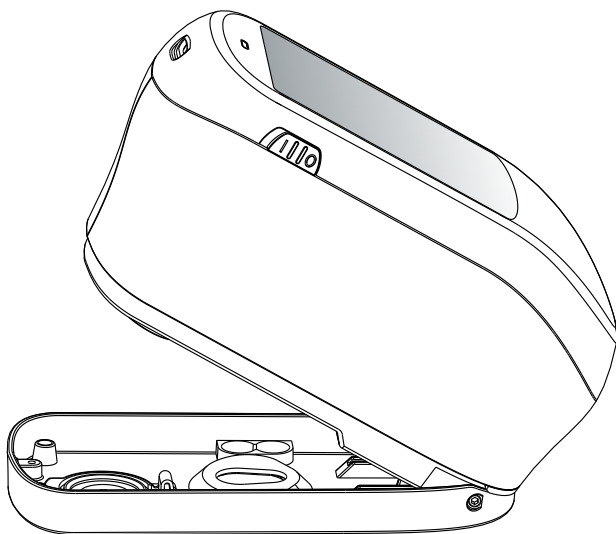


SPECTRODENSITOMETER

User Manual



V1.0

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

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Instruction

This Spectrodensitometer with 45/0 geometric optical structure is independently developed by 3nh company, who has complete intellectual property rights. It is fully compliant with ISO 5-4, CIE No.15, and supports the testing conditions of M0, M1, M2 and M3 specified in ISO 13655 standard. The instrument can accurately achieve the ISO Status T, E, A, I, M density measurement, easy to achieve a variety of printing parameters (such as: dot, trapping, hue error, etc.) measurement, and it also has many functions like built-in a variety of color space, color difference formula and color index, to meet kinds of customers' requirement. The spectrodensitometer has the character of stability, measurement density, chroma data precision and powerful function. Equipped with a variety of measuring Apertures ($\Phi 11\text{mm}$, $\Phi 10\text{mm}$, $\Phi 6\text{mm}$, $\Phi 5\text{mm}$, $\Phi 3\text{mm}$, $\Phi 2\text{mm}$, $\Phi 1.5\text{mm}$), the instrument is widely used in the ink printing industry, paper making industry, coating industry, scientific research institutions, quality inspection institutions and laboratory fields.

Features:

- 45/0 geometrical optics structure, comply with ISO 5-4, CIE No.15 standard. Support M0, M1, M2 and M3 test conditions specified in ISO 13655, and accurately measure printing parameters such as printing density and trapping.
- Perfect combination of beautiful appearance and the human body mechanics structural design.
- Use long life and low power consumption combined LED light source, UV-included.
- Apertures optional($\Phi 11/10/6/5/3/2/1.5\text{mm}$), suitable for more samples measurement.
- Measuring sample reflection spectrum, CMYK density, Lab, Yxy, s-RGB, color difference and other chromaticity value, used for accurate color transfer.
- High electronic hardware configuration, 3.5-inch TFT true color screen, capacitive touch screen, flat grating or high-precision nano-spectrophotometric device (varies by model), silicon photodiode array, etc.
- USB/Bluetooth2.1 dual communication mode, widely useful.
- Super stain-resistant and stable standard white calibration plate.
- Large capacity storage space, over 20,000 measurement data.
- Two standard observer angles (2 degree/10 degree), a variety of illuminant, a variety of color indexes, conforms with a variety of standard colorimetric data, meet a variety of customers' requirement for color density measurement.

- Especially suitable for printing plant process control, quality control.
- PC software has a powerful function extension.

1. Power On & Off

Toggle the power switch to "I" to power on the instrument; the green indicator light will flash, and it will turn off after the instrument boots up normally. Toggle the power switch to "O" to turn off the instrument, and the indicator light will extinguish.

If the instrument is not power on after switched to "I", the battery may need to be charged.

When the instrument is on for a long time without any operation, the instrument will automatically enter the standby state. At this time, press the measurement button to wake up the instrument into the working state (refer to chapter Setting ->screen backlight time section)

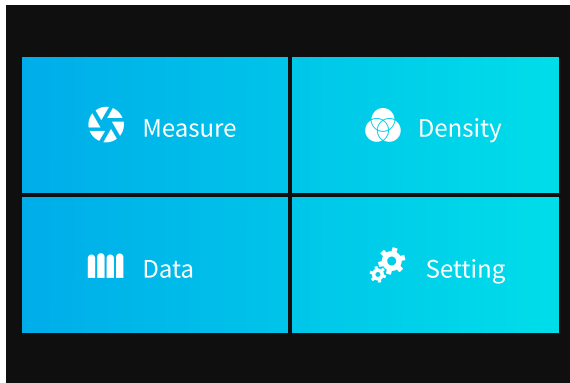


Figure 1 Main Menu

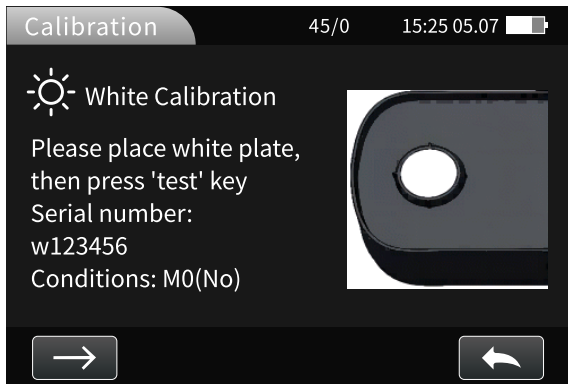


Figure 2 Black/White Calibration Interface

Note: Please cut off the instrument's power when it is not going to be used for a long time.

2. Instrument Communication

2.1 USB Connection

USB steps to use the spectrodensitometer:

1. If the PC software has not been installed, please install it immediately.
2. Insert the square end of the USB cable into the instrument.
3. Plug the other end of the USB cable into the available interface on the PC.
4. If the connection is successful, the status bar of the instrument will display USB icon  and it is able to manage the instrument by PC software. Otherwise, you need to find the problem.

Note: for Windows, it should install the software driver before connecting the instrument to the computer.

2.2 Bluetooth Connection

The Bluetooth function can be used for wireless communication with PC.

Many Windows PCs have built in Bluetooth capability. If this is the case with your computer you may use the built-in hardware. If not, you will need to purchase a Bluetooth device that plugs into your USB port before continuing.

Steps to use Bluetooth for Spectrodensitometer:

1. Turn on the "System Settings → Bluetooth" function; the instrument's status bar will display the Bluetooth connection icon.
2. Turn on Bluetooth function on the PC and search for the device, for example: 3nh-ble-device-01;
3. Fill in the matching code to connect;
4. If the connection is successful, the status bar of the instrument will display the Bluetooth connection icon “  ” and it is able to manage the instrument by PC software. Otherwise, you need to find the problem.

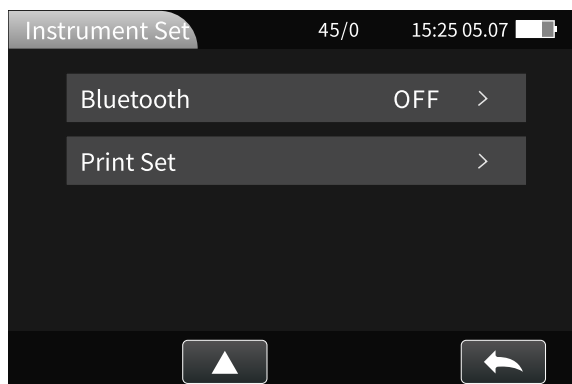


Figure 3 The Bluetooth icon is displayed in the status bar

3. User Interface

This instrument contains a graphical touch screen display, all functions are directly entered through the screen

3.1 Color Measurement

3.1.1 Standard Measurement

In the standard measurement interface, align the standard sample with the instrument's measurement aperture and press firmly. Gently press the measurement button; the buzzer will emit a "beep" sound, accompanied by the LED indicator flashing and then turning off. The buzzer will beep again, indicating the test is complete. The interfaces after the sample is tested are shown(Figure 4 &Figure 5). The standard sample interface is detailed below:

1. Title: Indicates that the current view is the standard measurement interface.
2. Edit Standard Name: Displays the name of the currently tested sample. Tap to quickly modify it; the default is "No name".
3. Switch Color Space: Displays the color space of the current sample. Tap to edit the color space; the default is CIE Lab.
4. Delete/Save: If measurement auto-save is enabled, tap to delete the current measurement data. If measurement auto-save is closed, it displays as a save button; tap to save the current test data.
5. Main Menu Button: Tap the main menu key to enter the instrument's main function interface.
6. Switch to Sample Measurement: Tap to switch to the sample measurement.
7. Page Turning: Swiping this area will quickly switch the current data between color space data and color index data.
8. Wavelength Switch Button: As shown in Figure 5, tap the ◀ ▶ button to switch the current test sample's light wavelength and reflectance at intervals of 10nm.

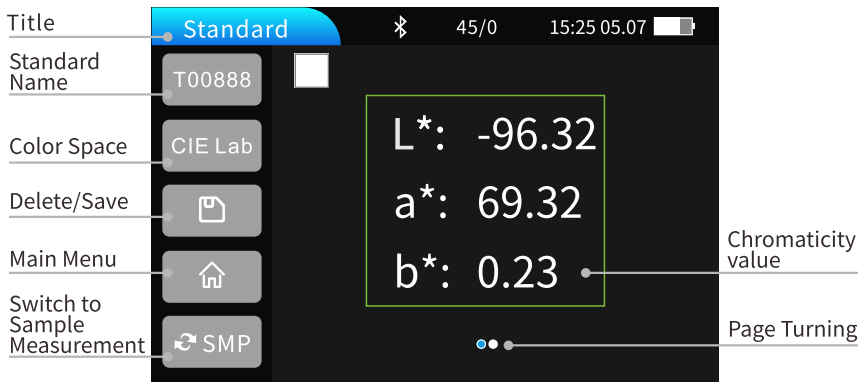


Figure 4 Standard Measurement Interface

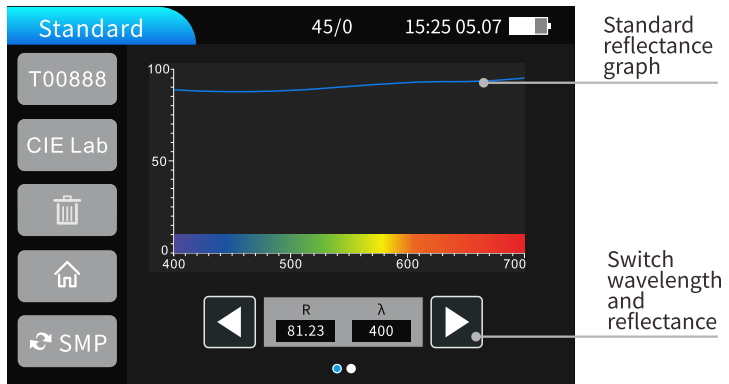


Figure 5 Standard Measurement

3.1.2 Sample Measurement

Under the standard measurement interface, tap "SMP" to switch to the sample measurement interface. Align the test sample with the instrument's measurement aperture and press firmly. Press the measurement button; the buzzer will emit a "beep" sound, accompanied by the LED indicator flashing and then turning off. The buzzer will beep again, indicating the test is complete. The interfaces after the test is completed(Figure 6 & Figure 7). The sample measurement interface is similar to the standard measurement interface, but displays the chromaticity value difference between the sample and the standard.

1. Title: Indicates that the current view is the sample measurement interface.
2. Sample Name: Displays the name of the currently tested sample. Tap to quickly modify it; the default is "No name".
3. Switch Color Space: Displays the color space of the current sample. Tap to edit the color space; the default is CIE Lab.
4. Delete/Save: If measurement auto-save is enabled, tap to delete the current measurement data. If closed, it displays as a save button.
5. Main Menu: Tap the main menu key to enter the instrument's main function interface.
6. Switch to Sample Measurement: Tap to switch to the sample measurement.
7. Page Turning: Swiping this area will quickly switch the current data between color space data and chromaticity value.
8. Sample chromaticity value: Displays the sample's chromaticity value.

9. Color Difference: Displays the difference calculated by subtracting the standard's chromaticity value from the sample's chromaticity value.
10. Measurement Result: Displays the test result of the current sample. Based on the standard's tolerance and the specified color difference formula, if the difference exceeds the tolerance, it will display "Fail" in red; otherwise, it will display "Pass" in green. This only displays if "Test Result" prompts are enabled in the system settings.
11. Color Offset: The color deviation direction of the current sample compared to the standard. This only displays if color offset is enabled in the system settings.
12. Wavelength Switch: As shown in Figure 7, tap the button to switch the currently measured sample's light wavelength, sample reflectance, and the reflectance difference between the sample and standard at intervals of 10nm.

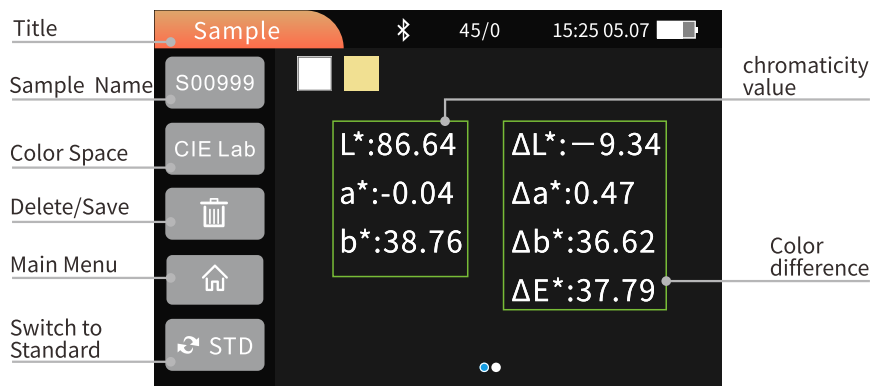


Figure 6 Sample Measurement Interface



Figure 7 Sample Measurement Spectral Graph Interface

3.2 Color Density

3.2.1 Standard Color Density

In the main menu interface, tap the optical density button to enter the interface (Figure 8). During measurement in the standard color density interface, align the standard sample with the instrument's measurement aperture and press firmly. Gently press the measurement button; the buzzer will emit a "beep", the LED indicator will flash and turn off, and the buzzer will beep again to indicate completion. The standard optical density interface is detailed below:

1. Title: Indicates that the current view is the setting mode.
2. Mode: After tapping " Mode", various modes can be chosen for data display. For example, selecting the chromaticity value mode changes the interface title to "Chromaticity Value", and the data will be displayed in the chosen color space.

- 3. Color Space/White Base: Displays the current color space; tap to edit (default is CIE Lab). If the selected mode is optical density or another mode, it displays as "White Base"(Figure 9).
- 4. Measurement Settings: Tap to edit measurement condition, density status, density white base, density precision, Tone Value, dot gain, trapping, all densities, and density scan.
- 5.Main Menu: Tap the main menu key to enter the instrument's main function interface.
- 6. Switch to Sample Measurement: Tap to switch to the sample interface.

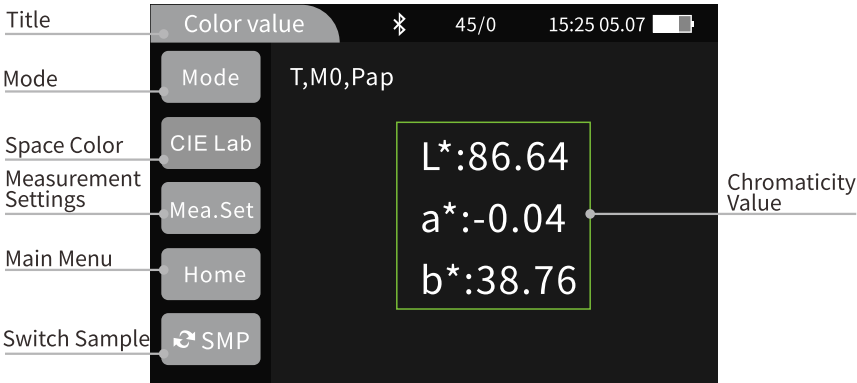


Figure 8 Standard Color Density Interface-1

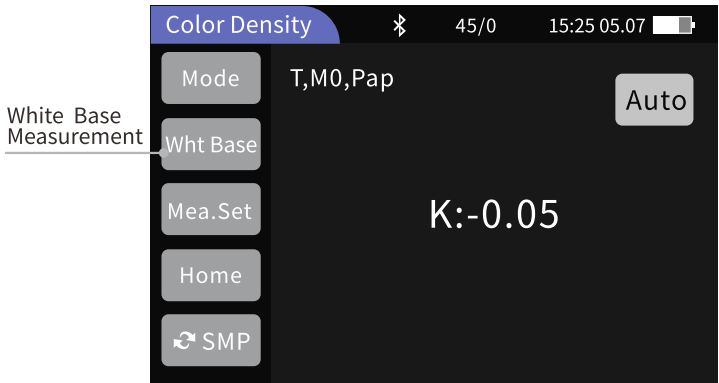


Figure 9 Standard Color Density Interface-2

3.2.2 Sample Color Density

In the standard color density interface, tap "SMP" to switch to the sample color density interface. Align the test sample with the aperture and press firmly, gently press the measurement button, the buzzer will "beep", the LED flashes and turns off, and a second beep indicates completion. The completed sample test interface is shown in Figure 10. It is similar to the standard color density interface, but it displays the comparative chromaticity value difference.

- 1. Title: Indicates the current set mode interface.
- 2. Mode: Tap to select various modes for data display.
- 3. Color Space/White Base: Displays the current color space; tap to edit. If color density mode is selected, it displays "White Base" (Figure 11).
- 4. Measurement Settings: Tap to edit the measurement condition, density status, density white base, density precision, Tone Value, dot gain formula, trapping, all densities, and density scan.
- 5. Main Menu: Tap to enter the main function interface.

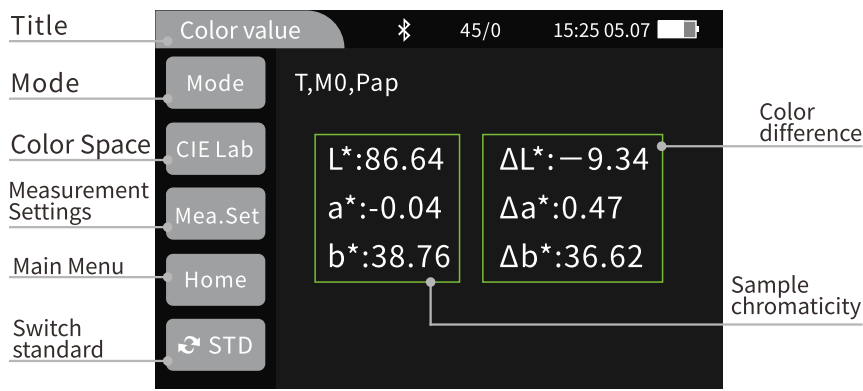


Figure 10 Sample Color Density Interface-1

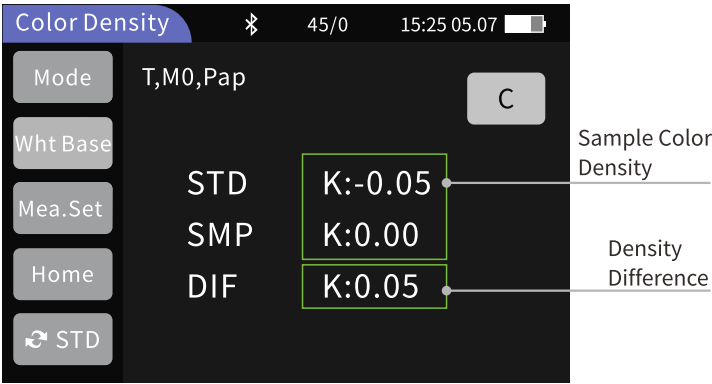


Figure 11 Sample Color Density Interface-2

In the color density interface, tap the "White Base" button to enter the density white base interface(Figure 12). Tap the main menu icon “  ” , and the screen will jump back to the main menu. Tap the checkmark icon “  ” to return to the color density measurement interface.

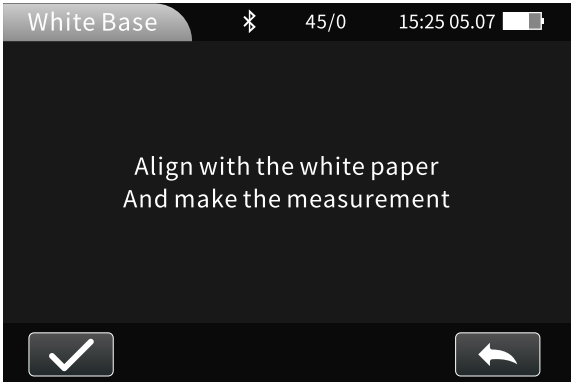


Figure 12 Density/TVI Interface

3.2.3 Density

This function is the measure of the ink thickness. For the process colors Cyan, Yellow, Magenta, or Black the desired Density Status (A, E, I, T) needs to be configured. For spot inks the result is given as the density value at the wavelength of maximum density for the spectral curve. This function can be optionally configured to subtract the white base/substrate.

Tap the icon “Auto” on the right side of the density function screen, and Jump to the set density color interface, you can set which color response to display.

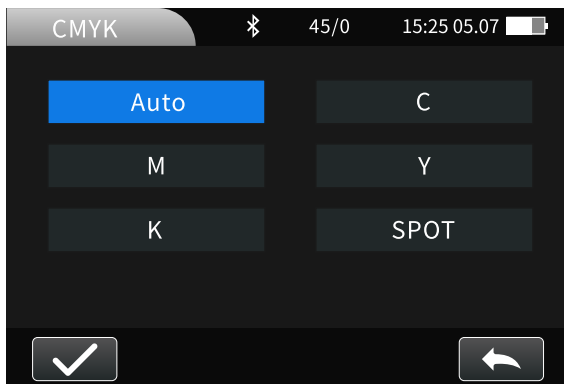


Figure 13 Set Density Color Interface

There are automatic, C, M, Y, K and spot color options setting density color interface. Auto color picks the dominant color response and also displays the last measurements for the other colors (C, M, Y, and K). Spot color picks the dominant spectral density wavelength. You can manually select the color response as well (C, M, Y, or K). In Job tools, the color response shown depends on the particular patch measured.

Density Measurement:

1. Choose Color density mode.
2. Select density condition.
3. Set density color (auto or spot color, etc.).
4. Measure sample.
5. Finish measurement and view data

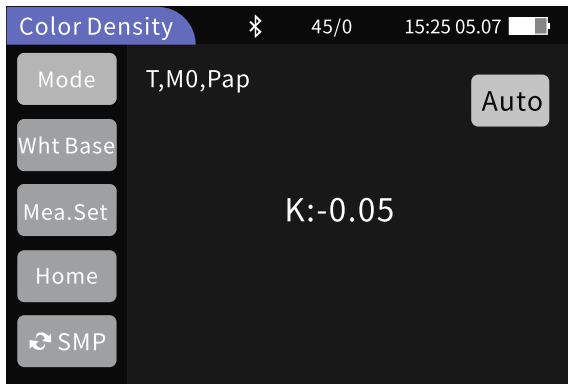


Figure 14 Color Density Interface

3.2.4 All Densities

This function displays the density values for the measured sample for all filters (Cyan, Magenta, Yellow and Black). This function can be configured to show additionally the density value at the wavelength of maximum density for the spectral curve.



Figure 15 All Densities Interface

All densities measurements are the same as density measurements, just select all density functions in step 3. When all densities functions are regarded as a setup tool, and the option is only CMYK.

3.2.5 Tone Value

This function is also called Hue Value. It is to point to the sum of all Tone Value of cluster on unit area and the ratio of total area, reflected the coverage of ink. The result can be calculated using either the Murray-Davies, Youl-Nielsen, or SCTV (ISO 20654) methods.

Spot Color Hue Value (SCTV) provides Hue values of colors that correlate well with visual appearance. If a Hue ramp is printed with visually equidistant steps the corresponding SCTV values should have approximately equidistant percentages from 0 to 100%. For the Murray-Davies formula, the degree of light optical absorption is predefined. For Youl-Nielsen formula, this can be adapted for different conditions. When Youl-Nielsen formula is selected for the color, you set the coefficient.

NOTE: The Youl-Nielsen formula should only be used in special cases, i.e. to determine the physical area coverage.

Tone Value Measurement:

The procedure requires one solid and one tint measurement.

1. Select Tone Value function.
2. Tap the icon “  ” and set density color.
3. Tap the icon “  ” and measure paper. Once paper is measured it is not required until there is a new substrate.
4. Measure solid patch.
5. Measure tint patch that corresponds to the measured solid.
6. View Tone Value data for the tint patch.
7. Continue with additional tint patches that correspond to the measured solid, or touch the solid patch on the left of the screen and measure another solid patch.

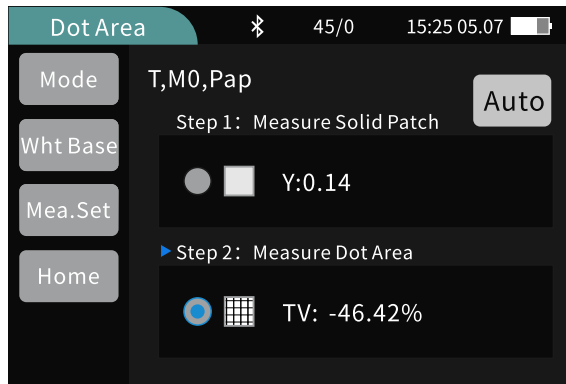


Figure 16 Tone Value Interface

3.2.6 Dot Gain

This function is also called Dot Gain. It is the difference between the actual Hue Value and the theoretical screen of a tint patch. The theoretical tint percent are configured by the TVI function settings (1 to 3 patches).

Dot Gain Measurement:

Displays Dot Gain for the selected color. The TVI(Tone Value Increase) settings define how many tint patches are used.

1. Select Dot Gain function.
2. Select Color option if required.
3. Measure paper.
4. Measure the solid patch.
5. Measure tint patch that corresponds to the measured solid. You can either follow the measurement sequence on the screen or manually touch the tint patch on the left of the screen to measure.
6. Continue with additional patches that correspond to the measured solid.
7. View dot gain data for the tint patches.

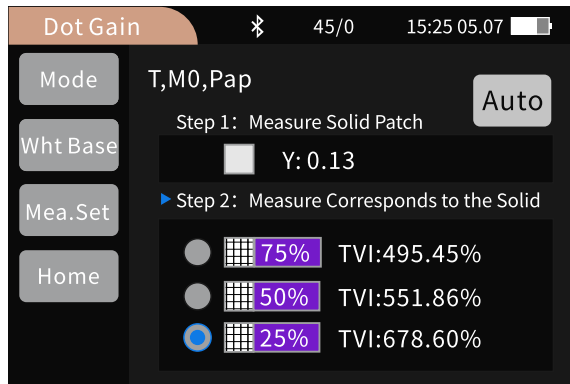


Figure 17 Dot Gain Interface

3.2.7 Print Contrast

This function is used to control the image to dark Hue index. It can determine proofing and printing standard ink. This value is the ratio of the difference between the actual density of the image and the integral density of a point in the image that is dimmed to the actual density.

Print Contrast Measurement:

1. Select Contrast function.
2. Select Color option (Setting density color).
3. Measure paper if required.
4. Measure solid patch.
5. Measure tint patch that corresponds to the measured solid.
6. View data.
7. Continue with additional tint patches that correspond to the measured solid, or touch the solid patch on the left of the screen and measure another solid patch.

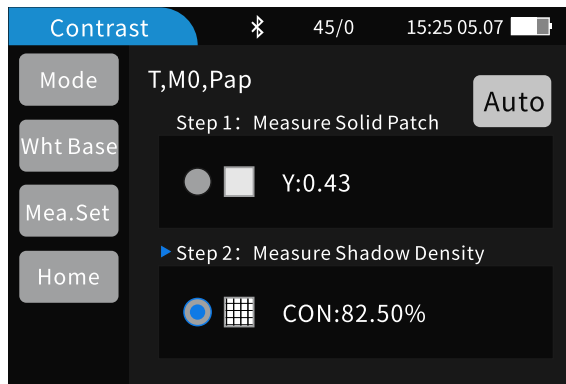


Figure 18 Print Contrast Interface

3.2.8 Trapping

This function is to measure the degree of ink overprint physical quantity. The higher the value, the better the overprint effect. This value describes the ratio of the ability of the post-printing ink to adhere to the previous printing ink to the ability of the ink to be printed on the blank form.

Setting the color response to Auto mode will operate Trapping with the process inks; use the Spotsetting if using spot colors instead.

Trapping interface displays the solid ink densities and overprint values. The procedure requires the first ink down, second ink down, and overprint measurements.

There are three ways to calculate overprint value: Preucil-(default), Brunner, and Ritz. It can be adjusted by setting.

Trapping Measurement:

1. Select Trapping function.
2. Measure paper. Once paper is measured it is not required until there is a new substrate.
3. Measure 1st ink down patch.
4. Measure 2nd ink down patch.
5. Measure overprint patch.
6. View data.
7. Continue with additional trap measurements.

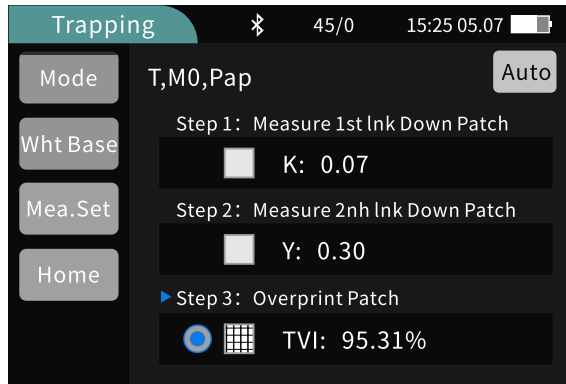


Figure 19 Trapping Interface

Note: after measuring the color block, touch the color block on the left side of the screen and re-measure the color block as required.

3.2.9 Hue Error and Grayness

Hue error occurs due to impure ink colors, causing poor spectral absorption and resulting in unwanted density. Grayness indicates the presence of gray in a color that makes it appear less saturated. Hue Error and Grayness are used to check for color consistency throughout a press run.

Hue error and Grayness values are displayed along with color toward color. For example, Y-->M indicates the color is yellow toward magenta.

Hue Error and Grayness Measurement:

1. Select Hue Error & Grayness function.
2. Measure paper if required.
3. Measure solid patch.
4. View data.

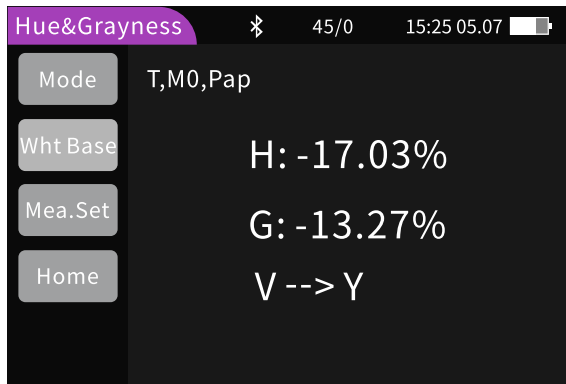


Figure 20 Hue Error and Grayness Interface

3.2.10 Print Characteristics

This function plots out a series of Hue value measurements made against a step wedge target.

You start out reading the solid and then the graph will automatically take you through each defined step. By tapping the “  Remes. ”, you can revisit previous measurements to re-measure them or view their results.

Print Characteristics Measurement:

1. Select Print Characteristics function.
2. Select Color option if required (Setting density color).
3. Measure paper.
4. Measure the 100% solid patch.
5. Measure the lowest step patch in the sequence (i.e. 10%).
6. Continue with additional step patches in an incrementing order until finished.
7. View data by tapping the arrow icons “  ” or “  ” to scan through the steps.

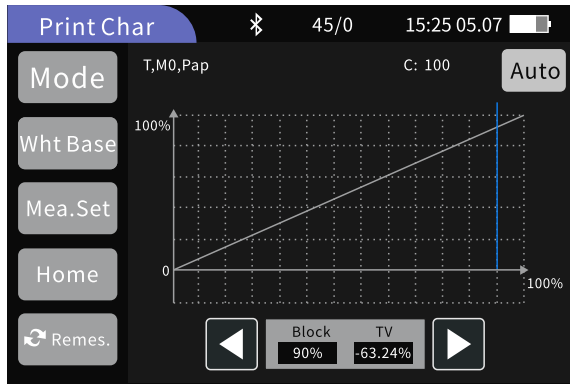


Figure 21 Print Characteristics Interface

Note: if you need to manually go back to view the previous measurement result or re-measure, tap the arrow icon on both sides of the icon “ ◀ ” or “ ▶ ” .

3.2.11 Printing Plate

This function is used to determine the Tone Value coverage of a tint or Halftone patch on a printing plate.

Printing Plate Function Setting:

1. Select Printing Plate function.
2. Measure the plate ground.
3. Measure solid patch.
4. Measure tint patch that corresponds to the measured solid.
5. View data.
6. Continue with additional tint patches that correspond to the measured solid, or touch the solid patch on the left of the screen and measure another solid patch.

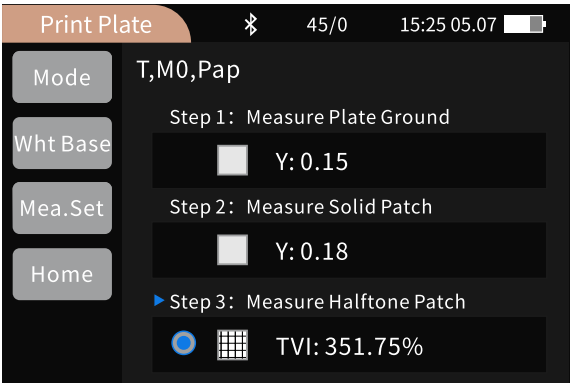


Figure 22 Printing Plate Interface

3.3 Data Management

In the main menu interface, tap "Data Mgmt" to enter the data management interface (Figure 23.) Data management primarily allows for viewing and operating on measured records.



Figure 23 Data Management

3.3.1 View Records

1) View Standard Records

In the data management interface, tap "View" to enter the "Standard Record" interface (Figures 24 & 25).

Tap the "Previous" up arrow to view the previous record, and tap the "Next" down arrow to view the next record. Operations available in this interface include: returning to the data management menu, paging up/down, deleting the standard, and switching to the sample measurement interface.



Figure 24 Standard Record Interface-1

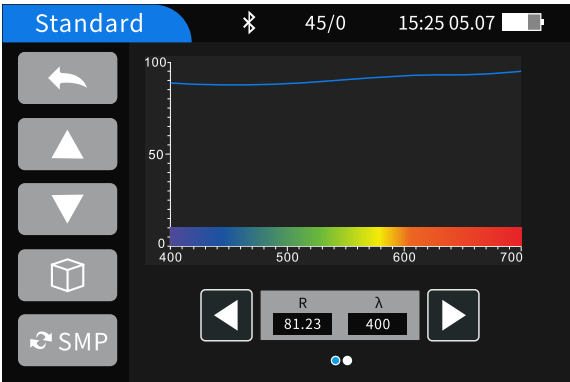


Figure 25 Standard Record Interface-2

2) View Sample

In the standard record interface, tap the switch sample icon “ SMP” to enter the "Sample Record" interface(Figures 26 & 27). The operations are consistent with the standard record interface.



Figure 26 Sample Record Interface-1

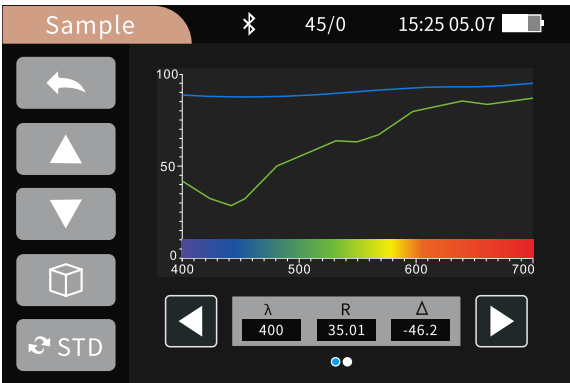


Figure 27 Sample Record Interface-2

3.3.2 Search Records

Tap "Search" in the data management interface to enter the search menu(Figure 28).

Options available are "By Standard Name" and "By Sample Name". Taking the standard name search as an example, the specific steps are:

- 1.Tap "By Standard Name" to pop up the input search name interface.
- 2.Input the name to search for, or characters contained in the name, and tap the checkmark “ ✓ ” to confirm.
- 3.The instrument will automatically execute a search across all standard records and list the matching standard records(Figure 29). Otherwise, it will prompt that the record does not exist and return to the search records menu.

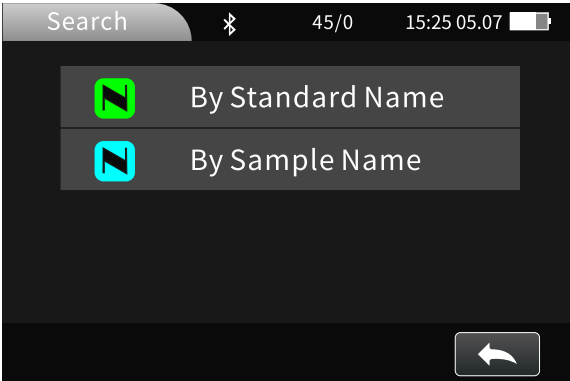


Figure 28 Search Records Interface Figure

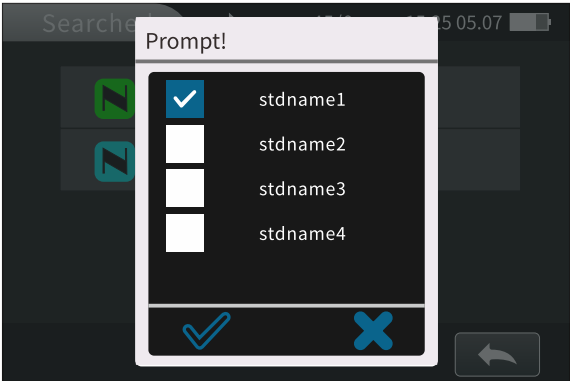


Figure 29 Searched Records List

3.3.3 Delete Records Interface

In the data management interface, tap "Delete" to enter the delete records menu(Figure 30). Deleting records is split into "Delete All Records" and "Delete All Samples". Tap the corresponding option to enter a deletion warning prompt. Tap the checkmark “✓” on the warning interface to delete all corresponding records; tap the return arrow “←” to cancel(Figure 31).

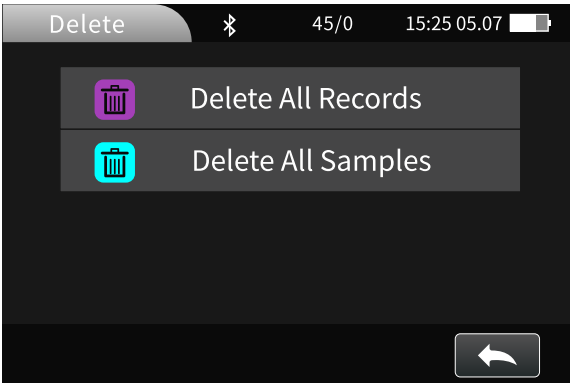
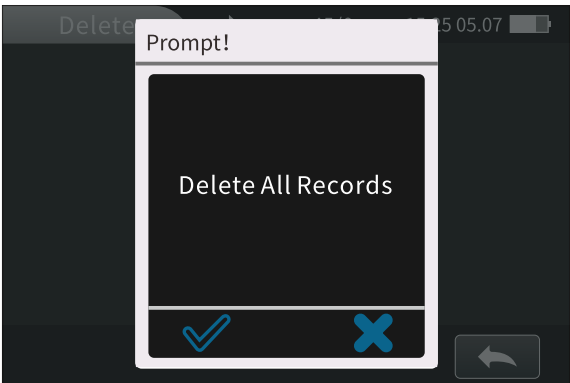


Figure 30 Delete Records Interface Figure



31 Delete Records Prompt

3.3.4 Standard Input

Tap "Std Input" in the data management interface to enter the standard input interface (Figure 32).

Tap Color Space to select the input color space. Currently, only CIELAB and CIEXYZ color spaces are supported.

Tap Illuminant to set the light source for the input standard.

Tap Observer Angle to set the observer angle for the input standard.

Tap the name location to edit the name of the input standard; the default is "No name".

Tap the corresponding chromaticity value coordinates to input values(Figure 33), tapping the L coordinate brings up an L value input window; enter the L value and confirm. After entering all the standard info, tap the checkmark “✓” to confirm, and the standard will be saved sequentially into the standard records list.

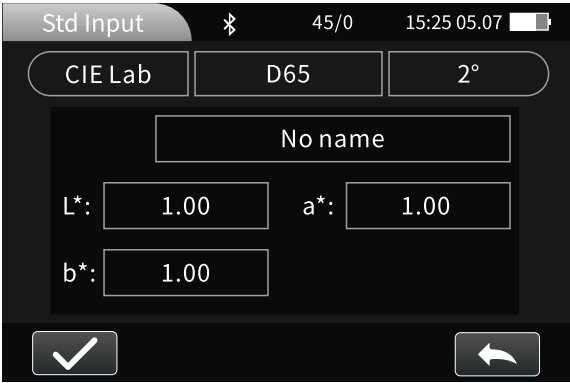


Figure 32 Standard Input Interface Figure



Figure 33 Input L Value Coordinate

Note: Manual input on the instrument only supports CIE Lab/XYZ coordinates. To input the standard's spectral reflectance, use the PC software and download it to the instrument. The inputted standard data is tied to specific observer angles, test modes, and illuminants; to view the input standard data, the matching conditions must be set. In the standard record viewing interface, if these parameters change, the chromaticity value will display as "- -".

4.Settings

4.1 Calibration

Black and white board calibration serves as the baseline for chromaticity measurements and must be performed accurately; otherwise, it will affect test data accuracy. When the calibration environment differs significantly from the current testing environment (e.g., drastic temperature or humidity fluctuations), or if data shows clear anomalies, black and white calibration must be performed immediately. Recalibration is also recommended if the instrument has been used continuously for 8 hours or has been rebooted. The working surface of the white plate should be cleaned regularly, and the black trap cavity must be routinely cleared of dust. The calibration tube must be stored properly in a dark, dust-proof, and dry condition.

Tap "Calibration" in the settings interface to enter the menu(Figure 35). It displays whether the current calibration is valid and the remaining validity time.

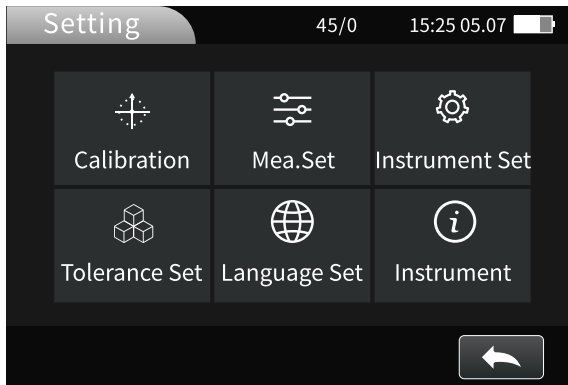


Figure 34 Settings Interface

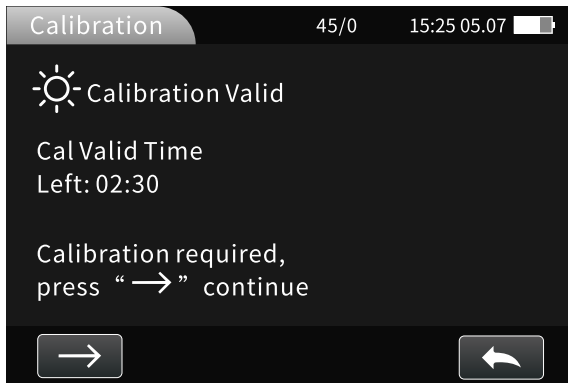


Figure 35 Calibration Interface

Tap the right arrow “→” to proceed to the reflectance black calibration interface, as shown in Figure 36.

Tap the back arrow “←” to return to the main menu.

In the reflectance black calibration interface, perform an air-black calibration as prompted: hold the instrument steadily against the black cavity and press the measure button. The interface will display "Calibrating..." along with a flashing indicator. Calibration is finished when the flashing stops.

A successful black calibration automatically redirects to the white calibration interface (Figure 37); if an error occurs, an alert will pop up.

Confirm the white plate serial number and aperture match, place the reflectance white plate, and press the measure button. "Calibrating..." will appear with a flashing indicator. Once finished, it automatically jumps back to the interface(Figure 35); if an error occurs, an alert will pop up.

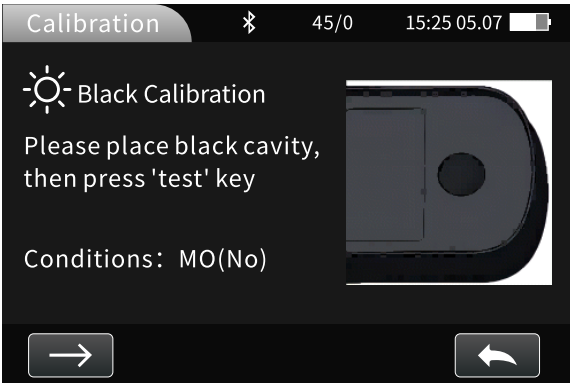


Figure 36 Black Calibration

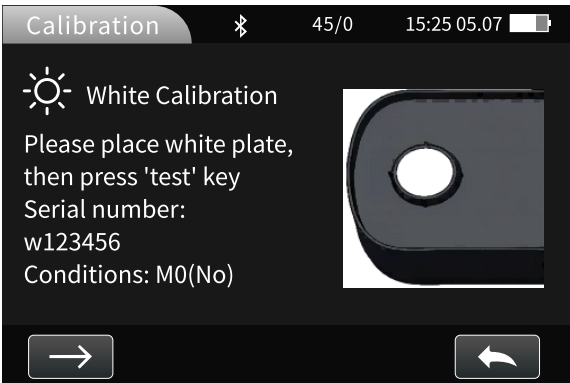


Figure 37 White Calibration Interface

4.2 Measurement Settings

Tap "Measurement Settings" in the settings to access the interface. It includes: Meas. Condition, Formulas, Color Space, Illuminant, Angle, Average, Color Offset, Test Result, Auto Save, Measurement Button, UV, Youl-Nielsen, Scan Interval, R400, Color Index, Factors (Figure 38-41).



Figure 38 Measurement Settings Interface-1



Figure 39 Measurement Settings Interface-2

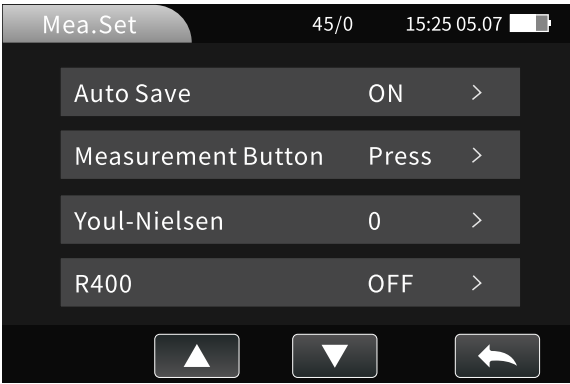


Figure 40 Measurement Settings Interface-3

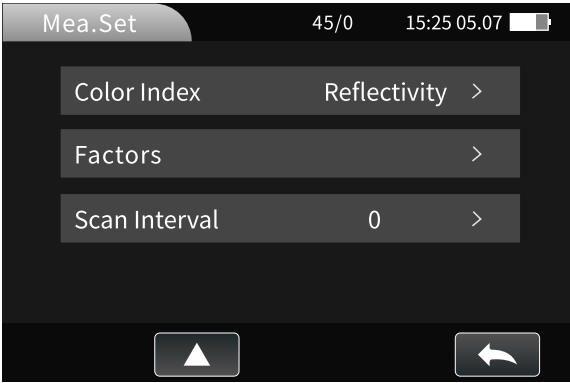


Figure 41 Measurement Settings Interface-4

4.2.1 Measurement Condition

Select from M0, M1, M2, and M3 conditions (Figure 42). Selections will appear in the chromaticity measurement interface.



Figure 42 Measurement Condition

4.2.2 Color Difference Formulas

Options include: ΔE^* , ΔE_{94} , ΔE_{00} , $\Delta E_{cmc}(2:1)$, $\Delta E_{cmc}(1:1)$, $\Delta E_{cmc}(l:c)$, ΔE_{uv} , $DIN\Delta E_{99}$, and $\Delta E(hunter)$ (Figures 43, 44).

Example for setting ΔE^* : Tap " ΔE^* " (Figure 43) and tap the checkmark “✓” to confirm.



Figure 43 Formulas Interface

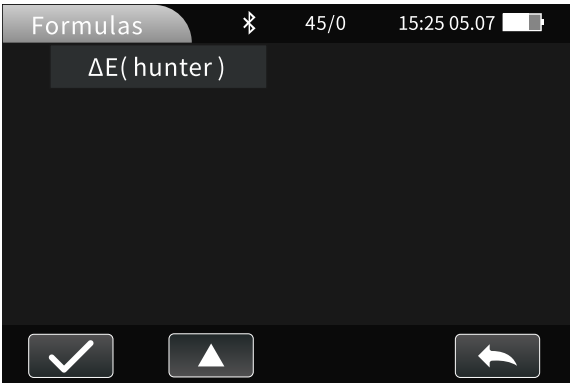


Figure 44 Formulas Interface



Figure 45 Using ΔE^* to Calculate Color Difference

4.2.3 Color Space

In the measurement settings interface, tap on "Color Space" to enter the color space selection interface(Figure 46). In the color space interface, select the corresponding color space, and then tap “✓” to complete the color space setting. The color space options include CIE Lab, XYZ, Yxy, LCh, HunterLab, s-RGB, Munsell, and βxy .



Figure 46 Color Space Interface

4.2.4 Illuminant

In the measurement settings interface, tap on "Color Space" to enter the color space selection interface, the options from Illuminant :D65, D50, A, C, D55, D75, F1, F2(CWF), F3, F4, F5, F6, F7(DLF), F8, F9, F10(TPL5), F11(TL84), F12(TL83/U30), CWF, DLF, TL83, TL84, TPL5, U30, B, U35, NBF, ID50, ID65, LED_B1, LED_B2, LED_B3, LED_B4, LED_B5, LED_BH1, LED_RGB1, LED_V1, LED_V2, LED_C2, LED_C3, LED_C5, LED_T8G, U3500(figure 47).



Figure 47 Illuminant Interface

4.2.5 Observer Angle

Toggle the observer angle between 2° or 10°.

4.2.6 Average

Tap "Average" to configure average measurement settings (figure 48).



Figure 48 Average Interface



Figure 49 Average Editing Interface

4.2.7 Color Offset

In the measurement settings interface, tap “Color Offset” to toggle between the enabled (ON) or disabled (OFF) status. When the color offset is turned on, the system will prompt the color offset of the sample compared with the standard during measurement; when turned off, no prompt will be displayed.

4.2.8 Test Result

In the measurement settings interface, tap "Test Result" to toggle between the enabled (ON) or disabled (OFF) status. If the test result prompt is turned on, during measurement, if the error of the sample falls within the allowable tolerance range of the standard, "Pass" will be displayed in green; if the test result exceeds the tolerance range set for the standard, "Fail" will be prompted in red.

4.2.9 Auto Save

When auto-save is turned on, every measured sample will be automatically stored in the instrument. When turned off, the sample record will not be automatically saved after measurement finishes; you must manually tap the save icon “” (Figure 50).

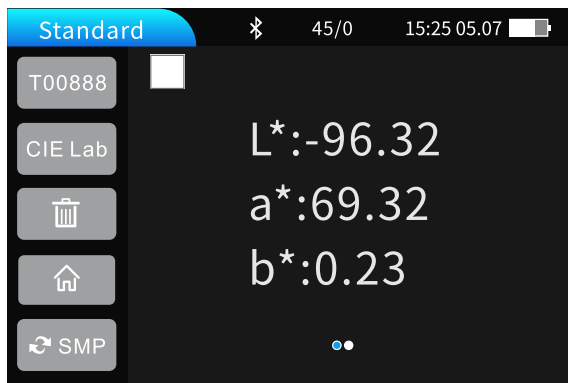


Figure 50 When Disabling Auto Save, Need to Manually Save.

4.2.10 Measurement Button

Press to measure: Button Press (only button triggers).

Hold to measure: Downward Press (only physical pushing triggers).

Press or Hold: Both can trigger measurement.

4.2.11 Youl-Nielsen

In the measurement settings interface, Tap to enter and edit the Youl-Nielsen factor (Figures 51 & 52).



Figure 51 Youl-Nielsen Interface



Figure 52 Youl-Nielsen Editing Interface

4.2.12 Scan Interval

In the measurement settings interface, tap "Scan Interval" to edit the scan interval (figure 53).



Figure 53 Scan Interval Interface



Figure 54 Scan Interval Interface

4.2.13 R400

In the measurement settings interface, tap "R400" to toggle between the enabled (ON) or disabled (OFF) status.

4.2.14 Color Index

In the measurement settings interface, tap color index to select options including Reflectivity, Yellowness, Whiteness, CMYK, Color Strength, Opacity, Color Fastness, and Staining Fastness (figure 55). These will appear in the measurement or viewing interfaces.



Figure 55 Color Index Interface

4.3 Instrument Settings Interface

Instrument Settings Interface includes Cal. Validity, Operation Habit, Aperture Set, Restore Factory, Brightness, Time Set, Buzzer, Screen Sleep, Bluetooth, and Print Set(Figure 56-58).



Figure 56 Instrument Settings Interface-1

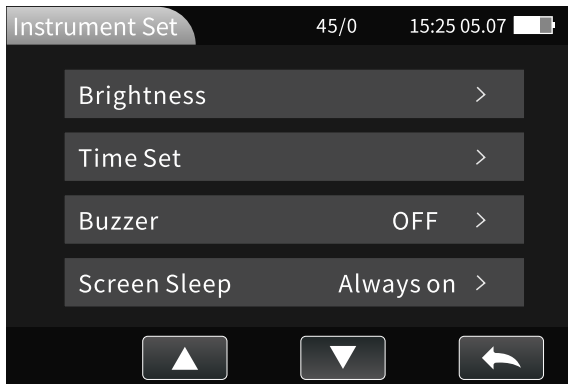


Figure 57 Instrument Settings Interface-2

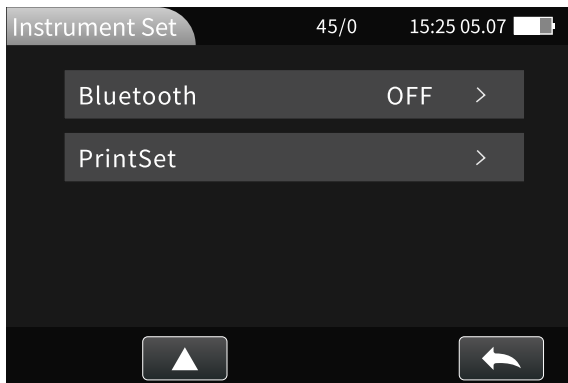


Figure 58 Instrument Settings Interface-3

4.3.1 Calibration Validity

The instrument manages the expiration time of black and white calibration via the "Calibration Validity" option under instrument settings. Since black and white board calibration serves as the baseline for colorimetric data measurement, it must be performed accurately; otherwise, the accuracy of the test data will be compromised.

When there is a large discrepancy between the calibration environment and the current sample testing environment (e.g., severe fluctuations in temperature or humidity), or when

the data shows obvious abnormalities, the instrument needs to undergo black and white calibration in a timely manner.

In the instrument settings interface, tap "Calibration Validity" to enter the calibration validity interface. You can select 4-hour calibration, 8-hour calibration, 24-hour calibration, or Calibration upon Power-on, as shown in Figure 59.

Note: It is highly recommended to perform black-and-white calibration after 8 hours of continuous operation or when the instrument is restarted.



Figure 59 Cal. Validity Interface

4.3.2 Operation Habit

Toggle the operating habit setting (e.g., Right hand, Left hand).

4.3.3 Aperture Set

This series includes $\Phi 11\text{mm}$, $\Phi 10\text{mm}$, $\Phi 6\text{mm}$, $\Phi 5\text{mm}$, $\Phi 3\text{mm}$, $\Phi 2\text{mm}$, and $\Phi 1.5\text{mm}$ measurement apertures (availability varies by model). When the measured surface of the sample is large and uniform, it is recommended to use the $\Phi 11\text{mm}$ or $\Phi 10\text{mm}$ measurement apertures. When the measured surface of the sample is small, it is recommended to use the $\Phi 6\text{mm}$, $\Phi 5\text{mm}$, $\Phi 3\text{mm}$, $\Phi 2\text{mm}$, or $\Phi 1.5\text{mm}$ apertures.

Switching steps:

Step 1: Aperture Installation. Rotate the measurement aperture counterclockwise to remove the original aperture. Align the new measurement aperture with the integrating sphere installation hole, and rotate it clockwise. A "tap" sound indicates that the measurement aperture is properly engaged with the integrating sphere slot, meaning it is successfully installed.

Step 2: Optical Lens Position Switching. If a $\Phi 6\text{mm}$, $\Phi 5\text{mm}$, $\Phi 3\text{mm}$, $\Phi 2\text{mm}$, or $\Phi 1.5\text{mm}$ aperture is installed, you need to toggle the aperture switch to the SAV position. If a $\Phi 11\text{mm}$ or $\Phi 10\text{mm}$ aperture is installed, you need to toggle the aperture switch to the MAV position.

Step 3: Software Switch. Tap "Aperture Set" in the software settings and manually select the matched aperture.

Note: Recalibration is strictly required after switching the aperture before new tests can proceed.

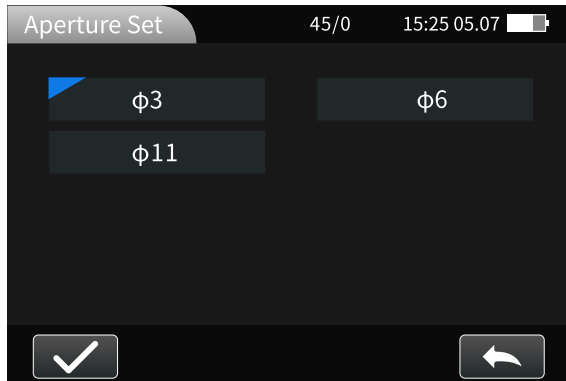


Figure 60 Aperture Set Interface

4.3.4 Factory Reset

Tap "Factory Reset" (Figure 61). Tap the checkmark “✓” to clear all records and custom settings, reverting the instrument to its factory state; tap the back arrow “↶” to cancel.

Note: This operation is irreversible and all datas will be permanently deleted. Operate with caution.



Figure 61 Factory Reset Interface

4.3.5 Screen Brightness

Use the slider to adjust screen brightness from 1 to 99. Tap the checkmark “✓” to save, or the back arrow “←” to cancel.

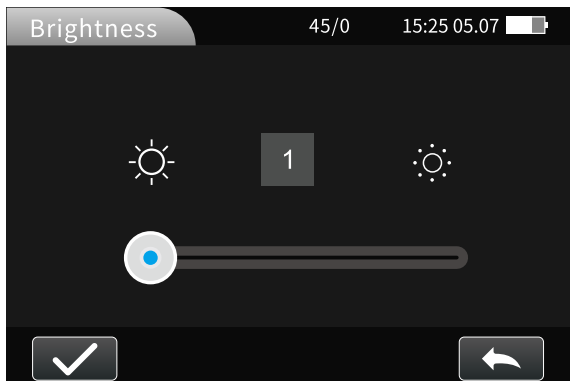


Figure 62 Brightness Interface

4.3.6 Time Set

When leaving the factory, the instrument is typically synchronized to the local time of the manufacturer. Users can also configure the instrument's time based on actual conditions. In the instrument settings interface, tap "Time Set" to enter the time configuration interface. After setting and verifying the correct time, save the configuration to synchronize the instrument internal clock.

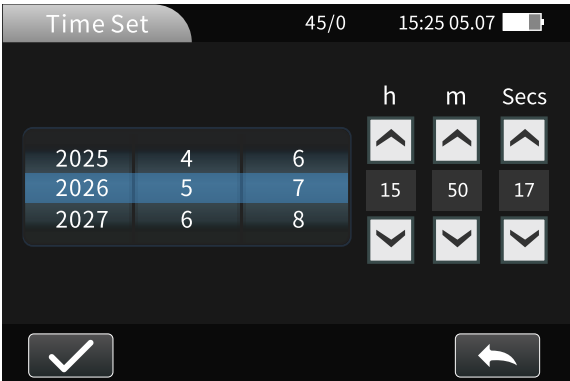


Figure 63 Time Set Interface

4.3.7 Buzzer

tap "Buzzer" to toggle between the enabled or disabled state. The buzzer switch controls whether an audible prompt sounds during measurement. When the buzzer is turned on, a prompt Hue will ring at the end of each measurement; otherwise, there will be no audio prompt during testing.

4.3.8 Screen Sleep

tap "Screen Sleep" to enter the screen sleep configuration interface. The sleep time options are: "Always On", "1 minute", "5 minutes", "10 minutes", and "30 minutes". If "Always On" is selected, the screen will not automatically turn off and the device will not automatically shut down when idle. If set to other options, the instrument will start timing from the user's last operation. The screen will turn off after the selected duration, and the instrument will automatically perform a soft shutdown 3 minutes after the screen turns off to enter power-saving mode.

During the screen sleep period, the display can be lit up by short-pressing the measurement button. When the instrument is softly shut down, it can be awakened by short-pressing the measurement button.

4.3.9 Bluetooth

For product models equipped with Bluetooth, you can choose to communicate with the PC-side software via Bluetooth.

When Bluetooth is enabled, the Bluetooth icon will be displayed on the status bar of the measurement interface. Ensure that the quality control software is installed on the PC. Turn on Bluetooth in the instrument's "System Settings", and pair the computer with the Bluetooth device. Once paired successfully, select the Bluetooth connection mode in the PC software. A prompt appearing in the lower right corner of the software indicates a successful Bluetooth connection. You can then achieve comprehensive control over the terminal instrument through the software to conduct relevant sample testing and analysis (refer to Section 2.2 for Bluetooth Wireless Communication details).

4.3.10 Print Set

Tap "Print Settings" to enter the print configuration interface(Figure 64).

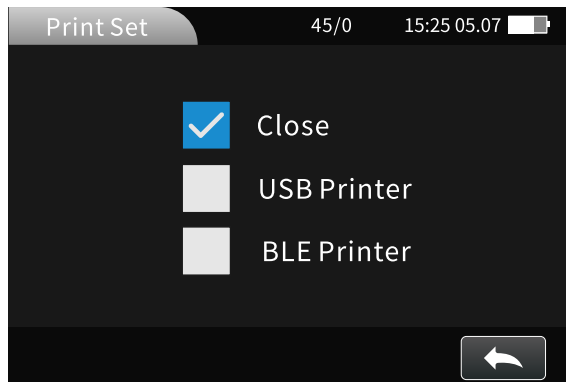


Figure 64 Print Set Interface-1

Select "USB Printer" (Figure 65) and tap the back arrow “” to return to settings.

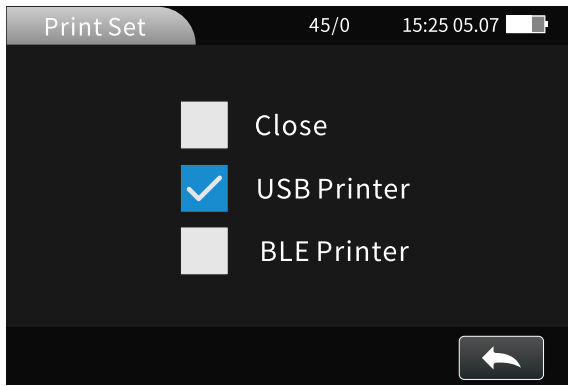


Figure 65 USB Printer Settings Interface

1. Connect the micro printer to the instrument via USB, and locate the record in the standard or sample records lists(Figure 66).

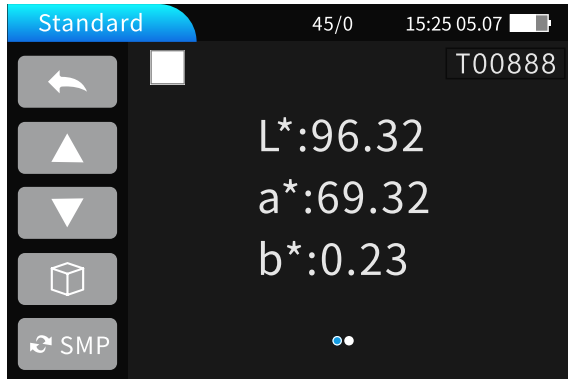


Figure 66 Sample Record to Print

2. Tap the operation icon “” and select "Printer" from the pop-up menu (Figure 67).

3. Tap the checkmark “” to confirm. The instrument sends the data, and the printer executes the job.

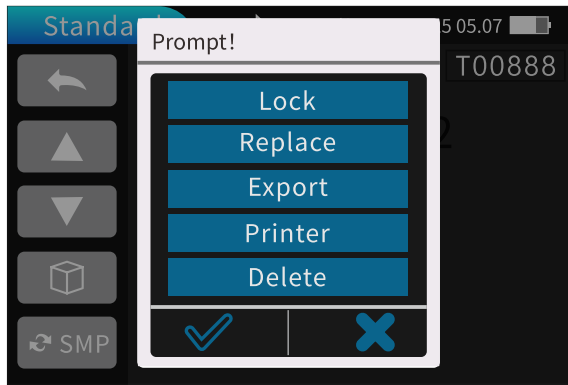


Figure 67 Printer Operation Prompt

The instrument also supports printing while measuring. Similar to USB, you can test a sample, save it, and initiate a print job instantly. Bluetooth printers function identically for this feature.

Bluetooth Printer Steps:

1. Long-press the Bluetooth printer's power button until the indicator flashes.
2. Go to the instrument's System Settings → Print Set → Bluetooth Printer.
3. Input the MAC address from the back of the printer into the "BLE MAC" field. It requires exactly 12 characters (e.g., 4CE173C3F00E) and auto-saves.
4. Tap to connect to the printer .
5. Locate a record, tap the operation icon.
6. Select "Printer" to execute the job.

4.4 Tolerance

Tap "Tolerance". This tolerance acts as the system tolerance. When this tolerance is configured, all standards will use it as the criteria to determine whether the standard and sample match are "Pass" or "Fail". Turn on the test result prompt in "Display Settings" to view the compliance status. Only the tolerances for ΔE^* , ΔL^* , Δa^* , and Δb^* can be configured.



Figure 68 Tolerance Set Interface

4.5 Language

Configures the interface language. Tap "Language Set", select the desired language, and confirm.

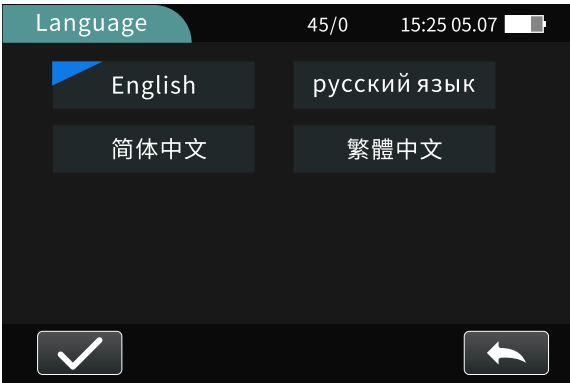


Figure 69 Language Set Interface

4.6 About Instrument

Tap "About Instrument" to view information such as the product model, SN code, software version number, hardware version number, and calibration board number(Figure 70).



Figure 70 Instrument Info Interface

5. Daily Maintenance

1. This instrument is a precision optical instrument. Please keep and use the instrument properly. Avoid using and storing the instrument under humid, strong electromagnetic interference, strong light and dust. It is recommended to use and store the instrument in a standard laboratory environment (temperature 20 degrees Celsius, 1 standard atmosphere, humidity 50~70% RH).
2. the whiteboard is a precision optical component, it should be properly kept and used, avoid rubbing the working surface with sharp objects, avoid staining the working surface with dirt, and avoid exposing the whiteboard under strong light. Regularly clean the whiteboard working surface with a cloth and alcohol. When cleaning, clean the dust on the whiteboard surface.
3. In order to ensure the validity of the test data, the instrument and the whiteboard are recommended to be tested by the manufacturer or a qualified metrology institute for one year from the date of purchase.
4. This instrument supplies power to the external power adapter. The power supply should

be used in a standard manner to avoid frequent plugging and unplugging of the power supply, to protect the power supply performance and to extend the service life of the power supply.

5. Please do not disassemble/assemble the instrument. If there is any problem, please contact the relevant after-sales staff. Torn the easy-to-tear label will affect the after-sales maintenance service of the instrument.

Technical Specifications (Variances exist among different models)

Spectrodensitometer		
Model	Standard	Advanced
Measurement Geometry	45/0(45 ring-shaped illumination, 0 degree viewing angle);standard ISO 5-4, CIE No.15	
Features	Common spectrophotometer densitometer, apply in ink printing, in Film Processing, Textile Printing and Dyeing, Plastic Electronics and Other Industries for Color Measurement and Quality Control; especially suitable for the measurement and quality control of optical density and dot enlargement in ink printing	High precision spectrophotometer densitometer, apply in ink printing, in Film Processing, Textile Printing and Dyeing, Plastic Electronics and Other Industries for accurate Color Measurement and Quality Control; especially suitable for the accurate measurement and quality control of optical density and dot enlargement in ink printing
Light Source	Combined LED Light, UV Light	
Spectral separation device	High-precision nano-spectrophotometric device	Planar grating
Detector	Silicon photodiode array (Dual array 16 groups)	Silicon photodiode array (Dual array 40 groups)
Wavelength range	400~700nm	
Wavelength Pitch	10nm	
Half Bandwidth	10nm	

DENSITOMETERS

Measurement Conditions	Compliance with ISO 13655 measurement conditions; M0 (CIE Light Source A) M1 (CIE Light Source D50) M2 (Excluding UV light source) M3 (M2+Polarized light filter)	
Density Standards	ISO Status T、E、A、I、M	
Density Index	Density value, Density difference, Dot area, Dot gain, Trapping, Printing characteristics, printing contrast, Hue error and Graynesss, Printing plate	Density value, Density difference, Dot area, Dot gain, Trapping, Printing characteristics, printing contrast, Hue error and Graynesss, Printing plate, Density scanning(customized)
Measurement Aperture	Φ11mm, Φ10mm, Φ6mm, Φ5mm, Φ3mm, Φ2mm, Φ1.5mm (varies by model)	
Color Spaces	CIE LAB, XYZ, Yxy ,LCh, CIE LUV, HunterLAB, s-RGB, βxy, DIN Lab99, Munsell	
Color Difference Formula	ΔE^*ab , ΔE^*uv , ΔE^*94 , $\Delta E^*cmc(2:1)$, $\Delta E^*cmc(1:1)$, $\Delta E^*cmc(1:c)$, ΔE^*00 , DIN $\Delta E99$, ΔE (Hunter)	
Other Colorimetric Index	Spectral reflectance, Whiteness (ASTM E313-00/73, CIE, ISO2470/R457, AATCC, Hunter, Taube, Berger, Stensby), Yellowness (ASTM D1925, ASTM E313-00/73), Tint (ASTM E313-00), Metamerism Index MI, Staining Fastness, Color Fastness, Color Strength, Opacity, 555 Hue Classification, Blackness (My, dM)	
Observer Angle	2°/10°	
Illuminants	D65, A, C, D50, D55, D75, F1, F2(CWF), F3, F4, F5, F6, F7(DLF), F8, F9, F10(TPL5), F11(TL84), F12(TL83/U30), B,U35, NBF, ID50, ID65, LED-B1, LED-B2, LED-B3, LED-B4, LED-B5, LED-BH1, LED-RGB1, LED-V1,L ED-V2, LED-C2, LED-C3, LED-C5	
Measurement Time	About1s	
Repeatabil	Density: Within 0.01D	Density: Within 0.001D
ity	Chromaticity value: within ΔE^*ab 0.02 (When a white calibration plate is measured 30 times at 5 second intervals after white calibration) Except M3	

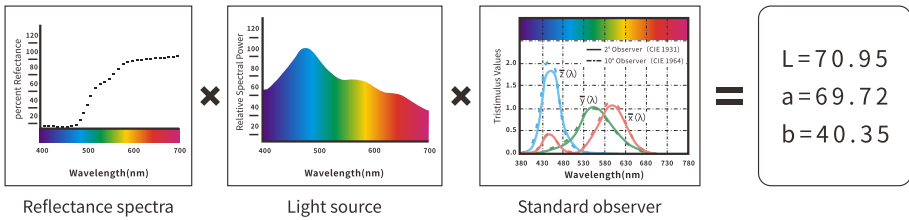
DENSITOMETERS

Inter-instrument Error	Within ΔE^*ab 0.20 (Average for 14 BCRA Series II color tiles) Except M3		Within ΔE^*ab 0.18 (Average for 12 BCRA Series II color tiles) Except M3
Measurement mode	Single Measurement, Average Measurement (2-99)		
Positioning	Integrated physical positioning hole		
Size(L*W*H)	184x77x105mm		184x77x105mm
Weight	About 600g		About 600g
Power Source	Li-ion battery. 5000 measurements within 8 hours		
Illuminant Life Span	5 years, more than 3 million times measurements		
Display	3.5-inch TFT color LCD, Capacitive Touch Screen		
Interface	USB, Bluetooth		
Data Memory	10000 pcs		20000 pcs
Software Support	Android, iOS, Windows, WeChat Mini Program, HarmonyOS		
Language	Simplified Chinese, English, Traditional Chinese, Russian		
Working Environment	Temperature: 0~40°C; Humidity: 0~85% (No Condensation); altitude: less than 2000 m		
Storage Environment	Temperature: -20~50 °C; Humidity: 0~85% (No Condensation)		
Network Calibration	Supports Netmetric (varies by model)		
Accuracy Guarantee	Metrology qualified		1-level Metrology qualified
Standard Accessory	Power Adapter, USB Cable, User Manual, software (download from the website), White and Black Calibration Board, Polarization filter box.		
Optional Accessory	Micro Printer, Netmetric (varies by model)		
Notes:	The specifications are subject to change without notice.		

Appendix 1

1.Object color

There are three elements to observe color: illumination source, object, observer. Any change in any of these three will affect the viewer's color perception. When the illumination source and observer do not change, then the object will determine the color perception formed by the observer. The reason why objects can affect the final color perception is because the reflection spectrum (transmission spectrum) of the object modulates the spectrum of the source. Different objects have different reflection spectra (transmission spectra), and the spectrum of the source is reflected by different objects (transmission spectrum). Spectral modulation yields different results, because the observer does not change, so it presents different colors, the principle of which is shown below.



ΔL large (positive) indicates a shift toward white, indicates a shift toward black.

Δa large (positive) indicates a shift toward red, Δa small (negative) indicates a shift toward green.

Δb large (positive) indicates a shift toward yellow, Δb small (negative) indicates a shift toward blue.

2.Color Difference Formula

CIE 1976 color difference formula ΔE^*_{ab} is as follows:

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

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

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

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

CIE 2000 color difference formula ΔE_{00} is as follows:

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

$$L' = L^*$$

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

$$b' = b^*$$

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

CIE 1994 color difference 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. Normal Color Difference Tolerance Range

The acceptable range for color difference varies greatly depending on the industry and application. The following provides an overview of tolerance ranges in major industries:

1.) Electronic Equipment Industry

Standard: Typically requires a ΔE^* lower than 0.5 to ensure color accuracy in screen displays and product appearances.

2.) Plastics and Coatings Industry

Standard: Requires a ΔE^* lower than 1.0, applicable to color control for plastic products and coating materials.

3.) Textile Industry

General Standard: A ΔE^* lower than 2.0 is viewed as the acceptable range, especially in textile color management.

Specific Standard: Certain standards dictate that the color difference for specific sections should not fall below Grade 4, equivalent to a ΔE^* value between 0 ~ 2.0.

4.) Printing Industry

Range: A color shift ranging from 1.5 to 3.0 is commonly deemed normal, but values can vary according to product grades and client demands.

Standard: Specific standards dictate that whether it is a fine or general product, the ΔE^* value must not exceed 6.

5.) Railway Signal Flags

Standard: Color difference must be $\leq \Delta E^*$ to ensure clarity and recognizability of the signals.

Color Difference Magnitude and Visual Perception:

ΔE^*	Visual Perception Level	ΔE^*	Visual Perception Level
0-0.25	Very small to no difference; ideal match	1.0-2.0	Medium difference; noticeable to the human eye, acceptable in specific applications
0.25-0.5	Minor difference; generally acceptable	2.0-4.0	Obvious difference; acceptable under specific conditions
0.5-1.0	Minor to medium difference; acceptable in some applications	4.0 and Above	Extremely large difference; unacceptable for most applications



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