The"5 Minutes", "10 Minutes", "30 Minutes" settings have the same meaning as above.

The instrument can light up the display during screen time by pressing the "Measure button" or by tapping the screen. The instrument default screen backlight time is"5 minutes", leaving it in power saving mode.
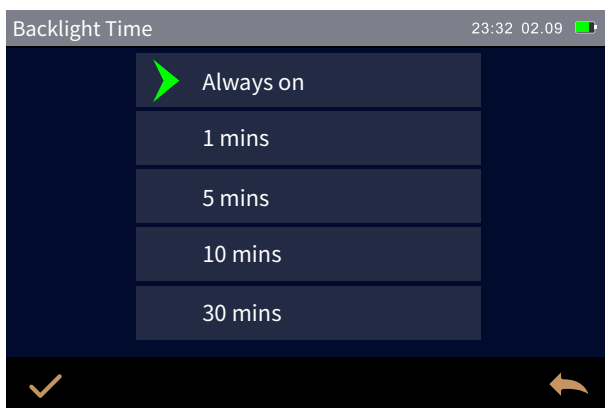
Figure 63 Screen Backlight Setup Interface

3.8. 11 Screen Backlight Brightness

Click "Screen Backlight Brightness" in the system settings interface to enter the Screen Backlight Brightness Adjustment interface, as shown in Figure 64. Move the brightness adjuster left and right to adjust the screen brightness.
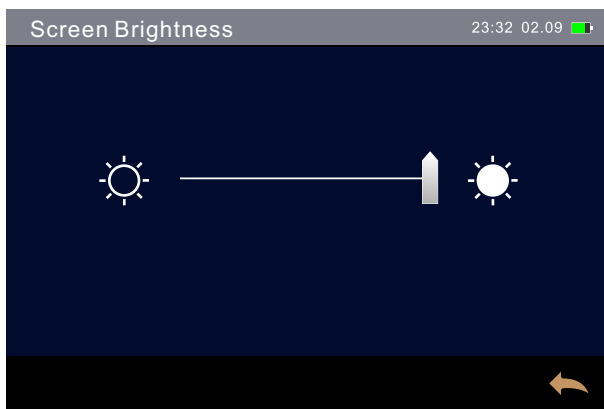
Figure 64 Screen Backlight Brightness Settings

3.8.12 Factory reset

Click "Factory Reset" in the system settings interface, you will enter the interface of Figure 65, click confirm (✓) the instrument to empty all measurement records and user settings, and restore to the factory state, click back (←) to cancel this operation.
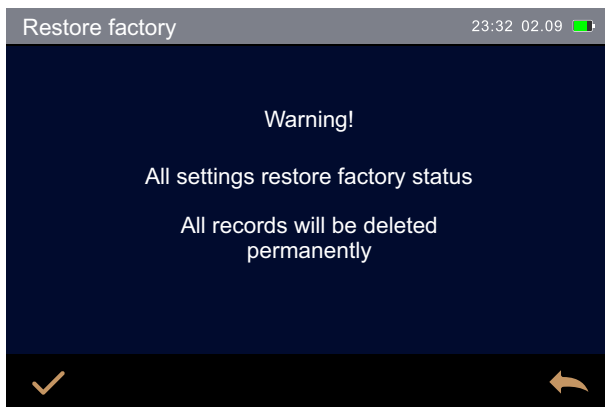
Figure 65 Factory Reset Interface

Note: The operating instrument will empty all data and user settings and restore to the factory setting state, all data is not recoverable, please operate with caution.

3.8. 13 System tolerance

The tolerance is for the standard sample, and the tolerance of the standard sample affects the instrument's determination of the test result. The system tolerance is the tolerance that the instrument assigns to the standard by default. If the standard tolerance is not set, the system tolerance is used by default.

Click "System Tolerance" in the system settings interface to enter the tolerance settings interface, as shown in Figure 66. System tolerances are set in the same way as standard tolerances, see Section 2.4.2. After setting up, click Confirm ($\checkmark$) to save, that is, this tolerance is the system tolerance.

Figure 66 System Tolerance Setup Interface

3.8. 14 Time Settings

When the instrument leaves the factory, it is usually synchronized with the local time of the manufacturer, and the user can also set the time of the instrument according to the actual situation. In the system settings interface, click "Time Settings", enter the Date and Time Settings interface, select the date and time, set it up, click Confirm (✓) to save the settings. If you don't want to modify it, click Back (←) to cancel the setting. This is shown in Figure 67.
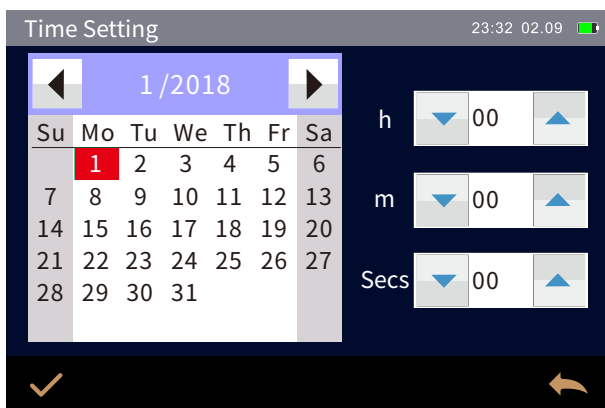
Figure 67 Date/Time Setup Interface

3.8.15 About the instrument

Displays instrument model, SN code and current software, hardware version, whiteboard number, etc.

4, The daily maintenance and maintenance of the instrument

1) This instrument is a precision optical instrument, please properly keep and use the instrument, should avoid the use and storage of instruments in humid, strong electromagnetic interference, strong light, dust environment. It is recommended to use and store the instrument in a standard laboratory environment (temperature 20 to 25 degrees Celsius,1 standard atmospheric pressure, humidity 30 to 70%RH).

2) In order to ensure the validity of the instrument measurement data, it is recommended to go to the manufacturer or a qualified metrology institute for measurement inspection one year from the date of purchase.

4) This instrument is powered by an external power adapter, please use the original power adapter, and at the same time should standardize the use of power supply, avoid frequent plugging and plugging of power supply, protect the performance of power supply, and extend the service life of power supply.

5) Please do not disassemble and install the instrument without permission, if you have any problems, please contact the relevant after-sales staff, tearing up the easy to tear label will affect the after-sales maintenance service of the instrument.

5, Technical Parameters

project	Technical parameters
Measure geometry	12 measuring angles (6 light sources, 2 receivers). 8 measuring angles (6 light sources, 2 receivers). 6 measuring angles (6 light sources, 1 receiver). 5 measuring angles (5 light sources, 1 receiver). 3 measuring angles (3 light sources, 1 receiver).
Color measurement angle	45° Receiver:45as-15°,45as15°,45as25°,45as45°,45as75°,45as110° (varies by model) 15°Receiver:15as-45°,15as-15°,15as15°, 15as-30°,15as45°,15as80°(different models vary). Conforms to: ASTM D2244, E308, E1164, E194, E2539, DIN5033, 5036, 6174, 6175-1, 6175-2; ISO 7724, 11664-4 SAE J 1545
characteristic	Accurate and consistent color measurements are provided for metallic, pearlescent and other complex special effect color products.
Illumination source	Blue-light-enhanced full-spectrum LEDs
Light source life	3 million measurements in 5 years
Spectroscopic mode	Concave gratings
detector	256-cell dual-array CMOS image sensor
Measure the wavelength range	400nm-700nm
Wavelength spacing	10nm
Measuring range	0~600%
Half bandwidth	10nm
Measuring caliber	Φ12mm
Color space	CIE LAB, XYZ, Yxy, LCh, βxy, DIN Lab99
Chromatic aberration formula	ΔE*ab, ΔE*94, ΔE*cmc(2:1), ΔE*cmc(1:1), ΔE*00, DIN ΔE99, ΔE DIN6175
Other chromaticity metrics	Flop Index, Radiation Intensity Value
Observer angle	2°/10°
Observe the light source	D65,A,C,D50,D55,D75,F1,F2(CWF),F3,F4，F5，F6,F7(DLF),F8,F9，F10(TPL5),F11(TL84),F12(TL83/U30)
display	Spectral Graphs/Data, Sample Chromaticity Values, Chromatic Aberration Values/Plots, Pass/Fail Results, Color Simulation, Color Bias, Sample Effect Values, Effect Differences (Varies by Model).
Measure time	The measurement time for a single angle is about 1s, and the measurement time for all angles is about 12s (different models vary).
Color repeatability	Spectro photonic reflectance: within 0.08% of the standard deviation Chromaticity value:0.02 ΔE*ab (after instrument warm-up correction, measure the average of 30 whiteboards at intervals of 5s). (Varies by model)

Color reproducibility	△E*<0.10, average on the gray BCRA swatch △E*<0.25, average on the color BCRA swatch
Poor instrument table to desk	0.18∆E*00 (average of 12 swatches in the BCRA Series II
Effect parameters	Flicker, Color flash, Granularity (some models do not have this feature).
Effect measurement	(Flicker area, flicker intensity, flicker grade and roughness)15as-45°,15as-15°,15as15°,15as-0°,15as45°,15as80° 15d diffuse particle size (Some models do not have this function)
Effect repeatability	Short-term repeatability of flicker:0.12% (10 standard deviations) (after instrument warm-up correction, measure the average of 10 color plates at intervals of 10s). Short-term repeatability of particle size:0.09% (10 standard deviations) (After instrument warm-up correction, measure color plates 10 at intervals of 10s Sub-average). (Some models do not have this function)
Effect reproducibility	Flicker reproducibility:1.9% (10 standard deviations) (average of BCRA series II. 12 swatch measurements) Granularity reproducibility:1.4%. (10 SDXs) (BCRA Series II. Average of 12 Swatch Measurements). (Some models do not have this function)
Trigger mode	Pressure sensing trigger, key trigger, software trigger
Measurement method	Single measurement, average measurement (2 to 99 times), continuous measurement (2to99 times).
Targeting methods	Color camera preview
size	L x W x H = 195X83X128mm
weight	Approx. 0.85Kg
Battery level	Lithium battery,3.7V, 3200mAh, can be tested continuously 6000 times within 8 hours of full charge
display screen	TFT True Color 3.5inch, capacitive touch screen
interface	USB, Bluetooth 5.0(different models vary).
Store data	1000 samples,4000 samples
language	Chinese (Simplified, Traditional) English
Operating temperature range	10°C to 50°C, humidity not exceeding 85%, non-condensing
Storage temperature range	-20°C to 50°C, humidity not exceeding 85%, non-condensing
calibration	Built-in whiteboard parameters, external whiteboard, color board (some models without color board), black light well
Calibration interval	4 hours,8 hours,24 hours, boot correction
Standard accessories	Power adapter, data cable, manual, quality management software (official website download), calibration box (external whiteboard, color board (some models without color board), black cylinder, protective cover, wrist strap
Optional accessories	Micro printer + companion power adapter
concentrate	The technical parameters are for reference only and shall prevail based on the actual sales of the product

Appendix

1. Object color

There are three elements of observing color: illumination, object, and observer. Any change in any of these three will affect the observer's color perception. When the illumination source and the observer do not change, then the object will determine the color perception formed by the observer.

The reason why the object can affect the final color perception is because the reflection spectrum of the object (transmission spectrum) modulates the light source spectrum, different objects have different reflection spectra (transmission spectrum), and the light source spectrum is modulated by the reflection spectrum (transmission spectrum) of different objects to obtain different results, because the observer is unchanged, so it presents different colors, the principle of which is shown in the following figure.

Reflectance spectra   Light source   Standard observer
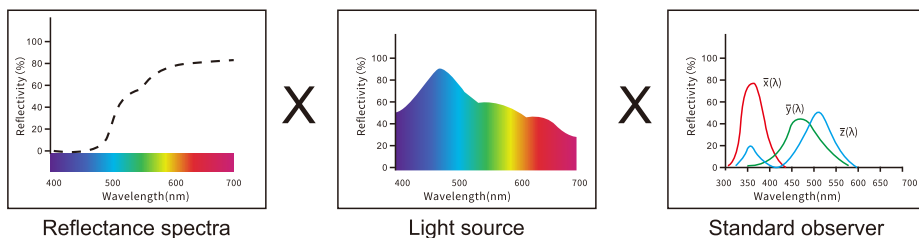
$$
=
\begin{vmatrix}
L = 70.95 \\
a = 69.72 \\
b = 40.35
\end{vmatrix}
$$

2. Chromatic aberration formula

CIE 1976 chromatic aberration formula ΔE*ab is as follows:

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

$$\Delta L^{*} = L^{*}_{1} - L^{*}_{0}$$
$$\Delta a^{*} = a^{*}_{1} - a^{*}_{0}$$
$$\Delta b^{*} = b^{*}_{1} - b^{*}_{0}$$

CiE 2000 chromatic aberration formula ΔE00 is as follows:

$$\Delta E_{00} = \left[\left(\frac{\Delta L'}{K_{L}S_{L}}\right)^{2} + \left(\frac{\Delta C'}{K_{C}S_{C}}\right)^{2} + \left(\frac{\Delta H'}{K_{H}S_{H}}\right)^{2} + R_{T}\left(\frac{\Delta C'}{K_{C}S_{C}}\right)\left(\frac{\Delta H'}{K_{H}S_{H}}\right)\right]^{1/2}$$

$$L' = L^{*}$$
$$a' = a^{*}(1+G)$$
$$b' = b^{*}$$

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

CIE 1994 Chromatic aberration formula ΔE*94 is as follows:

$$\Delta E^{*}_{94} = \left[\left(\frac{\Delta L^{*}}{K_{L}S_{L}}\right)^{2} + \left(\frac{\Delta C^{*}_{ab}}{K_{C}S_{C}}\right)^{2} + \left(\frac{\Delta H^{*}_{ab}}{K_{H}S_{H}}\right)^{2}\right]^{1/2}$$

$$S_{L} = 1$$
$$S_{C} = 1 + 0.045\,C^{*}_{ab}$$
$$S_{H} = 1 + 0.015\,C^{*}_{ab}$$

3. Judgment of color casts

△L large (positive) indicates whitening, △L small (negative) indicates blackness

△a large (positive) indicates a reddish side, △a small (negative) indicates a greenish side

△b large (positive) indicates yellowish, △b small (negative) indicates bluish

4. The human eye's ability to distinguish colors

The NBS unit of chromatic aberration is derived from the Judd-Hunter formula for calculating chromatic aberration, which was adopted by the National Bureau of Standards in1939 and calculated the color difference according to this formula, when the absolute value is 1, is called the "NBS Chromatic Aberration Unit". Later development of new chromatic aberration formulas often consciously adjusts the units to be close to the NBS units, such as Hunter Lab and CIE LAB, CIE LUV, etc. The units of the chromatic aberration formula are approximately the same (not equal) as the NBS units. Therefore, don't misunderstand that the chromatic aberration units calculated by other chromatic aberration formulas are all NBS. The approximate correspondence between human vision and NBS is shown in the following table.

The degree to which NBS units differ from the perception of color.

NBS unit chromatic aberration value	Sensory color aberration
0.00~0.50	(micro chromatic aberration) sensation minimal
0.50~1.50	(small chromatic aberration) sensation slight (slight)
1.5~3	(small chromatic aberration) feeling noticeable (obvious)
3~6	(larger chromatic aberration) feeling very noticeable (appreciable)
6 or more	(large color aberration) feels strong (much).