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# Manual

## Spectrophotometer

### PCE-CSM 8



# PCE-CSM 8 SPECTROPHOTOMETER OPERATING MANUAL

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## **Induction**

PCE-CSM 8 spectrophotometer is independently developed by 3nh which is in accordance with CIE (International Commission on Illumination) and CNS (China National Standards). The color meter features with touch screen and large screen display. It is configured with high-end color quality management software. Meanwhile it has characters of stable performance, precise measurement and easy to use. The instrument is powered by Li-ion battery or DC power adapter.

## **Advantages**

1. Touch screen, easy to operate.
2. Large screen (3.5 inch), high resolution (320\*480), full-view display with clear image.
3. Aesthetic design perfectly combined with ergonomics structure.
4. 15° oblique angle screen, more in line with the human eye observation.
5. Two standard observer angles, multiple light sources modes, a variety of color systems.
6. High hardware configuration with a number of innovative technologies.
7. Oversized integrating sphere, more effective homogenization ray of lights and precise measurement.
8. Visible spectrum 400~700nm reflectance curve.
9. Input standard data manually, easy to operate.

## Cautions

- The spectrophotometer is a precise measuring instrument. Please avoid dramatic changes of external environment when measuring. These changes, including the flicker of surrounding light and the rapid change of temperature, will affect measurement accuracy.
- Keep the color meter balanceable; make sure the measuring aperture close to the test sample, and no shaking or shifting when measuring. Please prevent the colorimeter from fierce collision or crash.
- The instrument is not waterproof. Do not use it in high humidity environment or in water.
- Keep the instrument clean. Avoid dust, powder or solid particles entering the measuring aperture and the instrument.
- Replace the white calibration cavity and put the spectrophotometer into instrument case when not in use.
- Please take out the battery to prevent the instrument from damage if you don't use it for a long time.
- Please keep the instrument in a cool dry place.
- Any unauthorized changes to the instrument are not permitted, or it will affect the measuring accuracy, even cause irreversible damage.

## 1. Interface Description



Figure 1 Instrument Structure Diagram

### Port Description

1. Power Switch: Push the switch to “1” to turn on the instrument. Push the switch to “0” to turn it off.
2. DC Power Port: Connect with AC adapter. The adapter specification is 5V=2A.
3. USB / RS-232 port: This port is a common port. The instrument will judge the connection status automatically. USB port is used to transfer data to PC. RS-232 port is used to connect to the printer.

## 2 .Battery Description

1. Battery specification: Li-ion 3.7V = 0.5A. The capacity is 3200mAh.
2. Please use original Li-ion battery. Do not use other batteries. Otherwise it will

cause irreversible damage.

3. Please remove the battery if you don't use it for a long time.
4. When charging the battery, please connect power adapter or USB cable (to PC).  
Meanwhile, push the switch to "1" to turn it on, and then the battery will be charging. If not charge the battery, you can remove the battery and connect power adapter, the instrument still works normally.
5. When charging, dynamic battery icon will display on the top right corner of measurement interface.

### **3. Battery Installation**

1. When installing battery, be sure the power is cut off. (Push the switch to "0"). Then remove the battery cover.
2. Insert the Li-ion battery into battery compartment and push it gently. Please pay attention to the battery contacts.
3. Put the battery cover on Li-ion battery, and then push it up as shown in Figure 2.

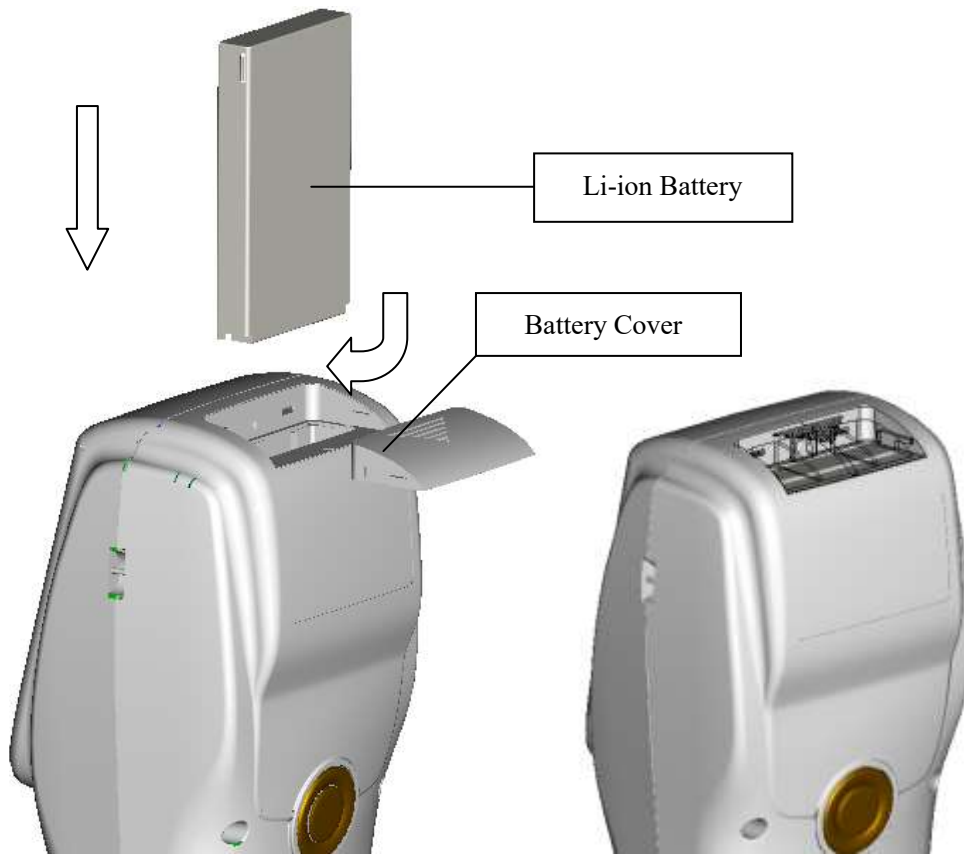


Figure 2 Battery Installation

## 4. Operating Instruction

### 4.1 Turn On

#### 4.1.1 Preparations

Check whether it is powered by battery or adapter.

#### 4.1.2 Turn On

Push the power switch to “1”, the screen will light and display logo. After a few seconds, it will enter Standard Measurement interface automatically, and the default display is  $L^*a^*b^*C^*H$  as shown in Figure 3.

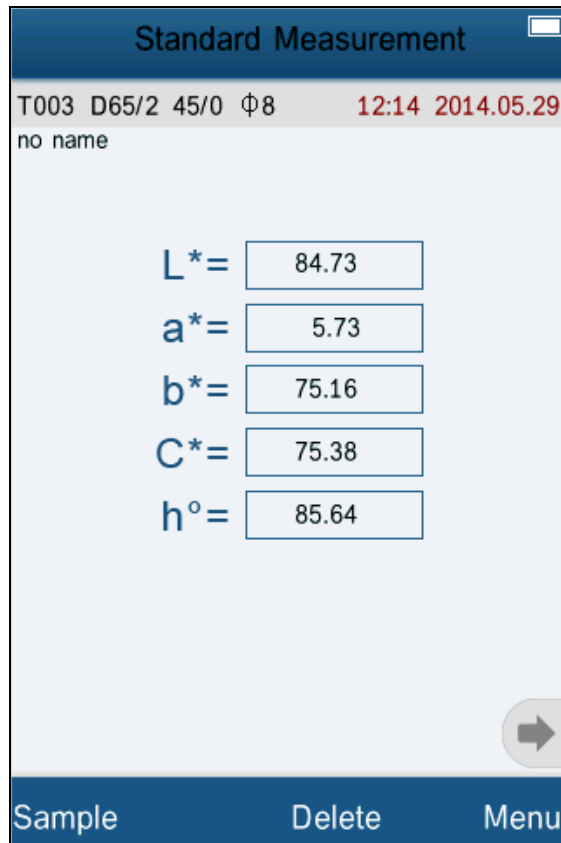


Figure 3 Standard Measurement

## 4.2 White Calibration and Black Calibration

Click “Menu” to enter main menu interface as shown in Figure 4.



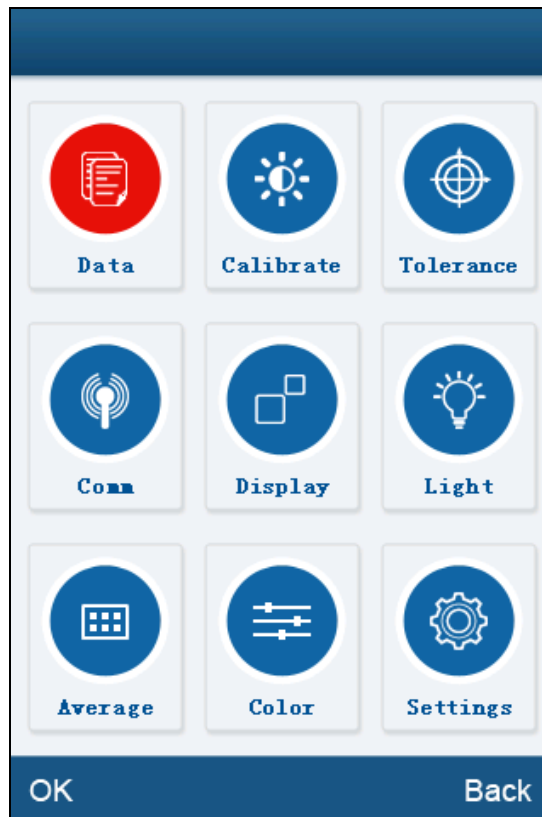


Figure 4 Main Menu

Select “Calibration” to enter white and black calibration interface as shown in Figure 5.

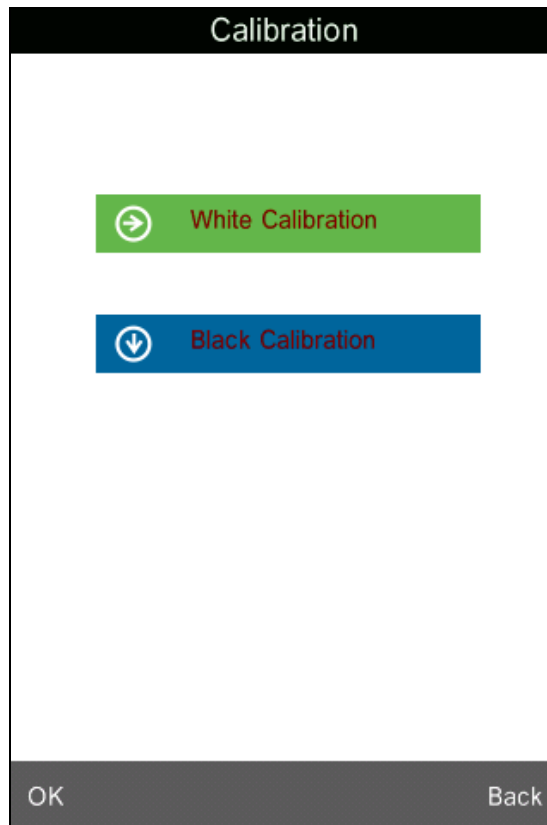


Figure 5 White and Black Calibration

Click “White Calibration”, it will prompt you to put away the white board. Put the measuring aperture on white board. Make sure the measuring aperture is close to the white board. Click “OK” or press “Testing” key to perform white calibration. Please pay attention that the serial number of white board must correspond to the instrument.

Click “Black Calibration”, it will prompt you to put away black cavity. Put the measuring aperture into black calibration cavity. Click “OK” or press “Testing” key to perform black calibration.

Then, white calibration and black calibration are completed.

## 4.3 Measurement

### 4.3.1 Measurement Locating

The instrument can visually locate through the cross of measuring aperture. It can be done by observing the alignment between the cross and the sample, while moving the measuring aperture to adjust the position.

### 4.3.2 Standard Measurement

Please enter “Standard Measurement” interface to perform measurements as shown in Figure 6.

Put the measuring aperture on the standard sample, press “Testing” key. The colorimeter will display color data of the standard sample.

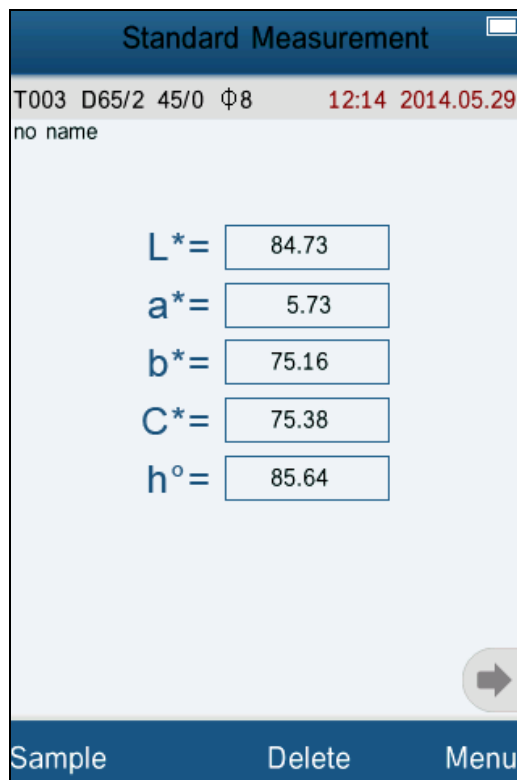


Figure 6 Standard Measurement

### 4.3.3 Sample Measurement

After testing the standard, press “Sample Measure”, it will enter Sample Measurement interface as shown in Figure 7. Put the measuring aperture on the sample, press “Testing” key. The colorimeter will display color data of the sample.

The  $L^*a^*b^*C^*h^*$  data on the left side is current sample data. The data on the right side is color difference data between current sample and standard.

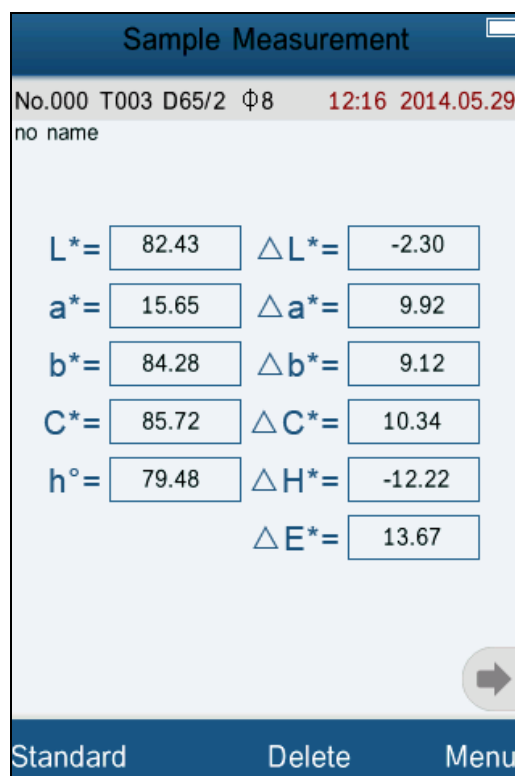





Figure 7 Sample Measurement

### 4.3.4 Measure and View Spectral Reflectance Graph

Under standard or sample measurement interface, click “” to switch to next page. It will display the spectral reflectance curve. Click “”, it will display wavelength data and reflectance data of next wave band. Click “”, it will display wavelength data and reflectance data of previous wave band. The wavelength range of the instrument is “400-700nm”. The interval is 10nm.

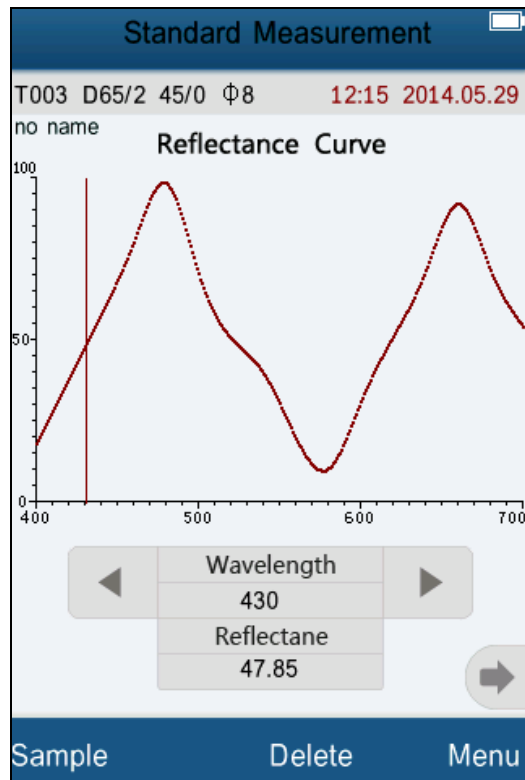


Figure 8 Spectral Reflectance Interface

#### 4.4 Connecting to PC

Click “Comm” to enter the interface shown in Figure 9. Follow the tips to connect instrument to PC. Click “OK”, the instrument will enter “Communicating...” as shown in Figure 10. Then you can control the instrument through the software.



Figure 9 USB Communication



Figure 10 Communicating

## 4.5 Print

Connect the instrument to micro printer. It can print measurement data automatically under “Standard Measurement” or “Sample Measurement” interface.

## 5. System Function Description

You can set the system function from main menu as shown in Figure 4.

### 5.1 Data Management

Click “Data” in main menu to enter data management interface as shown in Figure 11. Data management is mainly for checking, operating the measured records and inputting standard data manually.

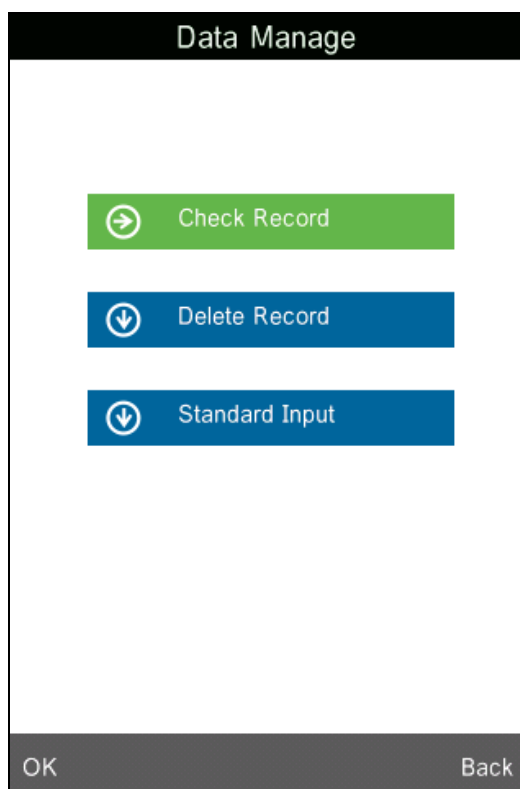


Figure 11 Data Management

### 5.1.1 Check Record

#### 1) Check Standard Record

Select "Check Record" to enter "Standard Record" interface as shown in Figure 12. It's the standard data. You can check different standard data by clicking "↑" and "↓" at the bottom of the screen. "T001" in the figure means standard record No. "no name" means the default name of the standard.

#### 2) Check Sample Record

Click "Sample" in standard record interface to check the sample data and the color difference between the standard and the sample as shown in Figure 13. You can check different sample data by clicking "↑" and "↓" at the bottom of the screen. "No.001" means the sample record No. "T001" means standard record No.

#### 3) Switch Standard Record and Sample Record

Click "Sample" in standard record interface to switch to sample record interface. Click "Standard" in sample record interface to switch to standard record.

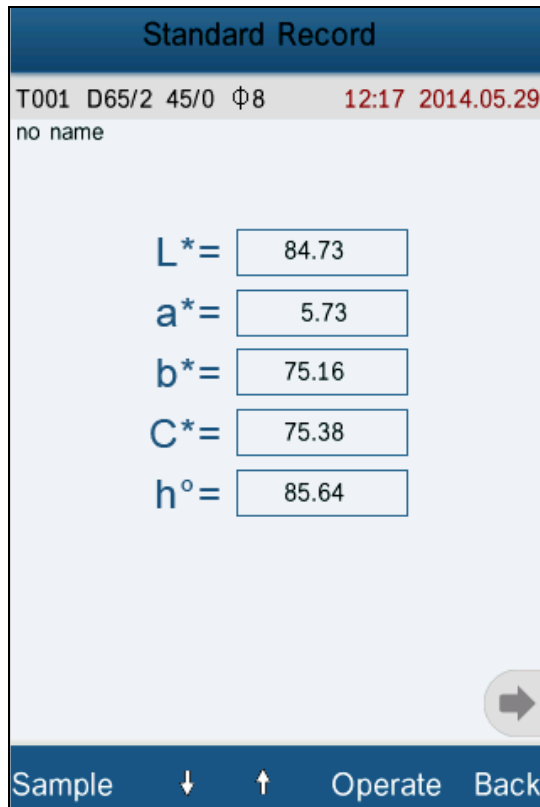


Figure 12 Standard Record

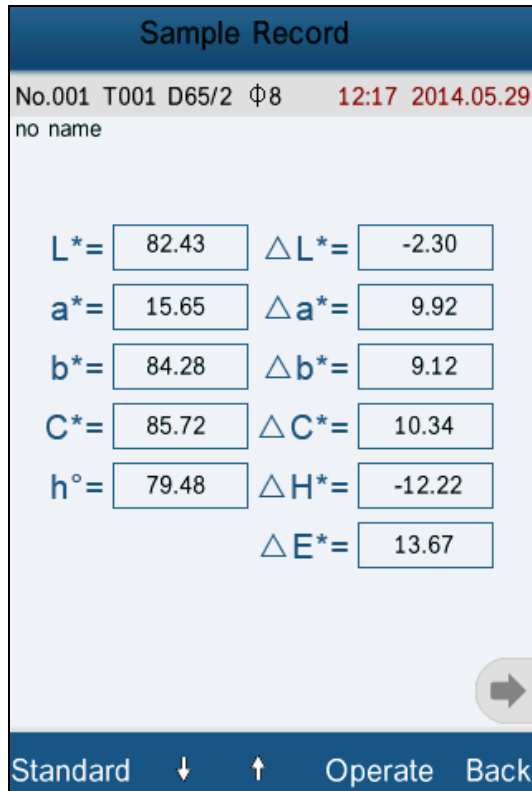







Figure 13 Sample Record



### 5.1.2 Check Spectral Reflectance Curve

Under standard or sample measurement interface, click “” to switch to next page. It will display the spectral reflectance curve. Click “”, it will display wavelength data and reflectance data of next wave band. Click “”, it will display wavelength data and reflectance data of previous wave band. You can check the spectral reflectance curve of difference standards or samples by clicking “” and “” at the bottom of the screen.

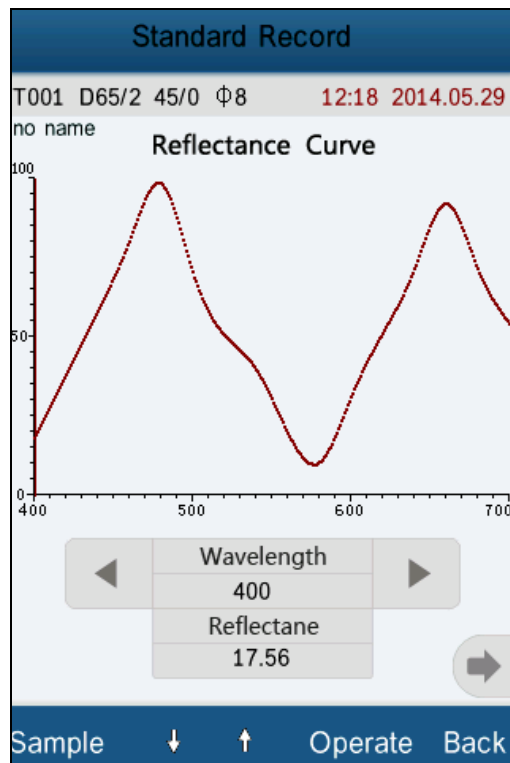


Figure 14 Spectral Reflectance Curve of Standard Record

### 5.1.3 Editing Record Name

Click “Operate” in record interface, popup a small menu as shown in Figure 15. Click “Edit Name” to enter figure 16. Click the characters or numbers on the virtual keyboard to edit current record name.

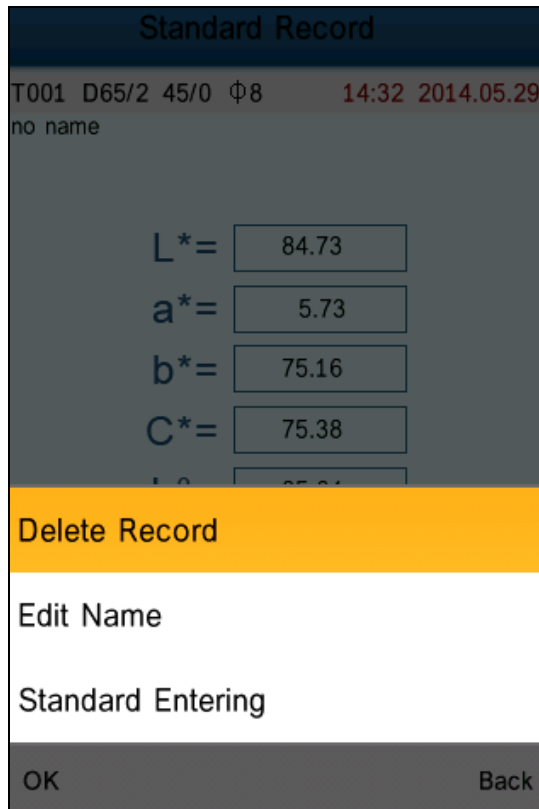


Figure 15 Record Operation Interface

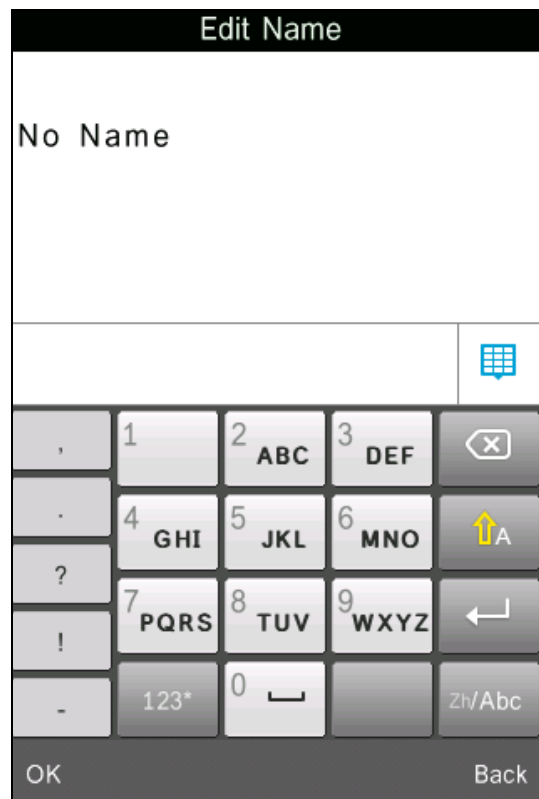


Figure 16 Name Edit Interface

#### **5.1.4 Deleting a Single Record**

In the popup menu under the standard record shown in Figure 15, click “Delete Record”. It will pop up a warning interface. Click “OK”, then the current standard and its sample records will be deleted. If delete record in sample record interface, it will only delete a single sample record.

#### **5.1.5 Turning Standard Record into Measurement Standard**

If you need to measure color difference under a saved standard, you can click “Standard Entering” in “Record Operation Interface” pop-up menu. Then the standard record is transferred to measurement interface. Click “Sample Measure”, you can start to perform sample measurement.

#### **5.1.6 Turning Sample Record into Measurement Standard**

In some cases, you need to use a saved sample record as a standard. You can click “Standard Entering” in “Record Operation Interface” pop-up menu. Then, the sample record will be transferred to measurement interface as a standard (Meanwhile, it will save as a new standard automatically.). Click “Sample Measure”, you can start to perform sample measurement.

#### **5.1.7 Deleting All Records**

Select “Data Delete” in main menu. It has two options: “Delete All Samples” and “Delete All Records”

##### **1) Delete All Samples**

Click “Delete All Samples”. It will pop up a warning interface. Click “OK”, all sample records will be deleted, but the standard records are still retained.

##### **2) Delete All Records**

Click “Delete All Records”, the records (including standard records and sample records) will be deleted. Then, it will pop up a warning interface. Click “OK”, all

records in the instrument will be deleted permanently.

**Note:** Please pay attention to this operation in case of accidentally deleting the needed historical records.

### 5.1.8 Standard Input

Select “Standard Input” in main menu. It includes two functions “Input L\*a\*b” and “Input XYZ”.

#### 1) Input LAB

Click “Input LAB”, enter “Input L\*” interface as shown in Figure 17. Click the numbers in virtual keyboard. Input value L\*, click “OK”. Then input value a\* and b\* and enter “Edit Name” interface.

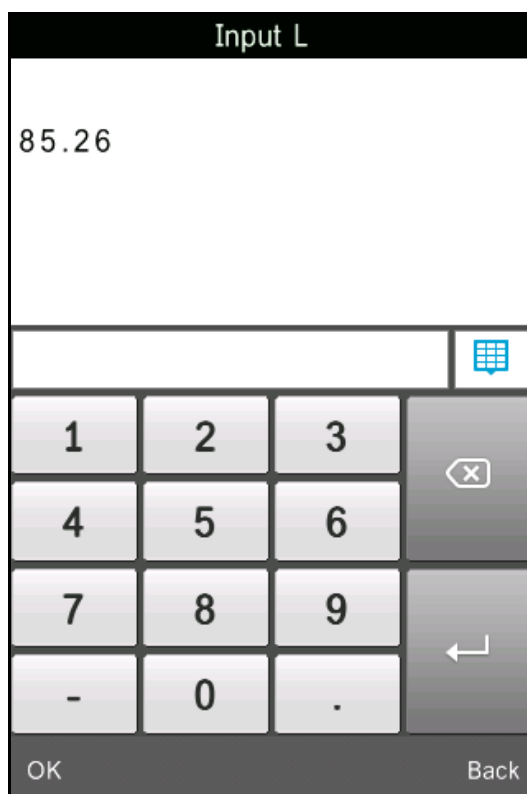


Figure 17 Input LAB

## 2) Input XZY

It is the same with “Input L\*a\*b”

## 5.2 Tolerance Setting

Select “Tolerance” in main menu as shown in Figure 18. Click the virtual keyboard to input tolerance. Then click “OK” to save the settings and back to main menu.

If you don't want to set or modify tolerance, click “Back” to return to the main menu.

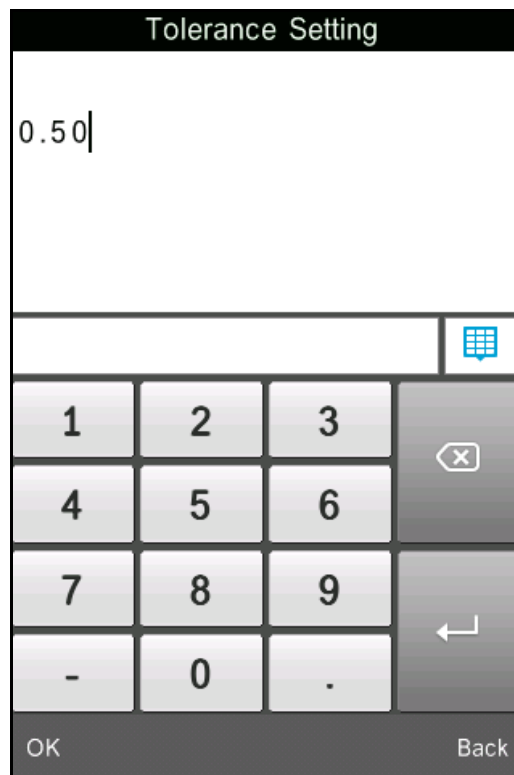


Figure 18 Tolerance Setting

Tolerance is set by users according to their color management requirements. The instrument will judge whether the color difference  $\Delta E$  is qualified or not. If  $\Delta E$  is less than tolerance, the sample color is qualified. If  $\Delta E$  is greater than tolerance, then sample color is unqualified.

### 5.3 Light Source Setting

Click “Light Source” in main menu to select light sources as shown in Figure 19. Users can select different light source to do measurements. After Selecting, click “OK” to save the settings and back to main menu.

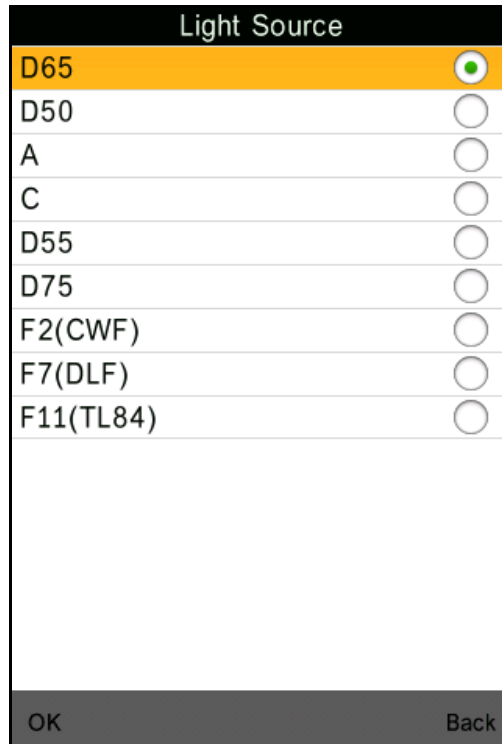


Figure 19 Light Source Setting

### 5.4 Average Measurement

Click “Average” in main menu to enter Figure 20. Click the virtual keyboard. Users can set the number of average measurements according to the requirements. Then click “OK” to save the settings and back to main menu. If set to “0” or “1”, the instrument will only do single measurement. The default measurement is single measurement.

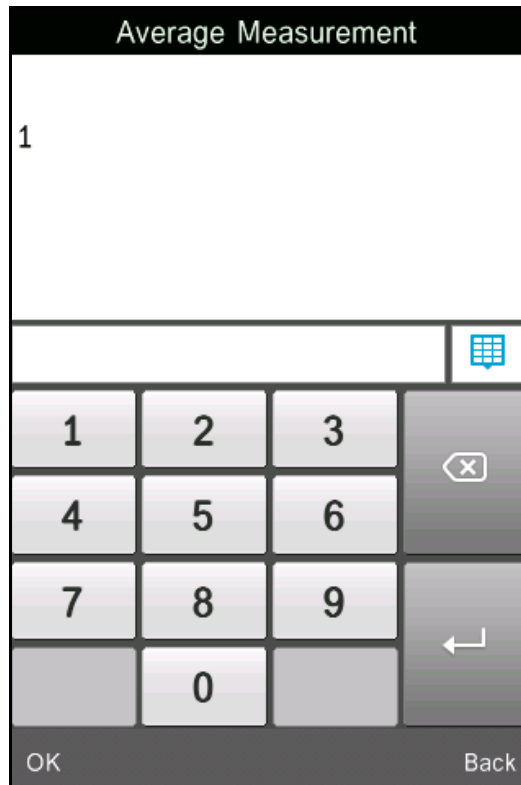


Figure 20 Average Measurement

### 5.5 Color Options

Click “Color Options” in main menu to enter Figure 21. Users can select different color space. Select the options by “↑” and “↓”, and press “OK” to save all the settings. This selection will affect the display content in “Standard Measurement” and “Sample Measurement”.

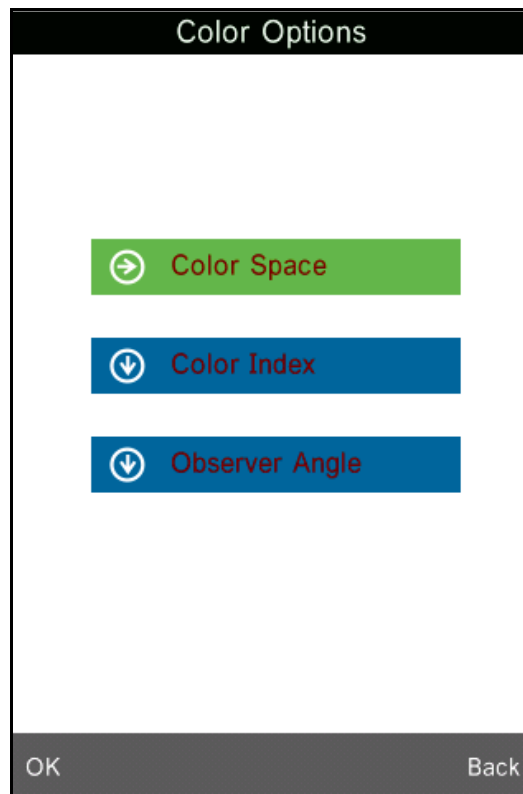


Figure 21 Color Options

### 5.5.1 Color Space

Click “Color Space” to enter Figure 22 interface. There are six color space modes in this instrument: “CIE LAB, LCh”, “CIE XYZ, Yxy”, “CIE LUV, LCh”, “LAB &WI &YI”, “Color Fastness”, “Staining Fastness”.

Different modes are corresponding to different standard measurement and sample measurement interface. The standard measurement interface of “CIE LAB, LCh”, “Color Fastness” and “Staining Fastness” is shown in Figure 3. The standard measurement interface of “CIE XYZ, Yxy”, “CIE LUV, LCh”, “LAB &WI &YI” is shown in Figure 23~25.

The sample measurement interface of “CIE LAB, LCh” is shown in Figure 7. The sample measurement interface of “CIE XYZ, Yxy”, “CIE LUV, LCh”, “LAB &WI &YI” is shown in Figure 26~30.



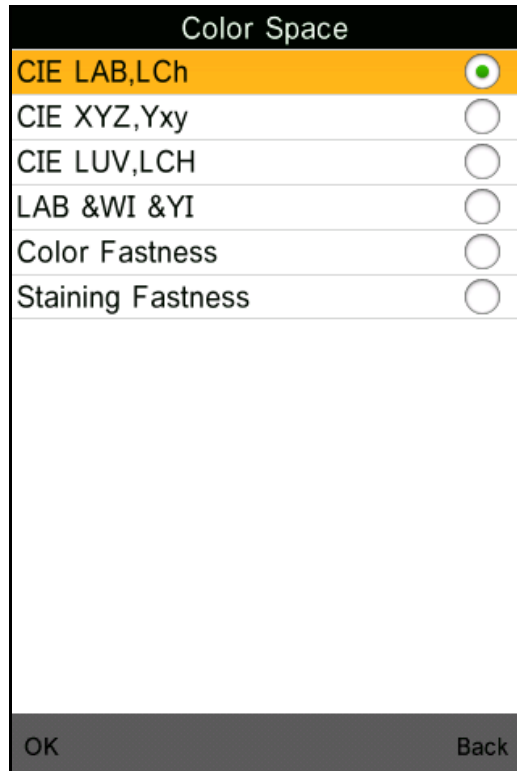


Figure 22 Color Space

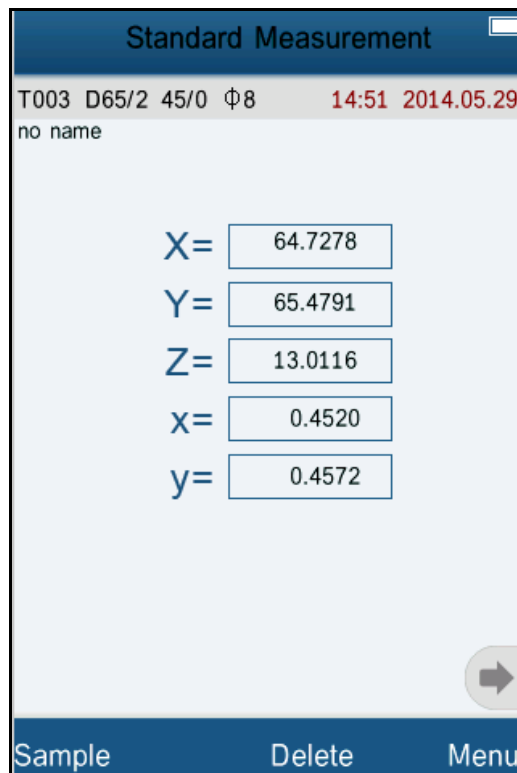


Figure 23 CIE XYZ Standard Measurement

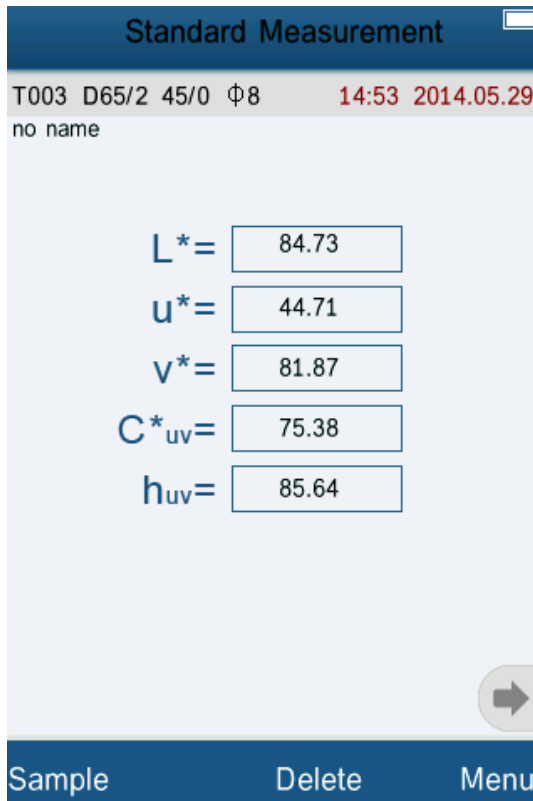


Figure 24 CIE L\*U\*V\* Standard Measurement

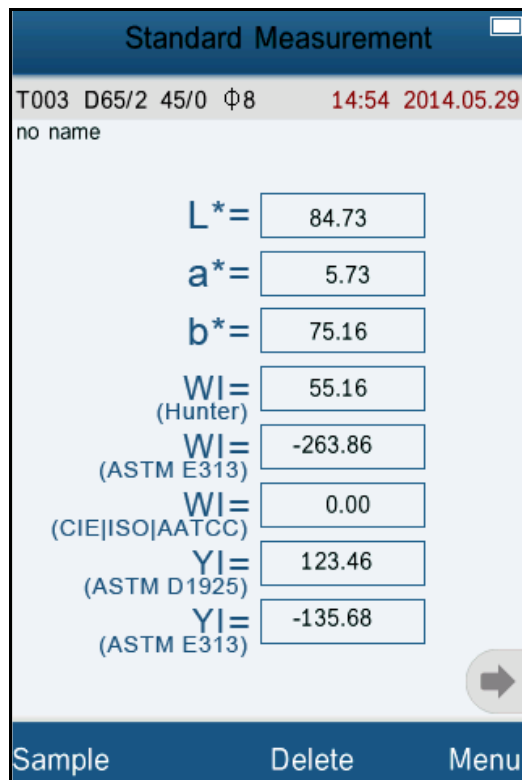


Figure 25 LAB & WI & YI Standard Measurement

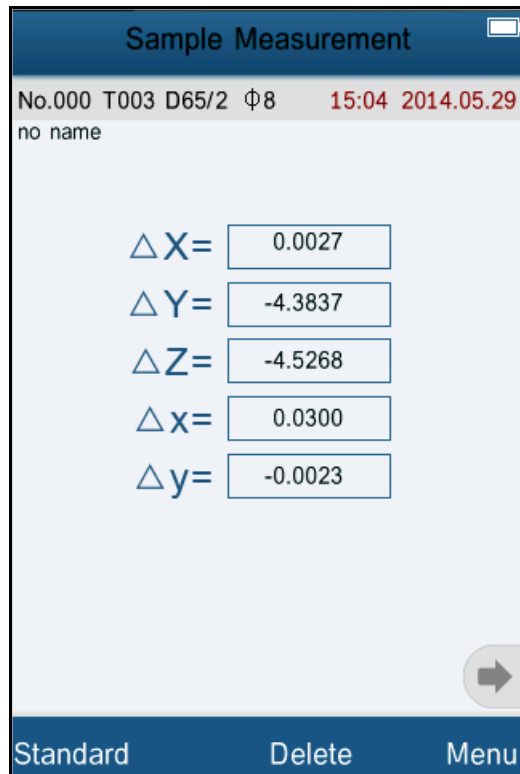


Figure 26 CIE XYZ Sample Measurement

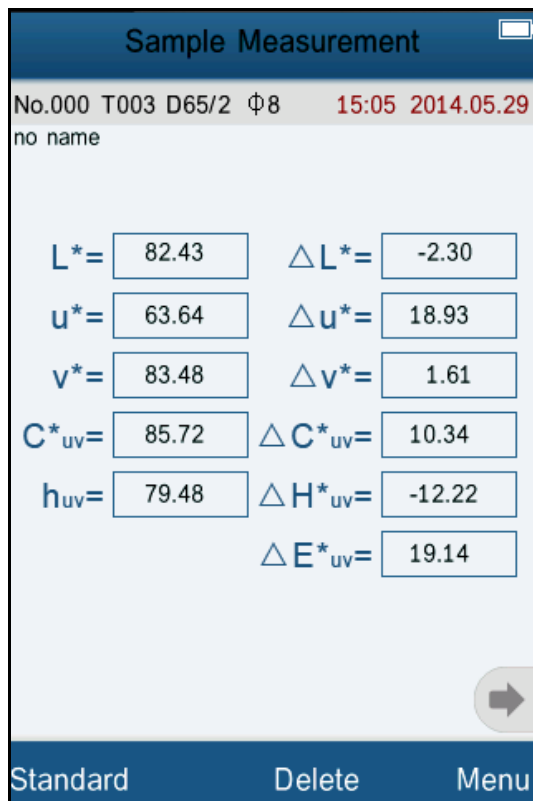


Figure 27 CIE L\*U\*V\* Sample Measurement

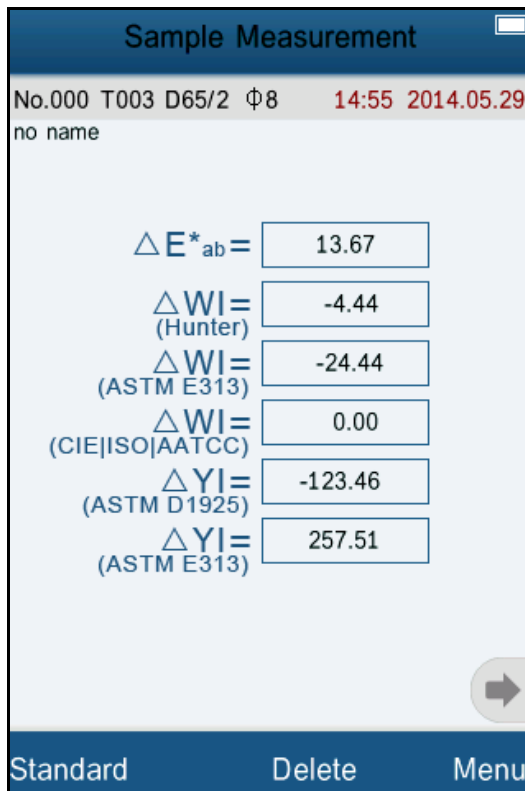


Figure 28 LAB & WI & YI Sample Measurement

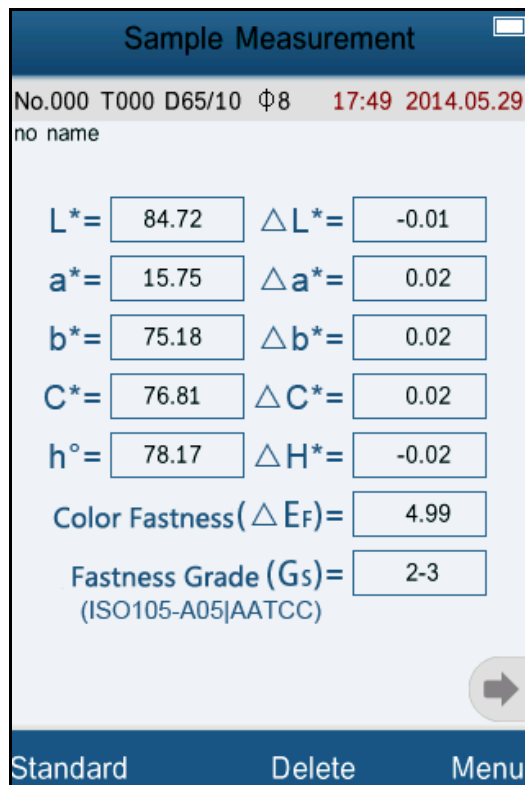


Figure29 Color Fastness Measurement

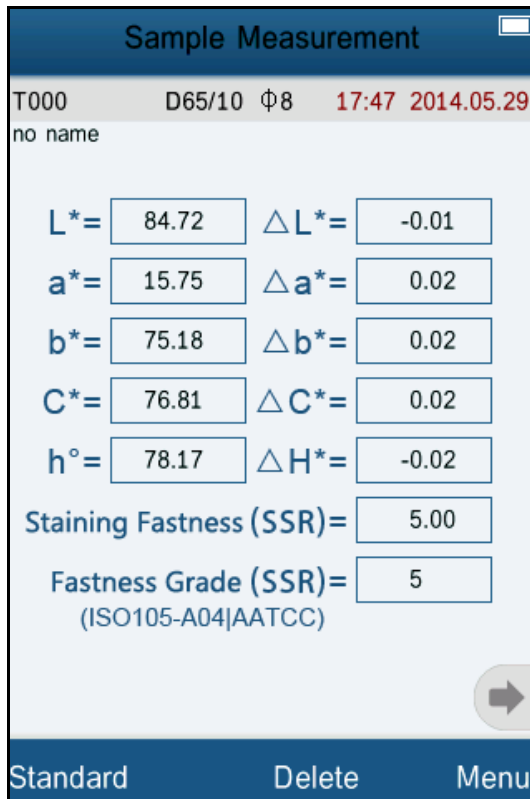


Figure 30 Staining Fastness Measurement

### 5.5.2 Color Index

Click “Color Index” to enter Figure 31. There are six color index modes in this instrument. “CIE1976  $\Delta E^*ab$ ”, “CIE94  $\Delta E^*94$ ”, “ $\Delta E$ (Hunter)”, “ $\Delta E^*cmc(2:1)$ ”, “ $\Delta E^*cmc(1:1)$ ”, “CIE2000  $\Delta E^*00$ ”.

Color Index is available to “CIE LAB, LCH” color space. Under color index, different modes are corresponding to special color difference formula. Each mode has different display in sample measurement interface as shown in Figure 32~37.

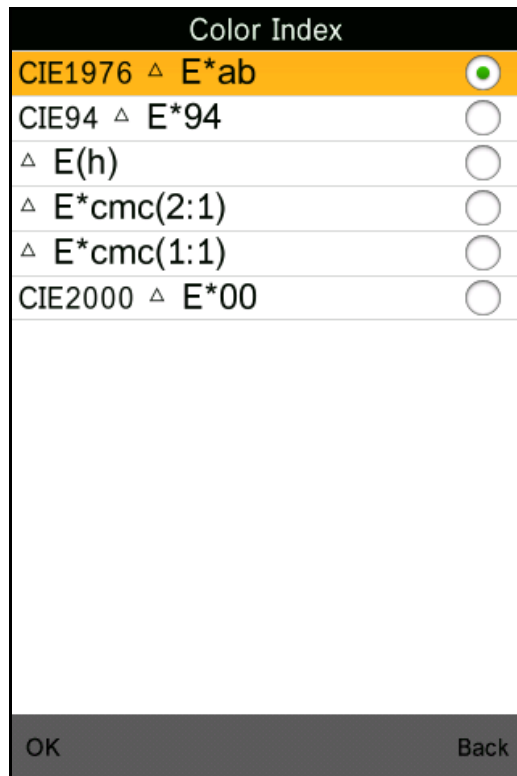


Figure 31 Color Index

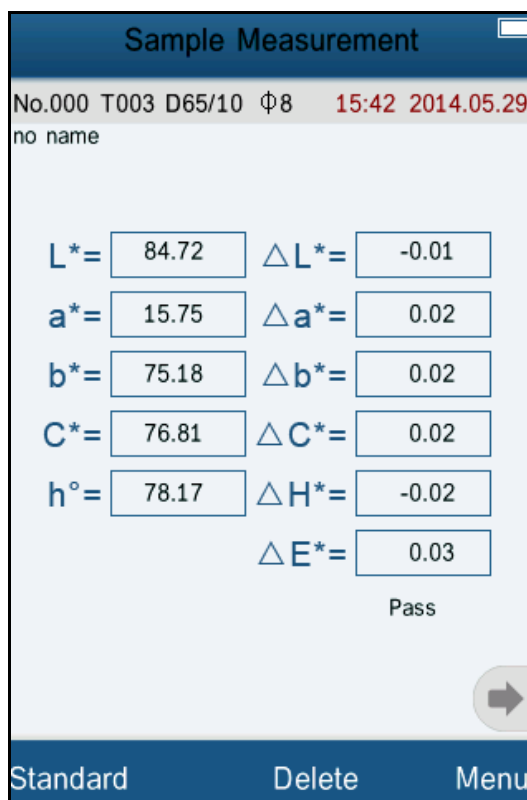


Figure 32 Color Index CIE1976 Sample Measurement

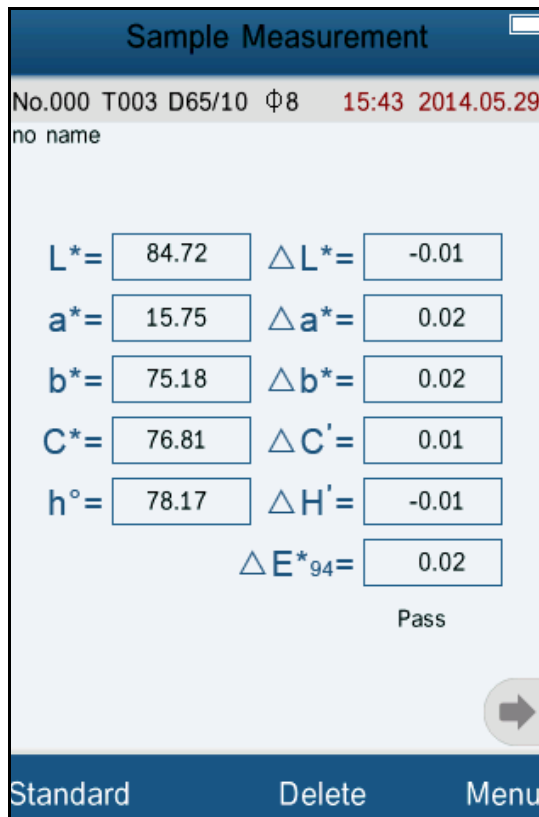


Figure 33 Color Index CIE94 Sample Measurement

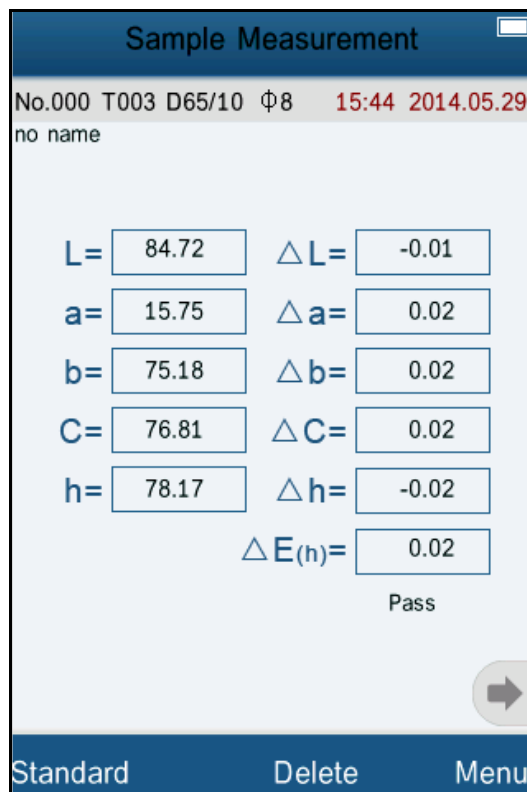


Figure 34 Color Index Hunter Sample Measurement

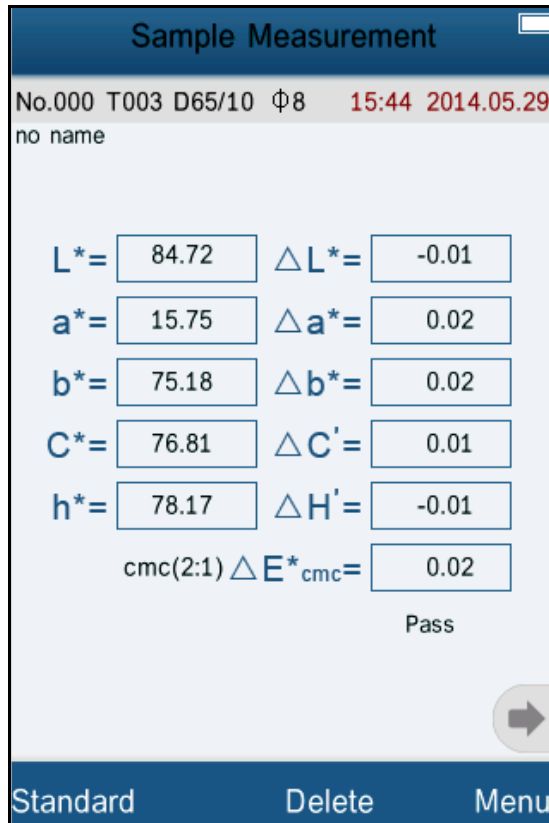


Figure 35 Color Index cmc(2:1) Sample Measurement

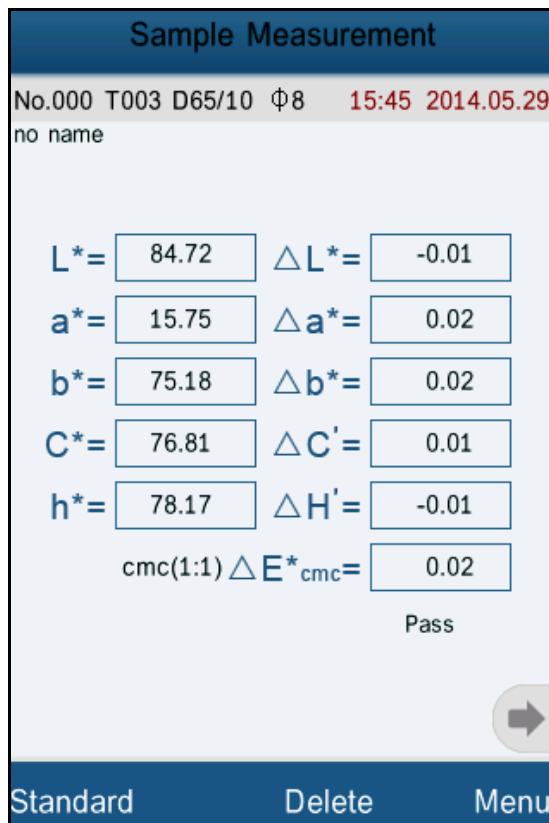


Figure 36 Color Index cmc(1:1) Sample Measurement



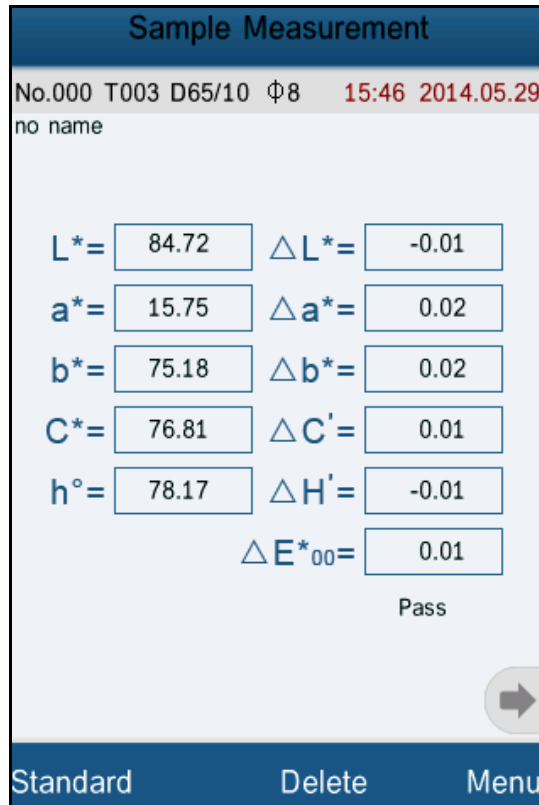


Figure 37 Color Index CIE2000 Sample Measurement

### 5.5.3 Observer Angle

In accordance with CIE standard, the instrument has two observer angles: 2° and 10°. Click “Observer Angle” in color options interface to select it.

### 5.6 Function Setting

Click ‘Settings’ to set other functions as shown in Figure 38.

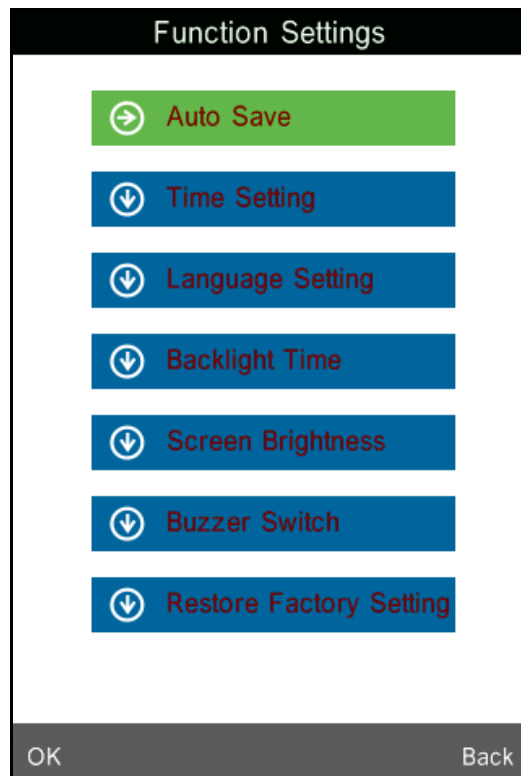


Figure 38 Function Settings

### 5.6.1 Auto Save

Click “Auto Save” in “Settings” interface. It has two options: “On” and “Off”. If select “Off”, you have to save the data manually when measuring. If select “On”, the instrument will save data automatically.

### 5.6.2 Time Set

Click “Time Set” in “Settings” interface, as shown in Figure 39. Click “Set Time” to set the current time.

Click “Set Date” to set the current date as shown in Figure 41.

Click “Time Format” to set the required time format as shown in Figure 42.

Click “Date Format” to set the required date format as shown in Figure 43.

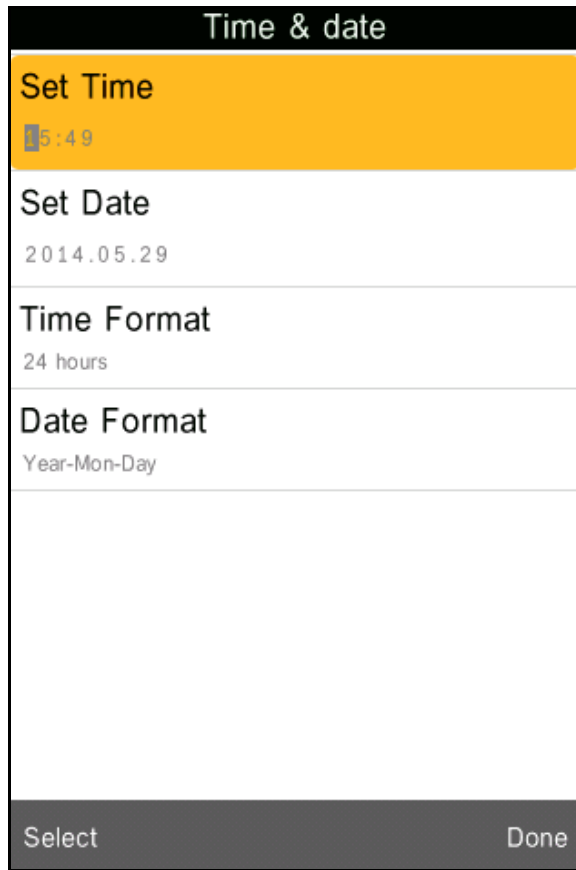


Figure 39 Time Set

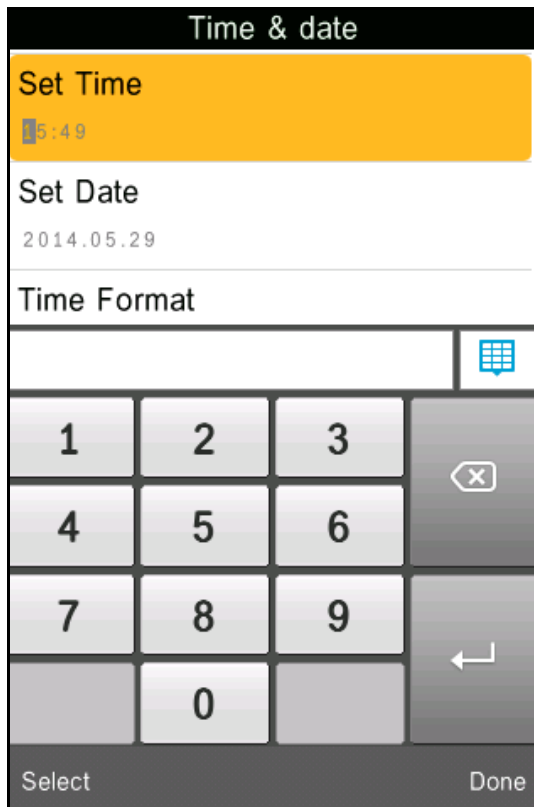


Figure 40 Set Time

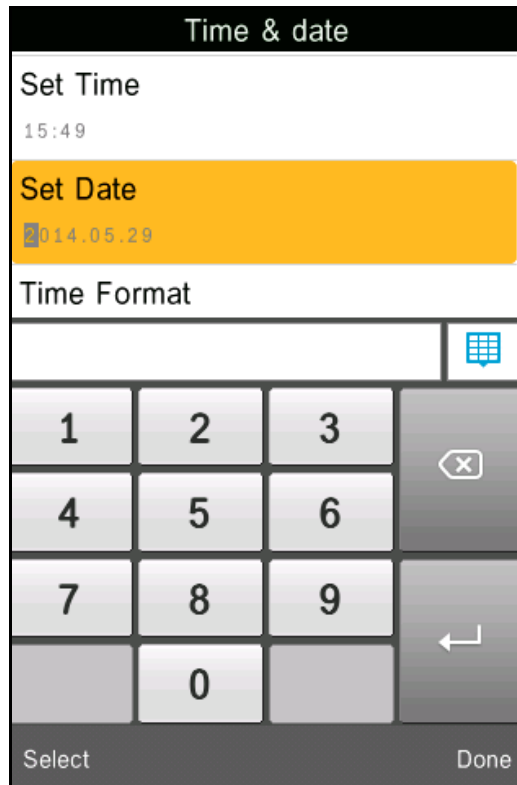


Figure 41 Set Date

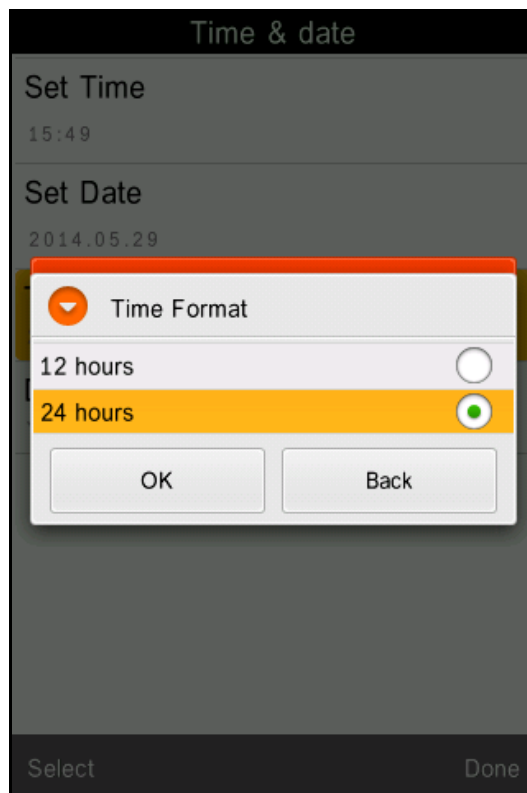


Figure 42 Time Format

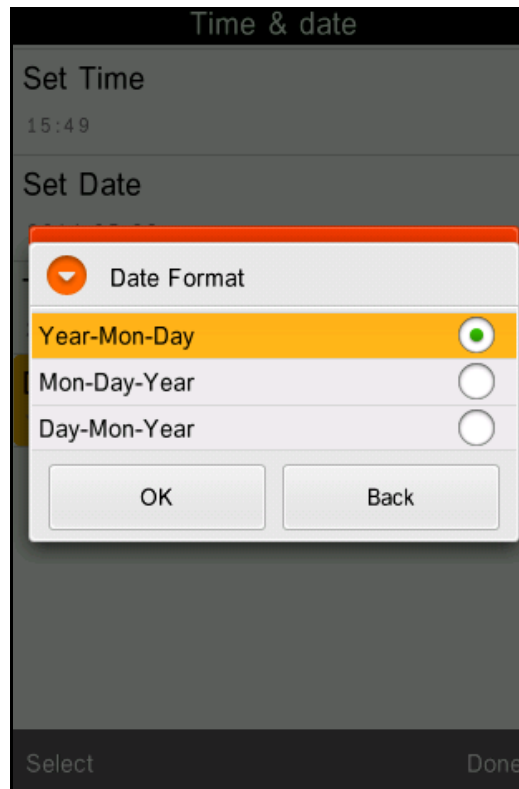


Figure 43 Date Format

### 5.6.3 Language Selection

Click “Language Selection” in “Settings” interface. Users can choose English or Chinese.

### 5.6.4 Backlight Time

Click “Backlight Time” in “Settings”. Users can set the backlight time according to the requirement.

### 5.6.5 Screen Brightness

Click “Screen Brightness” in “Settings”. Users can adjust the brightness by “+” and “-“.

### 5.6.6 Buzzer Switch

Click “Buzzer Switch” in “Settings”. When click “Off”, it will not make a sound when measuring. When click “On”, it will make a sound when measuring.

### 5.6.7 Restore Factory Settings

Click “Restore Factory Setting” in “Settings” as shown in Figure 44. Click “OK”, the instrument will restore to factory settings and all records will be cleared.

**Note:** When set it, there will be a warning. Please operate it carefully. If you don't want to restore to factory settings, please click “Back”.



Figure 44 Restore Factory Settings

## 6. Technical Parameters

### 6.1 Products Features

- 1) Touch screen, easy to operate.

- 2) Large screen (3.5 inch), high resolution (320\*480), full-view display with clear image.
- 3) Aesthetic design perfectly combined with ergonomics structure.
- 4) 45/0 geometrical optics structure, comply with CIE, ISO, ASTM, DIN standard.
- 5) Visible spectrum 400~700nm reflectance curve.
- 6) Two standard observer angles, multiple light sources modes, a variety of color systems.
- 7) The repeatability  $\Delta E^*_{ab}$  is within 0.04, the errors between each instrument  $\Delta E^*_{ab}$  is less than 0.2.
- 8) PC software with powerful extension functions.
- 9) High hardware configuration with a number of innovative technologies.
- 10) Oversized integrating sphere, more effective homogenization ray of lights and precise measurement.
- 11) 15° oblique angle screen, more in line with the human eye observation.
- 12) Large capacity storage, can save more than 10000 data.
- 13) Input standard data manually, easy to operate.

## 6.2 Technical Specifications

Model	PCE-CSM 8
Illumination/observation system	45/0 method (45 ring-shaped illumination, vertical viewing), Comply with CIE No.15, GB/T 3978
Integrating sphere Size	Φ58mm
Light Source	combined LED sources
Sensor	silicon photodiode array
Wavelength range	400~700nm
Wavelength interval	10nm
Measuring Aperture	Φ8mm
Color Space	CIE LAB, XYZ, Yxy, LCh, CIE LUV, HunterLAB
Color Index	$\Delta E^*_{ab}$ , $\Delta E^*_{uv}$ , $\Delta E^*_{94}$ , $\Delta E^*_{cmc(2:1)}$ , $\Delta E^*_{cmc(1:1)}$ , $\Delta E^*_{00}$ , $\Delta E$ (h)
Chromaticity Data	WI(ASTM E313, CIE/ISO, AATCC, Hunter) YI(ASTM D1925, ASTM E313) TI(ASTM E313, CIE/ISO) Metamerism Index Mt Color Stain, Color Fastness
Observer	2°/10°
Illuminant	D65, A,C,D50, D55, D75, F2, F6, F7, F8, F10, F11, F12
Display Data	Spectral Value/Graph, Colorimetric Value, Color Difference Value/Graph, PASS/FAIL Result, Color Offset, Color Simulation
Minimum Interval between Measurement	1.5s



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Repeatability Spectral Reflectance	standard deviation within 0.1% (400~700nm: within 0.2%), Colorimetric Value: Standard deviation within Delta E*ab 0.04
Errors between each instrument	Within Delta E*ab 0.2 (Average for 12 BCRA Series II color tiles)
Dimension: (L*W*H)	90*77*230mm
Weight	600g
Battery	Li-ion battery, 5000 times within 8 hours.
Lamp Life	5 years, more than 1.6 million measurements
Display Screen	TFT 3.5inch Capacitive Touch Screen
Port	USB/RS-232
Storage	1000 Standards, 10000 Samples
Operating Temperature	0~40°C (32~104°F)
Storage temperature	-20~50°C (-4~122°F)
Humidity range	less than 85% relative humidity, no condensation
Standard Accessories	Power Adapter, Li-ion Battery; Operation Manual, Software CD; USB Cable, White and Black Calibration Cavity, Protective Cover, Wrist Strap
Optional Accessory	Universal Test Components for liquid, powder and particle test, Powder Test Box

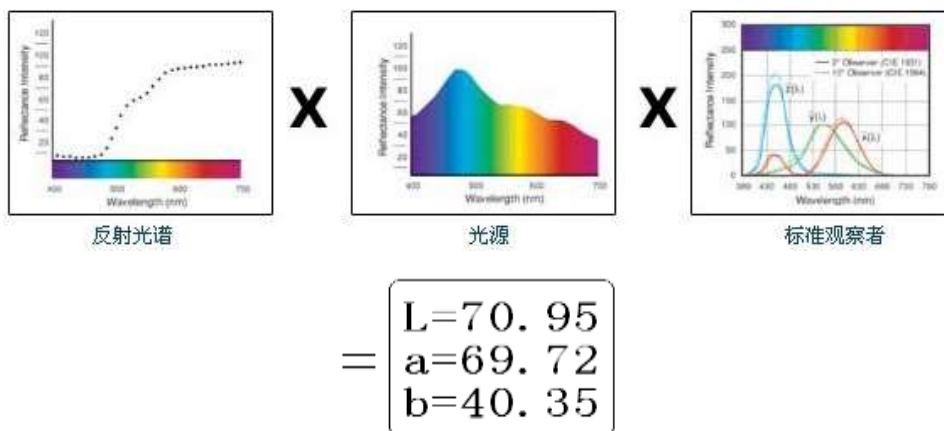
***\*Note: The specifications are subject to change without notice.***

## Appendix

### 1. The Color of Objects

There are three major elements to perceive color: light, object and observer. Any change of these three elements will influence the observer's color perception. When the light source and the observer don't change, then the object will determine the observer's color perception.

Objects can affect the final color perception because the reflectance spectra (transmittance spectra) of the object have modulated the light source spectrum. Different objects have different reflectance spectra (transmittance spectra). The light source spectrum modulates the reflectance spectra (transmittance spectra) of different objects to obtain different results. The observer is the same, so it shows different colors. The theory is shown in the figure below.



## 2. Color Difference Formula

CIE1976 color difference formula  $\Delta E^*_{ab}$  is shown as below:

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

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

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

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

CIE2000 color difference formula  $\Delta E_{00}$  is shown as below:

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

$$L' = L^*$$

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

$$b' = b^*$$

$$G = 0,5 \left( 1 - \sqrt{\frac{\overline{C^*}_{ab}}{\overline{C^*}_{ab} + 25^7}} \right)$$

CIE1994 color difference formula  $\Delta E^*_{94}$  is shown as below:

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

$$S_L = 1$$

$$S_C = 1 + 0,045 C^*_{ab}$$

$$S_H = 1 + 0,015 C^*_{ab}$$

### 3. Color Offset Judgment

$\Delta L$  is big (positive), stands for whitish;  $\Delta L$  is small (negative), stands for blackish.

$\Delta a$  is big (positive), stands for reddish;  $\Delta a$  is small (negative), stands for greenish.

$\Delta b$  is big (positive), stands for yellowish;  $\Delta b$  is small (negative), stands for bluish.

### 4. Human Eyes to Distinguish Colors

The color difference unit, NBS, is derived from the unit of color difference formula which is established by Judd-Hunter. In 1939, the American Bureau of Standards adopts this color difference formula and calculates the color difference according to it. When the absolute value is 1, it is called “The NBS Color Difference Unit”.

Since then, people would consciously adjust the later color difference formulas to be similar with the NBS units. The formulas such as Hunter Lab, CIE LAB and CIE LUV are generally similar to NBS (not exactly the same), therefore, do not mistake the color difference units calculated by other color difference formulas are all NBS.

In national standards GB7705-87 (lithograph), GB7706-87 (letterpress), GB7707-87 (gravure) which promulgated by the National Bureau of Standards, the color printings

rating in the same batch and same color according to color difference are defined as follows: General Product  $\Delta E^*_{ab} \leq 5.00 \sim 6.00$ , Fine Product  $\Delta E^*_{ab} \leq 4.00 \sim 5.00$ . Meanwhile, this quality standard is considered as a qualification for state enterprises promotion.

***Table: The Perception Degree between NBS Unit and Color Difference***

NBS Unit Color Difference	Perception Degree of Color Difference
0. 0~0.50	The Tiny Color Difference (Tiny)
0.5~1.51	The Smaller Color Difference (Slight)
1.5~3	The Small Color Difference (Noticeable)
3~6	The Big Color Difference (Appreciable)
Above 6	The Bigger Color Difference (Much)