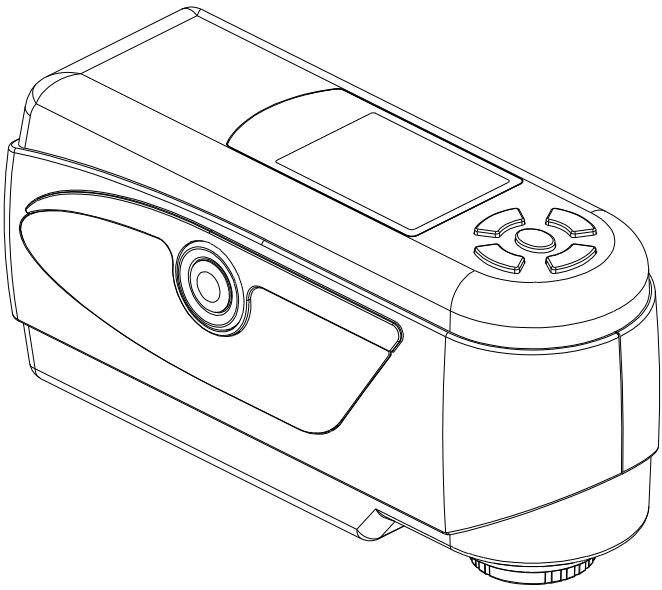
Colorimeter

OPERATION MANUAL



V8.0

Contents

Product Description

This user manual is for model Type A, Type B , Type C colorimeter, but all the following descriptions are according to model Type A. You will find Type B and Type C technical parameters in Product Specifications.

Type A colorimeter is researched and developed in accordance with CIE (International Commission on Illumination) and CNS (China National Standards). Type A colorimeter is a high precise colorimeter with simple user interface and stable performance. It can be powered by both Li-ion battery and external DC power supply.

Type A colorimeter adopts innovative patent technology -- automatic white and black calibration at startup which greatly simplifies the measuring steps.

Type A colorimeter adopts innovative patent technology -- camera locating and illumination locating which brings out more precise and quicker locating.

Type A colorimeter has been through numerous experiments and tests. It adopts complex advanced algorithms which make measurement performance more stable, more accurate and more compatible.

Cautions

- This colorimeter is a precise measuring instrument. Please avoid dramatic changes of external environment when measuring. These changes, including the flicker of surrounding light, the rapid change of temperature, will affect the measuring accuracy.

- Keep the instrument balanceable; make sure the measuring aperture cling to the test sample, and no shaking or shifting when measuring. Please prevent the colorimeter from fierce collision or crash.

- This instrument is not waterproof. Do not use it in high humidity environment or in water.

- Keep the colorimeter clean. Avoid dust, powder or solid particles entering the measuring aperture and the instrument.

- Replace the white calibration cover and put the colorimeter into instrument cabinet when not in use.

- If not used for a long time, please charge the instrument regularly to avoid battery damage.

- Please keep the colorimeter in a cool dry place.
- Any unauthorized changes to the colorimeter are not permitted, or it will affect the measuring accuracy, even cause irreversible damage.

I. Button Description

The following is a brief introduction of the buttons. We will give more detailed information about its function separately in next chapters.

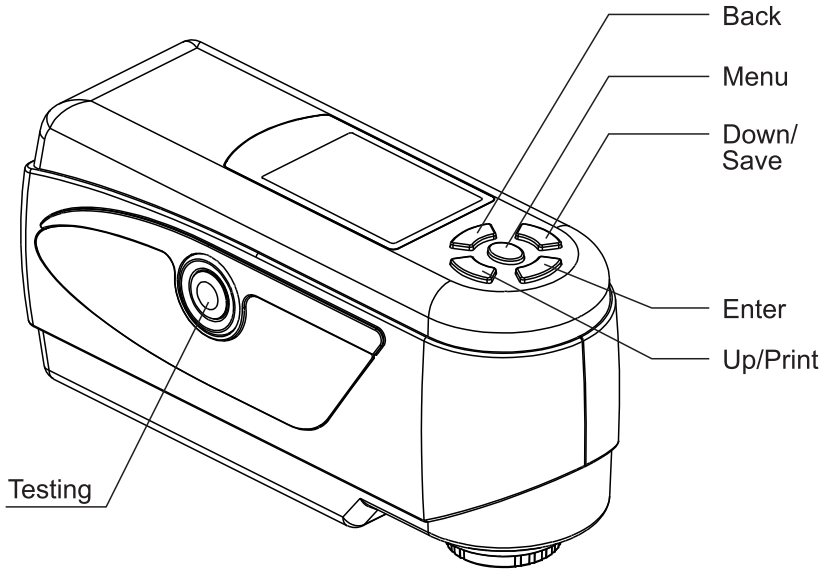


Figure 1 Button Function

Button Function Introduction

1. ◎ Testing
2. ⬭ Menu
3. ⬆ Up/Camera/Print
4. ⬇ Down/Save
5. ↵ Enter
6. ↩ Back

II. Interface Description

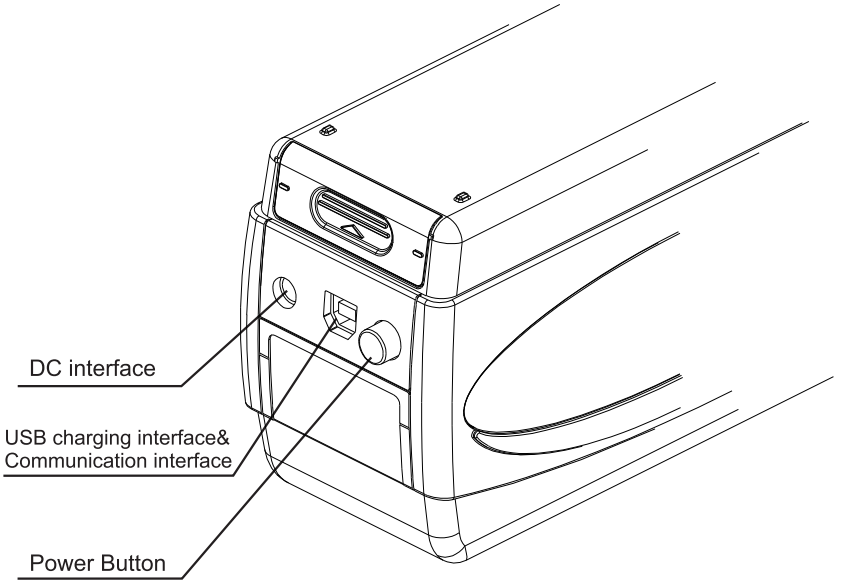


Figure 2 Interface Description

Interface Description

1. Power Switch: Press the button to turn on the colorimeter. Press the button again. The button will pop up. Then the colorimeter is turned off.

2. DC Interface: Connect with AC adapter. It is used to connect to external power source. The specification of external power source is 5V⎓2A.

3. USB Interface / RS-232 Interface: This interface is a common interface. The instrument automatically judges the connection status. USB interface is used to transfer data to PC. Its baud rate is 115200bps. RS-232 interface is used to connect to the printer; its baud rate is 19200bps.

Note: When connecting to external power source, please press

the power switch to start the instrument.

III. Battery Description and Installation

This instrument has a built-in lithium battery, please use a dedicated charging device. The battery is not removable, please do not open the battery cover.

When using external power source or connecting USB interface to PC, **if you press the power switch** , it will charge the Li-ion battery. If you don't want to charge the battery, Please turn off the power.

When charging the battery, dynamic battery icon will display on the top right corner of "Standard Measurement" and "Sample Measurement" interfaces. In figure 3, the charging icon displays in "Standard Measurement" interface; if no charging, the dynamic icon will not appear.

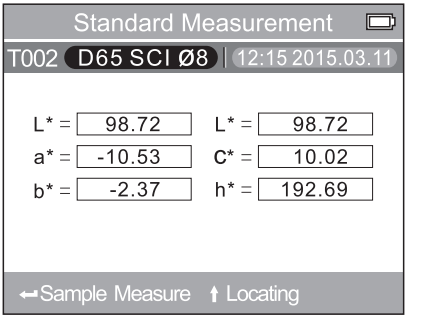


Figure 3 Charging Icon

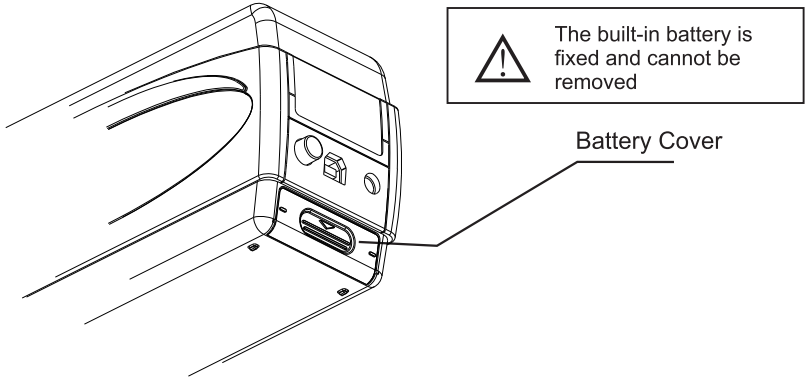


Figure 4 Battery Cover

Battery Information

Please use a dedicated charger to charge the instrument.

Battery Specification: Li-ion 3.7V⎓0.5A 3200mAh

IV. Colorimeter Operating Instruction

（I） Turning On

1. Preparations Before Power On

a) Check whether there is battery powered or external power supply.
b) Make sure the white calibration cover is connected to the instrument and well installed. If it is loose or the white calibration cover isn't will installed, you must put the cover on and be sure it is connected to the instrument tightly.

2. Turning On

Press the power switch on the back side of the instrument, the LCD screen will display logo. After a few seconds, it will enter Standard Measurement interface automatically, and the default display is L*a*b*C*H.

3. White Calibration and Black Calibration

a) Auto White Calibration (Recommend)

The instrument adopts a user-friendly design and automatically performs white correction during the startup phase, making it the most convenient colorimeter currently in use. When the instrument monitor enters the measurement interface after booting up, the instrument has automatically completed white calibration. At this point, the white board cover can be removed for color difference measurement.

If the white calibration cover is loose or not installed, Type A colorimeter will enter an interface "White Calibration Fail", as shown in Figure 5. It will display two options "Restart White Calibration" and "Skip White Calibration".

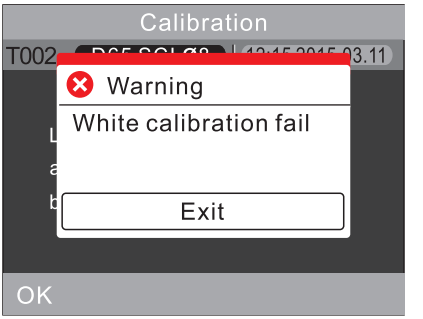


Figure 5 White Calibration Fail

Select option 1, you should replace the white calibration cover. After confirmation, the instrument will re-start white calibration automatically.

Select option 2, the instrument will skip white calibration and enter operating interface directly. At the moment, **the instrument will adopt the last white and back calibration data. We do not recommend you to choose this option, because it may make the measured data not accurate enough .**

b) Manual White Calibration and Black Calibration

After turning on Type A colorimeter, press “Menu” to enter the main menu, as shown in Figure 6. Select “Calibrate” to enter White and Black Calibration interface, as shown in Figure 7.

Be sure the white calibration cover is well installed. Selecting “White Calibration” and press “Enter” button, the instrument will prompt you to place the white calibration plate. Then press “Enter” or “Testing” key to start white calibration.

Be sure the white calibration cover is removed. Select “Black Calibration” and press “Enter”. The instrument will prompt you to direct the measuring aperture to the air. Press “Enter” again or press “Testing” key to start black calibration.

Note: When starting black calibration, direct the measuring port to the air. Be sure the black calibration is performing in a dark, no bright light source environment. Keep the measuring port more than 3m away from any refl ective items (hands, desks, walls etc.).

By then, manual white calibration and black calibration are completed.

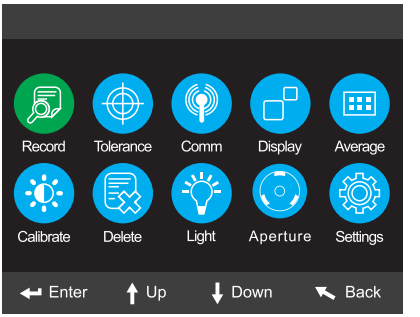


Figure 6 Main Menu

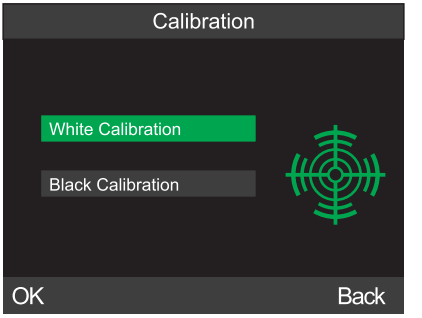


Figure 7 Manual Calibration

Suggestion: Manual white calibration and black calibration are only needed under the condit ion that the instrument has been used for a lo ng time and the measured data are not accurate.

4. Changing Measuring Aperture

Note: After changing the measuring aperture, you have to enter the "Settings –Aperture Setting" to select the corresponding aperture. Or it may lead to the inaccurate measured data.

Type A colorimeter can be configured with three measuring apertures: Φ8mm measuring aperture, Φ4mm measuring aperture and extended Φ8mm measuring aperture (optional). The users can change it for different needs.

a) Removing Measuring Aperture

As shown in Figure8 and Figure 9, turn the measuring aperture counter clockwise 20 degrees, and then remove the aperture downward.

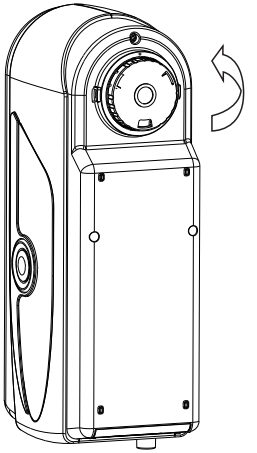


Figure 8 Counter Clockwise 20 Degrees

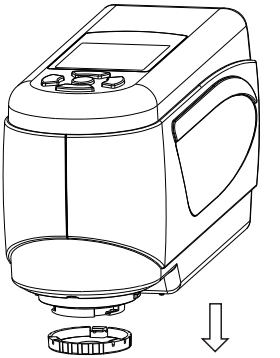


Figure 9 Remove the Aperture Downward

b) Installing Measuring Aperture

As shown in Figure 10 and Figure 11, align the measuring aperture with mounting hole, and then turn it clockwise about 20 degrees.

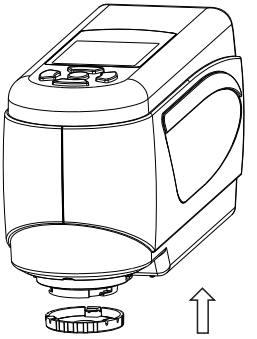


Figure 10 Align the Measuring Aperture With Mounting Hole

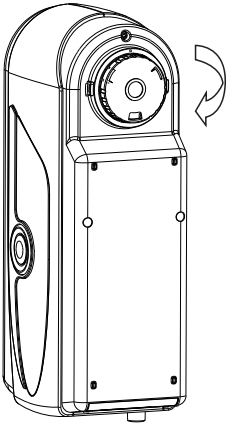


Figure 11 Turn the Measuring Aperture Clockwise About 20 Degrees

c) Installing Extended Measuring Aperture

As shown in figure 12 and figure 13, align the extended measuring aperture with mounting hole, and then turn it clockwise about 20 degrees. After the rotation, the arrow on the measuring aperture should be aligned with the red dot on the colorimeter, as shown in figure 12.

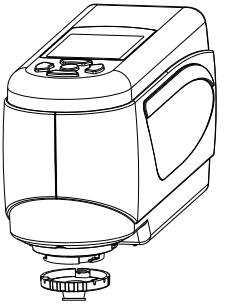


Figure 12 Align the Extend Measuring Aperture With Mounting Hole

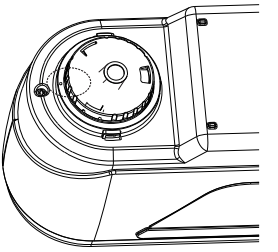


Figure 13 Turn the Extended Measuring Aperture Clockwise About 20 Degrees

（II） Measurement

1. Locating and Measuring Method

There are two locating methods:

a) Camera Locating

Enter “Standard Measurement” or “Sample Measurement” interface, align Type A measuring port with the test sample and cling to it. If you need precise locating, please press the “Up/Camera/Print” button, then, camera locating is starting. At the same time, the screen will display the matching status of the measuring aperture and the test sample. You can locate it accurately through moving the measuring port according to the display.

After aligning the measuring aperture, press the “Testing” key, the instrument will exit camera interface and finish sample testing in approx. 1 sec. After completing the measurement, the interface will display color parameters of the measured sample.

b) Facula Locating

Enter “Standard Measurement” or “Sample Measurement” interface, press the “Testing” key and hold it. The facula will appear at the moment. You can observe the matching status between the facula and the measured sample. At the same time, hold the measuring aperture close to the measured sample and adjust it. Then the alignment is achieved.

After the locating, release “Testing” button. The instrument will finish sample testing in approx. 1 sec and display color parameters of the measured sample.

2. Standard Measurement

There are two conditions about standard measurement. One is performing standard measurement after power on; another is after completing sample measurement or other operations, press “Back” button continuously to enter standard measurement.

a) Standard Measurement after Power On

After power on, the colorimeter will display “Standard Measurement”, as shown in Figure 14. Then, align measuring aperture to the standard, press “Testing” key, the screen will display color parameters of this standard. Press “Enter” button, the instrument will enter “Sample Measurement” interface.

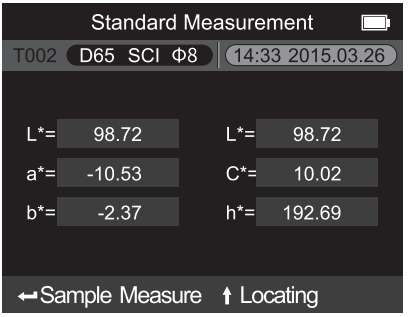


Figure 14 Standard Measurement Interface

b) Standard Measurement after Completing Sample

Measurement or Other Operations

After completing sample measurement or other operations, the instrument may display an interface. At this moment, press “Back” button repeatedly until the interface back to “Standard Measurement” interface, as shown in Figure 14. Then, perform standard measurement according to step a).

3. Sample Measurement

After completing standard measurement, press “Enter” button, the instrument will enter “Sample Measurement” interface automatically, as shown in Figure 15. Align the measuring aperture to the test sample to perform sample measurement.

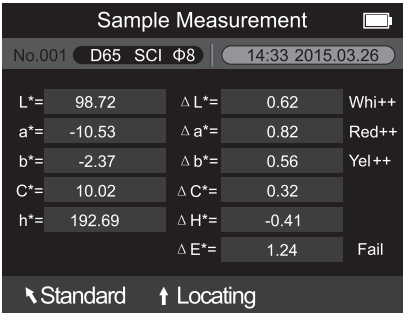


Figure 15 Sample Measurement Interface

Note: During the measure ment (Approx. 1 sec), all buttons are ineffective.

（III）Save Data

There are two methods to save data.

1. Auto Save

Press “MENU” button to enter the main menu, as shown in Figure 6. Select “Settings” to enter an interface shown in Figure 16. Select “Auto Save” to enter status setting interface, as shown in Figure 17. Select

"On" and press "Enter" button to save the setting. After completing this setting, the measurement data will be saved automatically.

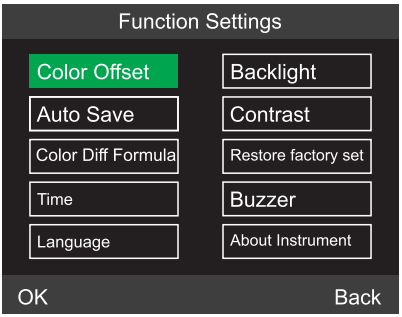


Figure 16 Settings Interface

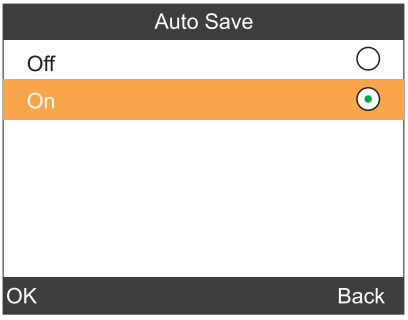


Figure 17 Auto Save

2. Manual Save

In Figure 17, select "Off", then the data will not be saved automatically. If you want to save data when measuring, please press "Down/Save" button after each measurement.

（IV）Connect Colorimeter to the PC

After installing the color management software on the PC, connect the instrument to the PC using a USB cable, and the software will automatically connect to the instrument.

（V）Print

Only when the colorimeter is in “Standard Measurement”, “Sample Measurement” or “Record” interfaces, you can print data through the printer.

Connect colorimeter to the printer. When the colorimeter is in one of the above interfaces, press and hold (about 5 second) “Up/Camera/Print” button to start the printer.

V. System Function Description

Except “Standard Measurement” and “Sample Measurement” interfaces, you should enter other function interfaces through the main menu. Main menu is shown in Figure 18.

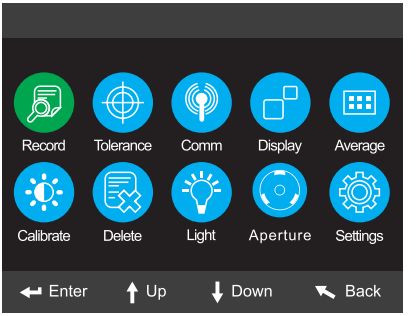


Figure 18 Main Menu Interface

1. Record and Standard Entering

a) Record

Select "View Record" in the main menu to enter the "Standard Sample Record" interface, as shown in Figure 19. The figure shows the recorded standard sample data, and different standard sample data can be viewed by pressing the "Up" and "Down" keys. "T002" in the figure is the standard sample number. After selecting a standard sample, press the "Confirm" key to view the sample data recorded under this standard sample and the color difference between the sample and the standard sample. As shown in Figure 20, different sample data can be viewed by pressing the "Up" and "Down" keys. In the figure, No 001 is the serial number for sample measurement.

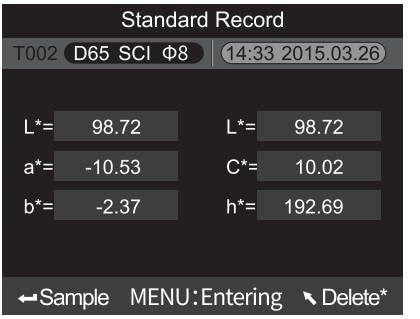


Figure 19 Standard Record

Note: "↖Delete * " means press Back key "↖" and hold it for 3 seconds, then the record will be deleted.

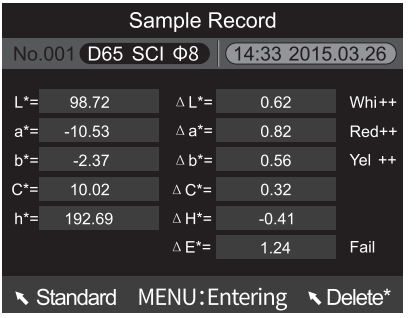


Figure 20 Sample Record

b) Standard Entering

In some cases, it's needed to measure color difference under a saved standard. Then, you can select "Record" in main menu to enter standard sample records interface. You can search the needed standard data through "Up" and "Down". After finding it, press "Menu" button, and then the standard record is entered to the measurement interface, press "Enter", you can perform sample measurement under this standard.

c) Sample Record Entered to a Standard

In some cases, it's needed to use a stored sample as a standard. Then, you can select "Record" to enter sample records interface, as shown in

Figure 20. You can search the needed sample data through “Up” and “Down”. After finding it, press “Menu” button, and then the sample record is entered to the measurement interface as a standard, press “Enter”, you can perform the color measurement under this standard.

2. Tolerance Setting

Select “Tolerance” in main menu to enter tolerance setting interface, as shown in Figure 21. You can add or subtract the number in which the cursor is positioned through “Up” and “Down” button. After setting the number to the needed one, press “Enter” button, the cursor will jump to the last number. When the cursor is in the last number, press “Enter” button to save the settings and return to the main menu.

If you don’t want to set or modify the tolerance, you can press “Back” button to return to the main menu.

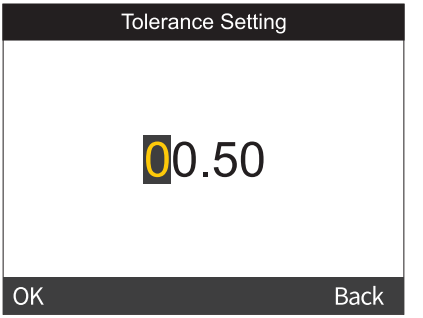


Figure 21 Tolerance Setting

3. Delete Records

Select “Delete” in main menu to enter the interface shown in Figure 22. There are two options: “Delete All Samples” and “Delete All Records”.

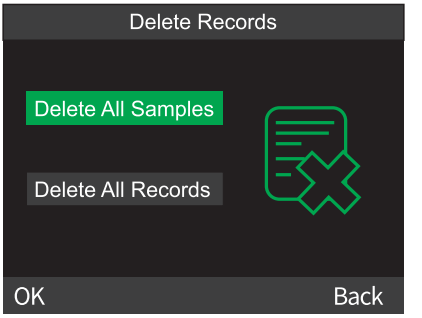


Figure 22 Delete Records

a) Delete All Samples

When select “Delete All Samples”, it will delete all samples in the instrument and save the standard records. Then, the instrument will display a warning interface, as shown in Figure 23. Press “Enter”, all sample data will be deleted, but the standard records are still retained.

b) Delete All Records

When select “All Records Delete”, all records in the instrument will be deleted, including all standard records and all sample records. Then, the instrument will display a warning interface, as shown in Figure 24. Press “Enter” button, all records in the instrument will be deleted.

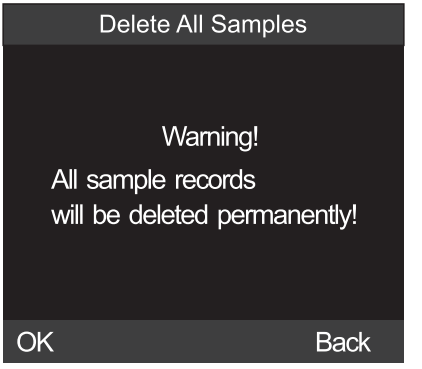


Figure 23 “Delete All Samples” Warning Interface

Figure 24 “Delete All Records” Warning Interface

4. Display mode

Select "Display Mode" in the main menu interface to enter the interface shown in Figure 25. Users can choose different color spaces for display according to their needs, which will affect the display content in the "Standard Sample Measurement" and "Sample Measurement" interfaces. The selection can be made by pressing the "up" and "down" keys. Pressing the 'Confirm' button will save the settings made and return to the main menu interface.

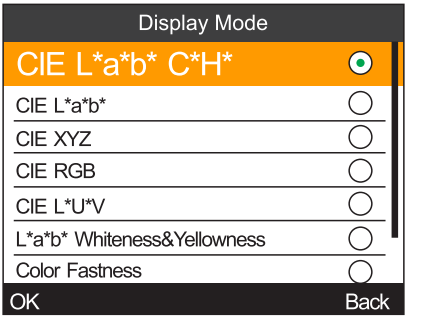


Figure 25 Display Mode Interface

In the computer colorimeter, the default display mode is "CIE L * a * b * C * H *", and other options include "CIEL * a * b *", "CIE XYZ", "CIE RGB", "CIEL * u * v *", "L * a * b * whiteness and yellowing", "color fastness", and "color fastness". The measurement interface for each option corresponds to Figure 26-35; Among them, when selecting "color fastness" and "color fastness", the measurement interface first displays Figure 32 and Figure 33 for standard sample measurement. After the standard sample measurement is completed, it enters the fastness measurement interface in Figure 34 and Figure 35.

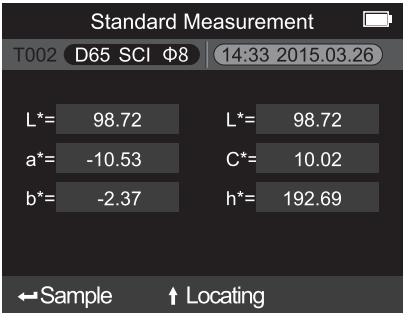


Figure 26 CIE L*a*b*C*H* Measurement Interface

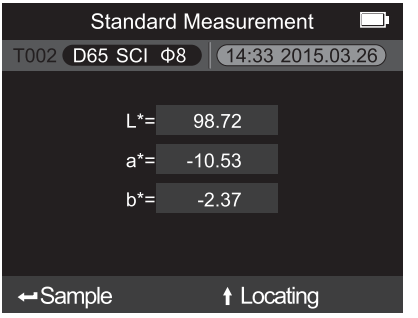


Figure 27 CIE L*a*b* Measurement Interface

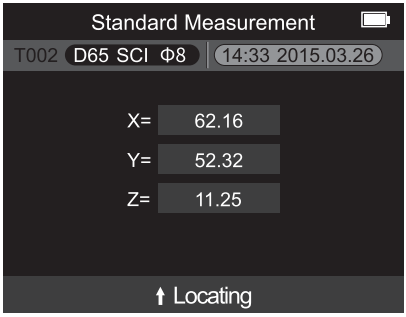


Figure 28 CIE XYZ Measurement Interface

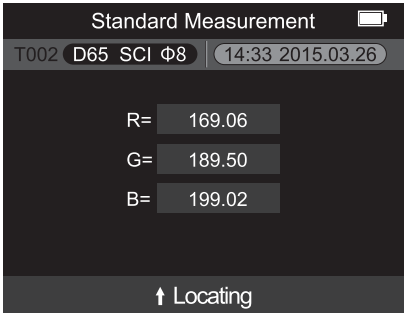


Figure 29 CIE RGB Measurement Interface

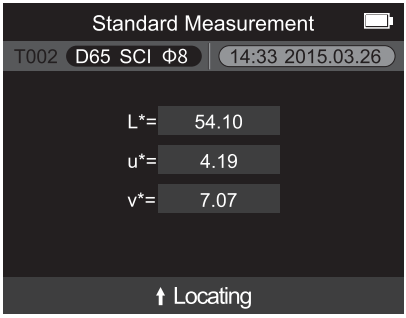


Figure 30 CIE L*u*v* Measurement Interface

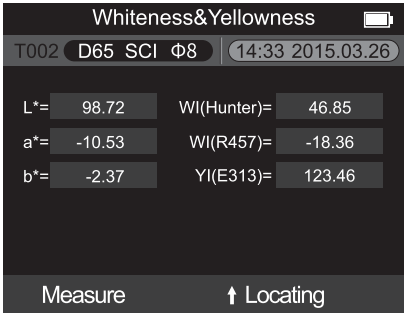


Figure 31 L*a*b* Whiteness & Yellowness Measurement Interface

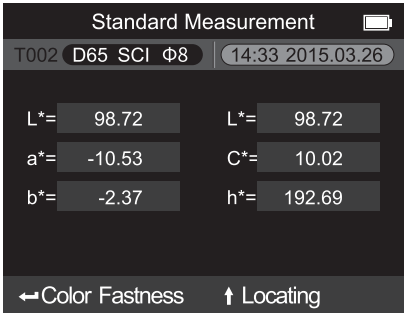


Figure 32 Color Fastness —Standard Measurement Interface

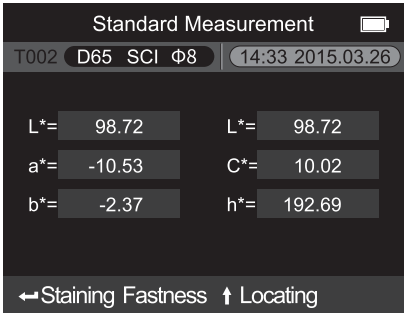


Figure 33 Staining Fastness —Standard Measurement Interface

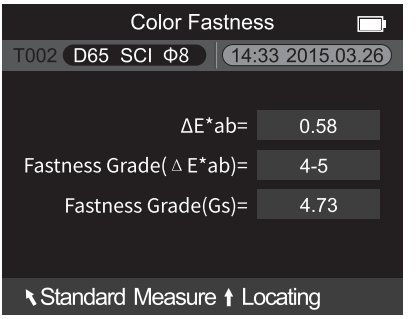


Figure 34 Color Fastness Measurement Interface

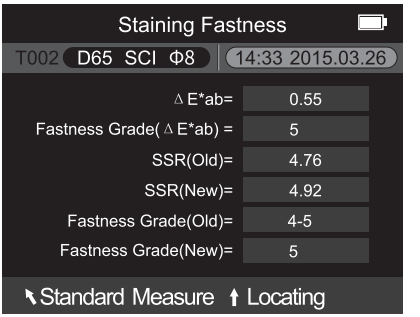


Figure 35 Staining Fastness Measurement Interface

5. Light source selection

Select "Light Source Selection" in the main menu interface to enter the interface shown in Figure 36, where users can choose different light sources for measurement according to their needs. The selection can be made by pressing the "up" and "down" keys. Pressing the 'Confirm' button will save the settings made and return to the main menu interface.

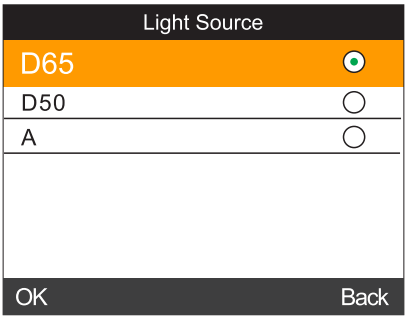


Figure 36 Light Source Selection Interface

6. Measure aperture

Some instruments are equipped with multiple calibers, and the "Measuring Caliber" icon can be selected in the main menu interface. Users can choose 4mm or 8mm according to their measurement needs. After selecting, press the "Confirm" button to save the settings and return to the main menu interface.

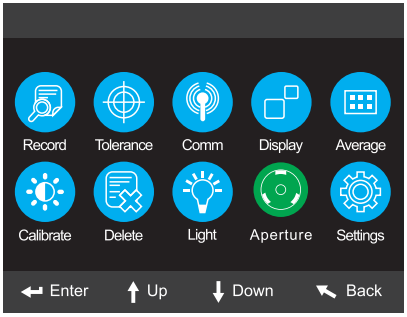


Figure 37 Measure aperture

7. Average Measurement

Select “Average” in the main menu to enter an interface shown in Figure 38. You can set the number of average measurements according to your need. You can add or subtract the times by pressing “Up” and “Down” buttons. Press “Enter” to save the settings and return to the main menu. When the number is set to “01”, the instrument will only make single measurement, and will not perform average measurement. The instrument is defaulted to one time measurement.

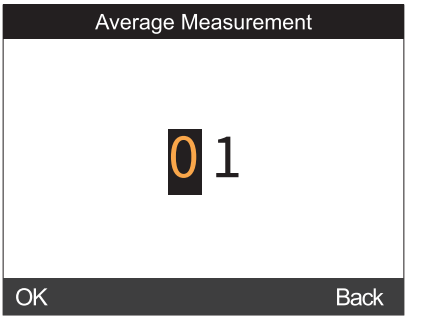


Figure 38 Average Measurement Setting Interface

8 . Function Setting

Select “Settings” in the main menu to enter an interface shown in Figure 39. You can select the object according to your need by pressing “Up” and “Down” buttons. Press “Enter” to enter the corresponding setting interface. After completing these settings, press “Enter” button to save the settings and return to the previous menu.

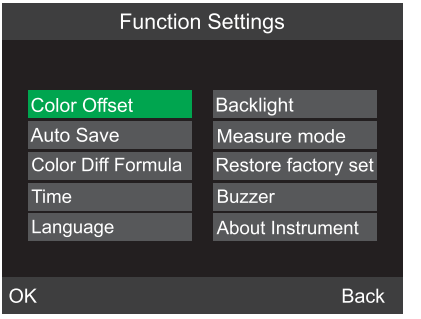


Figure 39 Function Settings Interface

a) Select “Settings” - “Color Offset” to enter an interface shown in Figure 40. You can set whether to display the color offset or not through this interface. Select “Open”, the corresponding color offset will display on the right of the measurement interface, as shown in Figure 41.

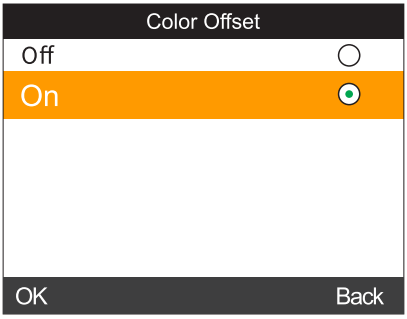


Figure 40 Color Offset Setting Interface

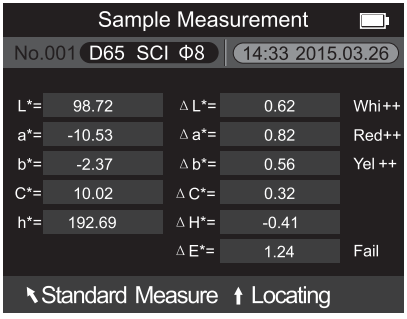


Figure 41 Color Offset Display

Notes: 1. "White++" means the color of the measured sample is a little white

2. "White+" means the color of the measured sample slant white.

3. The same as other displays of color offset.

b) Select "Settings" - "Auto Save" to enter an interface shown in Figure 42. This interface enables you to set measured data automatically or not. Select "Open", each sample data and standard data will be saved automatically. Select "OFF", data will not be saved automatically.

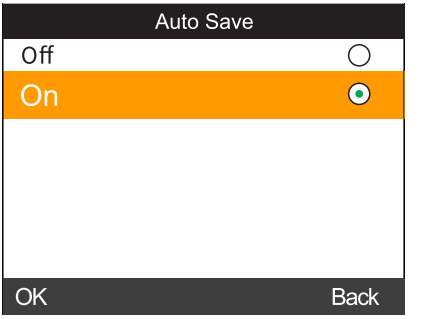


Figure 42 Auto Save Interface

c) Select “Settings” - “Aperture Setting” to enter an interface shown in Figure 43. This interface is used for selecting measuring aperture. **After changing the aperture, be sure to select the corresponding aperture in “ Aperture Setting ”, or it will cause the inaccuracy of the measured data.** After changing the aperture, **you need to re-perform white and black calibration, or it will also cause the ina ccuracy of the measured data.**

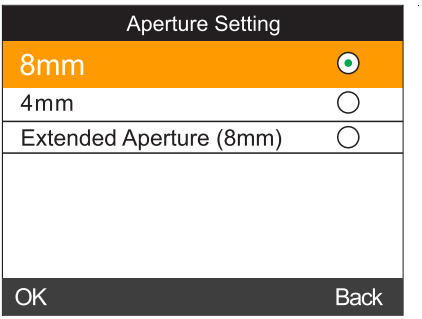


Figure 43 Aperture Setting

d) Select “Settings” - “Color Diff Formula” to enter an interface shown in Figure 44. You can select the needed color difference formula through this interface. After selecting and saving this formula, the instrument will calculate the color difference according to the selected formula when measuring.

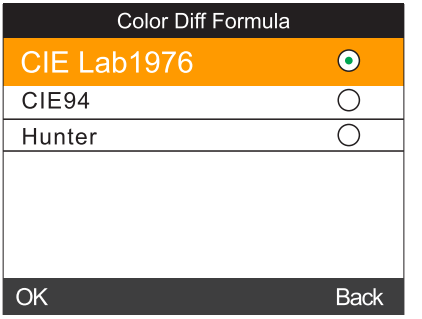


Figure 44 Color Diff Formula

e) Time settingSelect "Time Settings" in the function settings interface to enter the time and date settings interface, as shown in Figure 45. Use the "Up" and "Down" keys to select the object to be set, and then press the "Confirm" key to enter the corresponding settings interface; In Figures 46 and 47, the time and date can be added or subtracted using the "up" and "down" keys. In Figures 48 and 49, the desired time and date display format can be selected using the "up" and "down" keys. Pressing the 'Confirm' button will save the settings made and return to the previous menu interface.If you do not want to set or modify the time and date, you can press the "Back" button to return to the function settings interface.

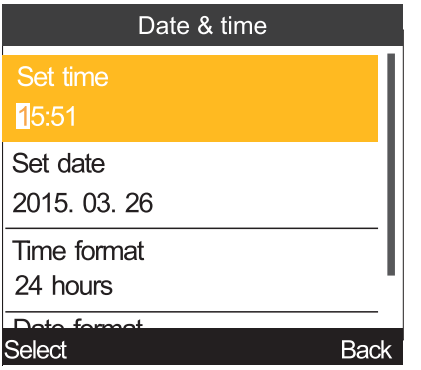


Figure 45 Time Setting Interface

Figure 46 Set Time

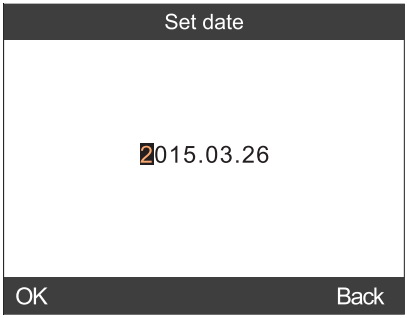


Figure 47 Set Date

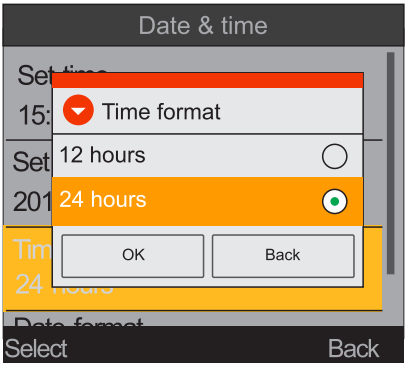


Figure 48 Time Format Setting

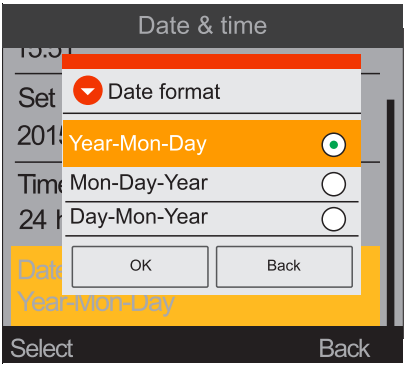


Figure 49 Date Format Setting

f) Language selection Select "Language Selection" in the function settings interface to enter the interface shown in Figure 50, where users can choose the display language according to their needs. You can select by flipping up or down, press the "confirm" button to save the settings, and return to the function settings interface.

Figure 50 Language Selection Interface

g) Screen backlight time Select "Screen Backlight Time" in the "Function Settings" to enter the interface shown in Figure 51. This interface is used to set the time when the screen backlight is on when the instrument is idle, which is beneficial for saving the instrument's power consumption.

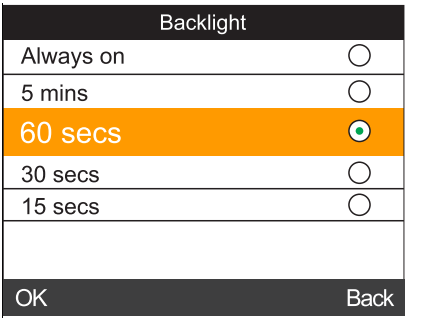


Figure 51 Backlight Time Setting Interface

h) Screen backlight brightnessSelect "Screen Backlight Brightness" in the "Function Settings" to enter the interface shown in Figure 52, which is used to set the brightness level of the screen backlight for users to use in various environments.

Figure 52 Brightness Setting Interface

I) Measurement mode Select "Measurement Mode" in the "Function Settings" to enter the interface shown in Figure 53, where you can choose between normal mode or fast mode for measurement

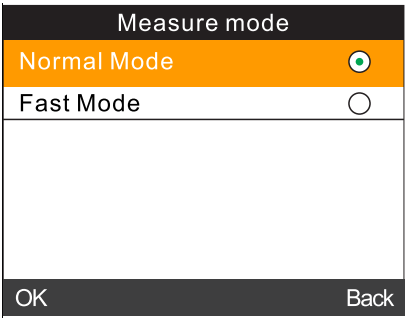


Figure 53 SCI/SCE Setting Interface

j) Restore factory settingsSelect "Restore Factory Settings" in the "Function Settings" to enter the interface shown in Figure 54. Select the "Confirm" button to restore the instrument to its factory state and clear all records.

Figure 54 Restore Factory Set

Ⅵ. Product Parameters

1. Product Features

- This instrument adopts both accurate camera locating and illumination locating and fully considers users' need and adopts user-friendly design. It has original camera locating and illumination locating. You can select it according to your need.

- The colorimeter adopts auto white and black calibration. The calibration will be done during startup. This function can ensure the precision of this instrument, and it eliminates complex manual white and black calibration which greatly improves the convenient use of the colorimeter. You only need to turn on the colorimeter before performing measurements.

- The standard deviation of this colorimeter is △E*ab<0.06 (Average of 30 measurements of standard white calibration plate.).

- The colorimeter is configured Φ8mm measuring aperture, Φ4mm measuring aperture and extended aperture (Φ8mm) (optional), which can meet different requirements.

- The colorimeter adopts international standard illuminate D65, D50 and A. Users can select the light source according to their needs.

- This colorimeter has various color spaces. The users can select it according to their needs. And the instrument can display Whiteness, Yellowness and Color Fastness which is used widely.

2. Product Specifications

Model	**Type A**
Display Mode	CIE L*a*b; CIE XYZ; CIE RGB;CIEL*u*v; CIE*C*H; Whiteness &Yellowness; Color Fastness
Color Difference Formula	ΔE*ab; ΔL*ab; ΔE*C*H; ΔECIE94; ΔEHunter
Illuminating/viewing geometry	8/d (8°illumination angle/diffuse viewing)
Light Source	LED blue light excitation
Detector	Silicon photoelectric diode
Measuring Aperture	Φ8mm; Φ4mm; Φ8mm extended aperture (optional)
Measuring Conditions	Observer: CIE 10°Standard Observer Illuminant: CIE Standard Illuminant D65; D50; A
Measuring Range	L: 0 to 100
Repeatability	Standard deviation within ΔE*ab 0.06 (Measurement Conditions: Average of 30 measurements of standard white plate)
Storage	100 pcs standard samples; 20000 pcs test samples
Minimum Interval Between Measurement	Approx. 1 sec
Battery Life	More than 3000 measurements
Lamp Life	more than 1.6 million times in 5 years
Display	TFT True-color; 2.4 inch
Interface	Model B: USB RS-232: Baud rate 19200bps
Operating Temperature	-10℃ to 40℃ (14℉ to 104℉)

Range	
Storage Temperature	-20℃ to 50℃ (-4℉ to 122℉)
Humidity Range	less than 85% relative humidity, no condensation
Weight	500g
Dimensions	205 x 70 x 100 mm
Size of the Packing	435 x 205 x 345mm
Standard Accessories	Horizontal charger; Li-ion Battery; Operation Manual; Software CD; USB Cable; White Calibration Cover; Φ8mm Measuring Aperture; Φ4mm Measuring Aperture
Optional Accessories	Extended Aperture(Φ8mm); Mini-printer; AC Adapter, Universal Test Components, Powder Test Box

Model	**Type B**
Display Mode	CIE L*a*b*c*h; CIE L*a*b; CIE XYZ
Color Difference Formula	ΔE*ab;
Illuminating/viewing geometry	8/d (8ĩllumination angle/diffuse viewing)
Light Source	LED blue light excitation
Detector	Silicon photoelectric diode
Measuring Aperture	Φ8mm;
Measuring Conditions	Observer: CIE 10°Standard Observer Illuminant: CIE Standard Illuminant D65
Measuring Range	L: 0 to 100
Repeatability	Standard deviation within ΔE*ab 0.07 (Measurement Conditions: Average of 30 measurements of standard white plate)

Storage	100 pcs standard samples; 20000 pcs test samples
Minimum Interval Between Measurement	Approx. 1 sec
Battery Life	More than 3000 measurements
Lamp Life	more than 1.6 million times in 5 years
Display	TFT True-color; 2.4 inch
Interface	Model B: USB RS-232: Baud rate 19200bps
Operating Temperature Range	-10℃ to 40℃ (14℉ to 104℉)
Storage Temperature	-20℃ to 50℃ (-4℉ to 122℉)
Humidity Range	less than 85% relative humidity, no condensation
Weight	500g
Dimensions	205 x 70 x 100 mm
Size of the Packing	435 x 205 x 345mm
Standard Accessories	Horizontal charger; Li-ion Battery; Operation Manual; Software CD; USB Cable; White Calibration Cover; Φ8mm Measuring Aperture;
Optional Accessories	Mini-printer; AC Adapter, Universal Test Components, Powder Test Box

Model	**Type C**
Display Mode	CIE L*a*b*c*h; CIE L*a*b; CIE XYZ
Color Difference Formula	ΔE*ab;
Illuminating/viewing geometry	8/d (8îllumination angle/diffuse viewing)

Light Source	LED blue light excitation
Detector	Silicon photoelectric diode
Measuring Aperture	Φ8mm;
Measuring Conditions	Observer: CIE 10°Standard Observer Illuminant: CIE Standard Illuminant D65
Measuring Range	L: 0 to 100
Repeatability	Standard deviation within ΔE*ab 0.08 (Measurement Conditions: Average of 30 measurements of standard white plate)
Storage	100 pcs standard samples; 20000 pcs test samples
Minimum Interval Between Measurement	Approx. 1 sec
Battery Life	More than 3000 measurements
Lamp Life	more than 1.6 million times in 5 years
Display	TFT True-color; 2.4 inch
Interface	Model B: USB RS-232: Baud rate 19200bps
Operating Temperature Range	-10℃ to 40℃ (14℉ to 104℉)
Storage Temperature	-20℃ to 50℃ (-4℉ to 122℉)
Humidity Range	less than 85% relative humidity, no condensation
Weight	500g
Dimensions	205 x 70 x 100 mm
Size of the Packing	435 x 205 x 345mm
Standard Accessories	Horizontal charger; Li-ion Battery; Operation Manual; Software CD; USB Cable; White Calibration Cover; Φ8mm Measuring Aperture;
Optional Accessories	Mini-printer; AC Adapter, Universal Test Components, Powder Test Box

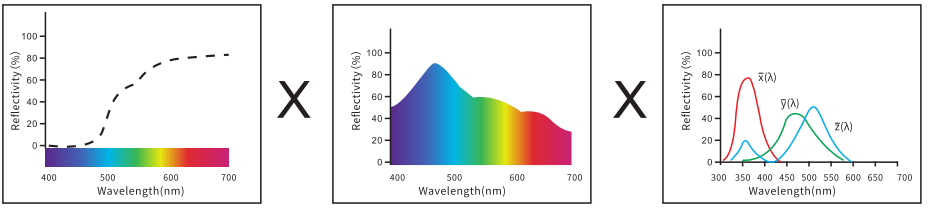
***Note: The specifications are subject to change without notice.**

Appendix

1.Object Color

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

The reason why an object can affect the final color perception is that the reflection spectrum (transmission spectrum) of the object modifies the light source spectrum. Different objects have different reflection spectra (transmission spectrum). (Spectrum) modulation to obtain different results, because the observer does not change, so it presents different colors, the principle is shown in the figure below.



Reflectance spectra X Light source X Standard observer

=

L=70.95
a=69.72
b=40.35

ΔL+ represent whitish, ΔL- represent blackish

Δa+ represent reddish, Δa- represent greenish

ΔL+ represent yellowish, ΔL- represent bluish

2.Color Difference Formula

CIE 1976 ΔE*ab

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

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

CIE 2000 ΔE*ab

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

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

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

CIE 1994 ΔE*ab

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

$$S_L = 1$$
$$S_C = 1 + 0.045\, C^*_{ab}$$
$$S_H = 1 + 0.015\, C^*_{ab}$$

3. Normal color difference allowable range

The allowable range of normal color difference varies depending on different industries and application scenarios. The following are the allowable ranges of color difference for some major industries

Overview:

1. Electronic device industry

Standard: △ E (color difference unit) is usually required to be less than 0.5 to ensure color accuracy in screen display, product appearance, and other aspects.

2. Plastic coating industry

Standard: Require △ E to be less than 1.0, applicable to color control of plastic products and coating products.

3. Textile industry

General standard: △ E below 2.0 is considered an acceptable range, especially in textile color management.Specific standards: In some standards, it is required that the color difference of specific parts should not be 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 between 1.5 and 3.0 is usually considered normal, but specific values may vary depending on product grade and customer requirementsSeeking to be different.

Standard: Some standards stipulate that the color difference value for both fine and general products should not exceed 6.

5. Railway signal flag

Standard: The color difference is less than or equal to 3.0 to ensure the clarity and recognition of the signal flag.

Color difference and perception

ΔE	Perception
0-0.25	Very small or no color difference, ideal match
0.25-0.5	Minor color difference, usually acceptable
0.5-1.0	Minor to moderate color difference, certain applications Acceptable
1.0-2.0	Moderate color difference, perceptible to the human eye, Acceptable in specific applications
2.0-4.0	Obvious color difference, acceptable under specific conditions
> 4.0	The color difference is very large, most applicationsunacceptable

Safety Precautions

To ensure correct and safe use of colorimeter, please read the following terms carefully and comply with them. If there are any need or unclear, please refer to this description.

External Power Source	Always use the AC adapter supplied as a standard accessory if you need to connect an external power source. If the AC adapter other than those specified , this may result in damage to the unit,fire or electric shock. Please switch off external power source if you don't use the instrument for a long time. Or it may damage the instrument or cause a fire.
Instrument	Do not use the instrument in places where flammable or explosive gases (gasoline etc.) are present. Doing so may cause explosion or a fire.Do not disassemble the instrument. Take special care not to allow liquid or metal objects to enter the instrument. Or it may cause short circuit,electric shock, even a fire. If the instrument has burning smell or other peculiar smell, turn the power off immediately, disconnect the AC adapter from the AC outlet (or remove the batteries if they are used),and contact the nearest authorized service center.