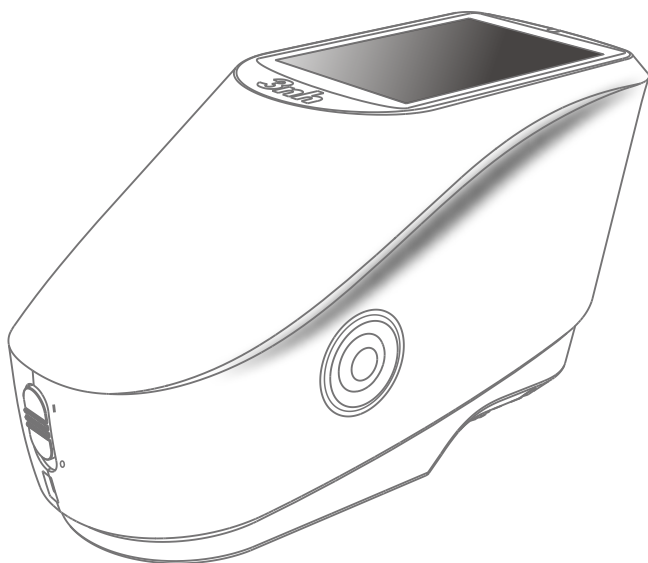


3nh

SPECTRODENSITOMETER
OPERATION MANUAL



V1.0

FCC Warning

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE 1: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

NOTE 2: Any changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Safety Instructions

Safety Symbol

In order to avoid accidents caused by improper operation, the following symbols are used in this manual or on the instrument label.



This symbol instructs relative safety warnings or precautions.

Read these instructions carefully to use this instrument safely and correctly.



This symbol is a description of electrical hazards associated with electric shock.

Read these instructions carefully to use this instrument safely and correctly.



This symbol is a description of fire hazards.

Read these instructions carefully to use this instrument safely and correctly.



Represents a prohibiting execution. This is absolutely not executable.



Represents an instruction.

The instruction must be strictly performed.



Represents a prohibiting execution.

Do not disassemble this instrument.



Represents an instruction.

Make sure that the AC adapter is pulled out from the AC socket.

Safety Instructions

Cautions

- No copy or copy of all or part of this manual is strictly prohibited without authorization from the company.
- The contents of this manual are subject to change without prior notice.
- When preparing this manual, we have done our best to ensure the accuracy of its contents. If you have any questions or find any errors, please contact your retailer or our authorized maintenance agency.
- The company has no liability for all consequences arising from the improper operation of this instrument.

Please keep this manual carefully for your reference at any time.





Safety Instructions

Safety Measures

To ensure proper use of this instrument, please read carefully and strictly observe the following points.



Warning: Failure to comply with the following points may pose a danger to personal safety.

	<ol style="list-style-type: none">1. Do not use this instrument in a place where there are combustible or flammable gases (gasoline, etc.), otherwise it may cause fire.2. Do not allow liquid or metal objects to enter the instrument, otherwise it may cause fire or electric shock. If a liquid or metal object enters the instrument, turn off the power immediately, unplug the AC adapter plug, and contact the nearest authorized maintenance institution.3. Do not force, twist or pull the power cord of the AC adapter. Do not scrape or modify the power cord, or place heavy objects on the power cord, otherwise it may damage the power cord, and cause fire or electric shock.4. Do not use wet hand to plug AC adapter plug, otherwise it may cause electric shock.5. If the instrument or AC adapter is damaged, or smokes, do not continue to use this instrument, otherwise it may cause fire. In this case, power should be switched off immediately, AC adapter plug removed from the AC socket, and contact the nearest authorized maintenance institution.6. Do not measure the face directly on the sample measuring aperture, otherwise it may damage the eyes. <p>Do not place the instrument on an unstable or inclined surface, or it may cause the instrument to slide or overturn, causing injury to personnel.</p>
	<ol style="list-style-type: none">1. Be sure to always use a standard AC adapter or an optional AC adapter and connect it to an AC socket with rated voltage and frequency. If you use a not specified AC adapter, it may damage the instrument or cause a fire or electric shock.2. Be careful not to put your hand in the notch of the instrument, or you may get stuck in your finger and cause injury.



Safety Instructions

Safety Measures

To ensure proper use of this instrument, please read carefully and strictly observe the following points.



Warning: Failure to comply with the following points may pose a danger to personal safety.

	Do not disassemble or refit the instrument or AC adapter, otherwise it will cause fire or electric shock.
	<ol style="list-style-type: none">1.If the instrument is not used for a long time, please pull the AC adapter plug from the AC socket. Because the dust or water stains on the AC adaptor pins may cause a fire, they should be pulled out immediately.2.When pulling the AC adapter plug out of the AC socket, be sure to always hold the plug itself to avoid pulling the power cord, which may damage the power cord and cause fire or electric shock.

Technical Description

The benchtop spectrophotometer is designed for the measurement of color and color difference in all fields. It can measure the color for reflection and transmission with high accuracy.

Operating Environment

- Please use this instrument at ambient temperatures ranging from 0°C to 40°C without condensation. Do not use this instrument in areas where temperature varies dramatically.
- Do not place this instrument near direct sunlight or heat sources such as furnaces. In this case, the internal temperature of the instrument may be higher than the ambient temperature.
- Do not use this instrument in the presence of dust, cigarettes or chemical gases, or it may cause performance degradation or even system collapse.
- Do not use this instrument near devices such as loudspeakers that generate strong magnetic fields.
- The bench-top spectrophotometer and its standard AC adapter are designed for indoor use only. Because rain or other factors may damage the instrument, SO do not use it outside.

White Calibration Plate

- Do not scrape or dirty the white correction board, for example, do not leave fingerprints.
- When white calibration plate is not used, be sure to place them properly to prevent white calibration plate from being exposed to light.
- To achieve accurate measurement, we advise that the white calibration plate should also be calibrated periodically.

Power

- Ensure that the power switch is switched to "O" when the benchtop spectrophotometer is not used.
- Make sure you always use a standard AC adapter and connect it to an AC socket with rated voltage and frequency.

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Instruction

This Spectrodensitometer with 45/0 geometric optical structure is independently developed by our company, who has complete intellectual property rights. It is fully compliant with ISO 5-4 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 density measurement, easy to achieve a variety of printing parameters (such as: dot, trapping values, color 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 calibers (2mm, 4mm, 8mm), 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:

- (1) 45/0 geometrical optics structure, comply with 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 values.
- (2) Perfect combination of beautiful appearance and the human body mechanics structural design.
- (3) Use long life and low power consumption combined LED light source, UV-included.
- (4) Three apertures optional (Φ 2/4/8mm), suitable for more samples measurement.
- (5) Measuring sample reflection spectrum, CMYK density, Lab, Yxy, s-RGB, color difference and other chromaticity data, used for accurate color transfer.
- (6) High electronic hardware configuration, 3.5-inch TFT true color screen, capacitive touch screen, concave grating, 256-pixel dual array CMOS detector, etc..
- (7) USB/Bluetooth 2.1 dual communication mode, widely useful.
- (8) Super stain-resistant and stable standard white calibration plate.
- (9) Large capacity storage space, over 20,000 measurement data.
- (10) 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.
- (11) Especially suitable for printing plant process control, quality control.
- (12) PC software has a powerful function extension.

1. Power On & Off

Turn the power switch to "I", the instrument is powered up, and the indicator light is always green. Turn the power switch to "0", the instrument is off and the indicator is off.

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).

When the instrument is started, jump from the LOGO interface to the main menu or the black and white calibration interface (beyond the validity period of the correction) to complete the Self diagnosis.



Figure 1 Main Menu

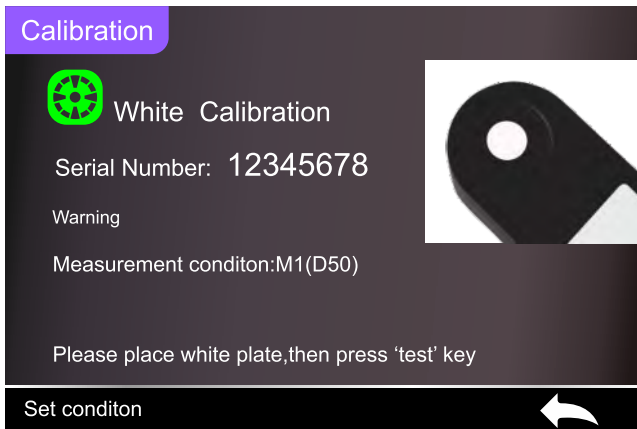



Figure 2 White and Black Calibration

Note: If the instrument is not in use for a long time, please cut off the power of the instrument.

2. Connecting to PC

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

Some of the Bluetooth devices communicate wirelessly with computers.

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;
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.

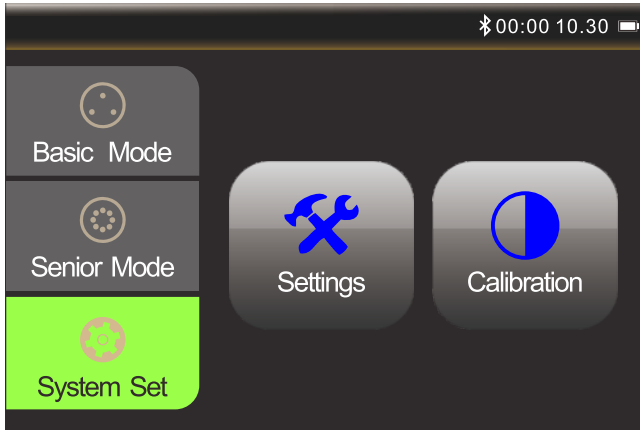


Figure 3 The Bluetooth icon is displayed in the status bar

3. User Interface

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


3.1 Enter basic mode

The basic mode has two quick menu screens, density /TVI and CIE L*a*b*.

Tap the icon to open the appropriate tool on the on-screen menu.



Figure 4 Basic Mode

Tap the "Density /TVI" icon to enter the interface of density /TVI. Tap the main menu icon “  ”in the lower right corner of the icon to jump back to the interface of the main menu. Tap the "Settings" in the lower left corner and the screen jumps to the corresponding settings interface.

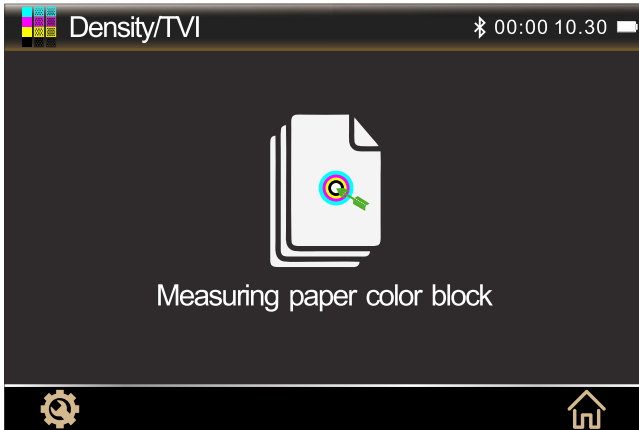


Figure 5 Density /TVI interface

Note: the density /TVI interface settings include: measurement conditions, density states, density reference white, density accuracy, tone values, and tone value increase. The CIE L*a*b* interface is set up differently, including measurement conditions, light source and observer angle.

3.2 Enter advanced mode

Advanced mode has two quick menu screens, densitometer and basic comparison. Tap the icon to open the appropriate tool on the menu.

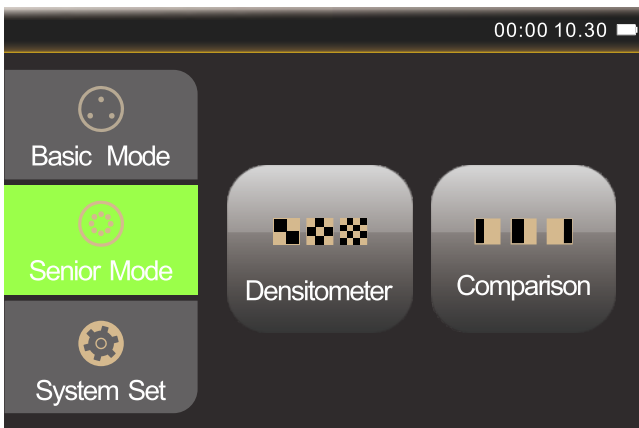


Figure 6 Advanced Mode

Tap the "Densitometer" icon to enter the interface of Densitometer. Tap the main menu icon "🏠" in the lower right corner of the icon to jump back to the interface of the main menu. Tap the "Settings" in the lower left corner and the screen jumps to the corresponding settings interface.

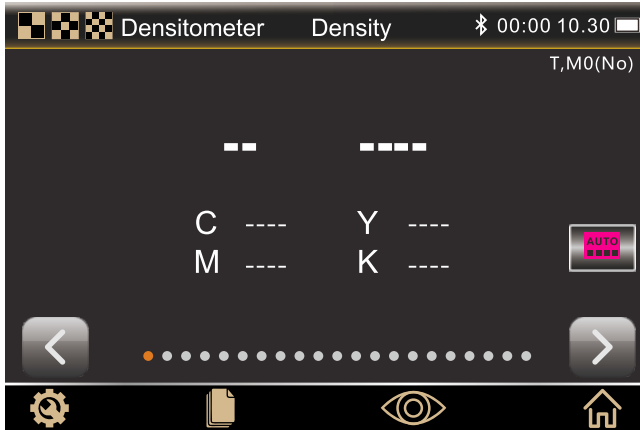


Figure 7 Densitometer Interface

3.3 Enter System Settings

System Settings have two quick menu screens, Settings and Calibration.

Tap the icon to open the appropriate tool on the menu.

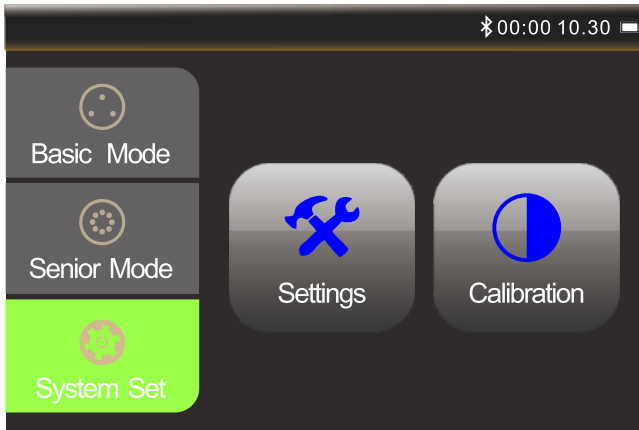


Figure 8 System Settings

Tap the "Settings" icon to enter the device setup interface, as shown in figure 9. Tap the icon "←" in the lower right corner, and the screen will jump back to the main menu interface.

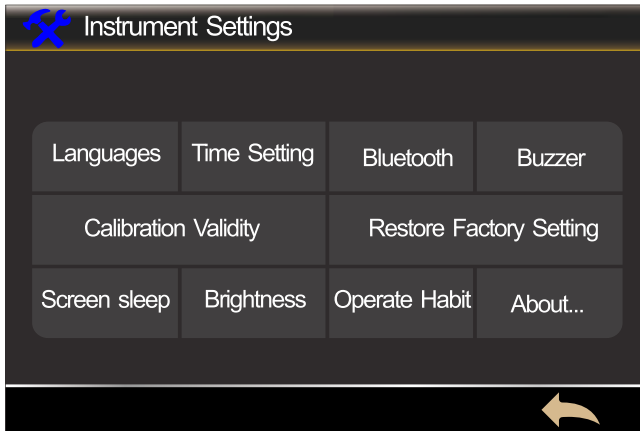


Figure 9 Instrument setting interface

3.4 Viewing the Functions

This feature is available in advanced mode. Tap the icon "←" or "→" to quickly switch screen views.

The dots that appear on the various measurement tool screens indicate the number of functions that have been activated for that particular tool. The highlighted dots on the screen represent the current screen, and the other dots represent the functional screens that can be switched.

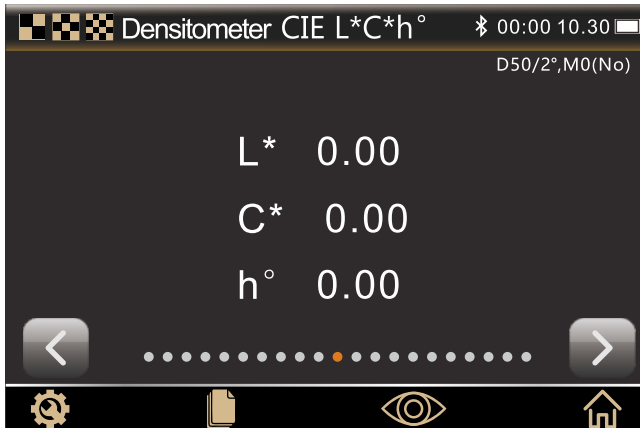





Figure 10 Viewing the Functions

3.5 Scrolling through Options

A scrolling bar appears on screens when all options cannot be accessed at the main view.

Tap the icon“  ”, on the function screen to enter the scroll option interface. The scroll bar on the right indicates that there are other options, and you can quickly view the other options by sliding the scroll bar up and down, as shown in figure 11.

To quickly check the value of the trapping screen, tap“  ”,scroll down, select" trapping "in the scroll option interface, and click“  ”to confirm to jump to the trapping screen interface, as shown below.

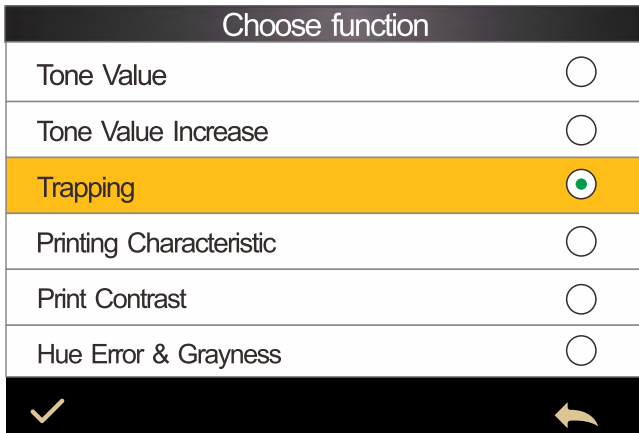


Figure 11 Scrolling through Options “trapping”



Figure 12 scroll option "trapping"

3.6 Calibration

The instrument is equipped with a calibration box, and it will be prompted when calibration is required before measurement. Calibration before measurement can improve the accuracy of data.

Re-calibration is required as following:

1. The instrument is used for the first time.
2. Over the calibration validity.
3. Measurement conditions have been changed.
4. The calibration environment is very different from the test environment.
5. Abnormal measurement data.

Note: Dirt and dust will seriously affect the calibration of the instrument and it should be kept clean. It is recommended to do regular cleaning.

Calibration steps:

When calibration is required, the instrument pops up a warning message, as shown in figure 13.



Figure 13 Calibration expiration warning

1. Locate the instrument on a flat surface, touch "OK" in Figure 13, and the instrument screen will jump to the calibrated whiteboard calibration interface.

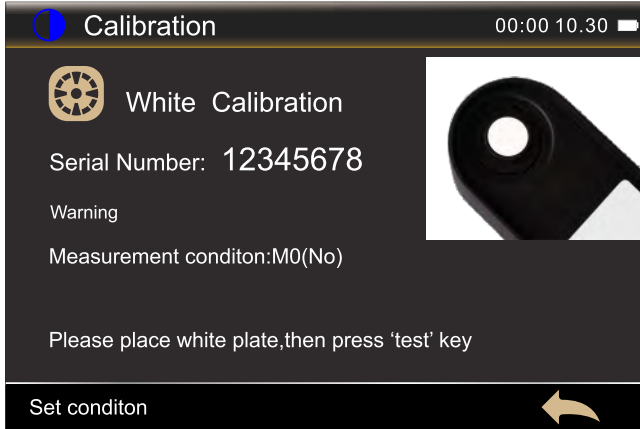


Figure 14 White calibration

2. After confirming the measurement conditions, place the whiteboard as required and press the "Test" button. During the calibration process, the words "Calibration..." appear in the lower right corner of the screen. After the whiteboard calibration is completed, the "Successful Calibration" reminder box will pop up, as shown in Figure 15 below.

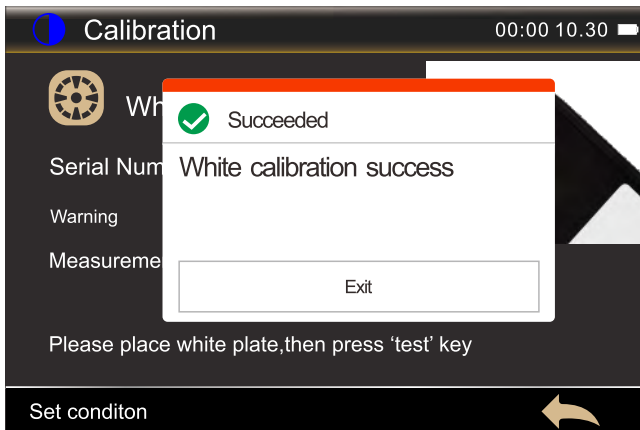


Figure 15 White calibration success

3. After the white calibration is completed, it will automatically enter the black calibration interface, as shown in Figure 16.

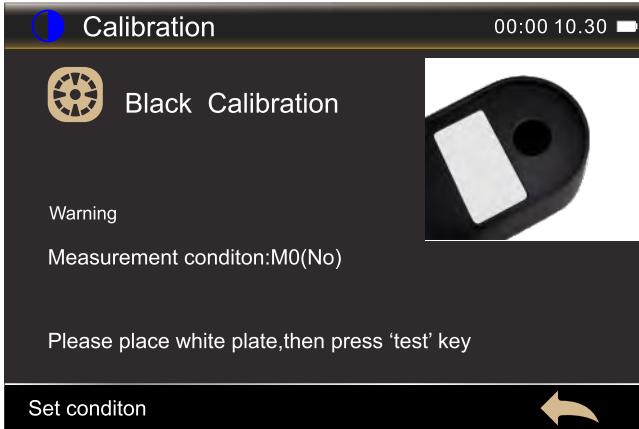



Figure 16 Black calibration

4. Place the blackboard as required and press the "Test" button. The steps are similar to the whiteboard correction. After the blackboard correction is completed, it will automatically jump to the main menu interface, giving the user a good operation convenience.

4.Basic Mode

View and edit the settings for this tool before making density/TVI measurements. Touch the setting icon "  "in the lower left corner of the density/TVI interface (Figure 17) to select the setting options you want to edit, as shown in Figure 18.

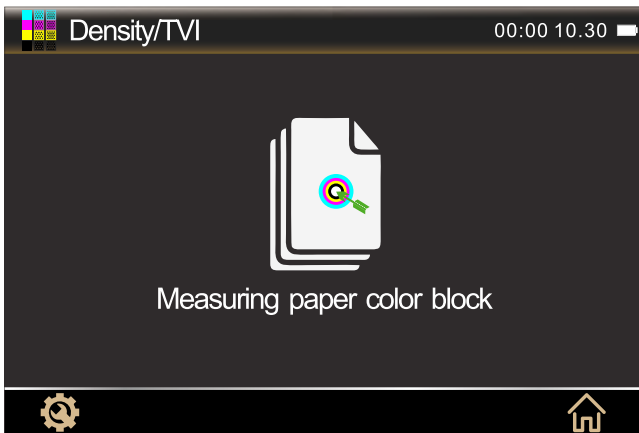


Figure 17 Density /TVI interface

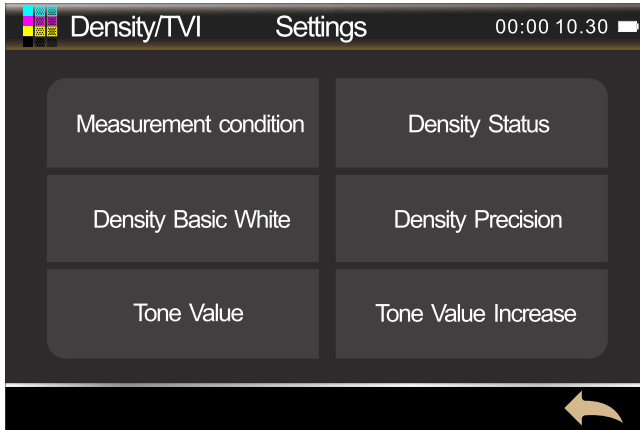


Figure 18 Setting of density /TVI measurement

Note: the density /TVI measurement Settings here affect only basic mode and do not extend to any advanced mode.

Measurement Condition

Used to select the measurement condition for colorimetric (e.g. CIE $L^*a^*b^*$) and densitometric (e.g. Density, TVI, Trapping, etc.) functions. Options are: M0, M1, M2,M3.

M0: Reflectance measured with A Illuminant, previously called: No-Filter, UV-Included.

M1: Reflectance measured with D50 Illuminant previously called: Daylight or D65-Filter.

M2: Reflectance measured with A Illuminant excluding UV component, previously called: UV Cutoff Filter, UV excluded.

M3: Reflectance measured with cross-polarized A Illuminant excluding UV component, previously called: Polarization-Filter.

Density State (Density / TVI only)

Used to select the status for all densitometric functions. Options are: Status A, E, I, and T.

Density White Base(Density / TVI Tool only)

Used to set a paper or absolute requirement. If you select Paper, as white base, all subsequent

measurements will refer exclusively to the printed ink layer, while the paper color effect will not be included. If you select Absolute, besides the printed ink layer, the measurement will also include the paper effect.

Density Precision (Density / TVI Tool only)

Used to select the density value display precision. Options are: Normal (x.xx) and High (x.xxx).

Tone Value (Density / TVI only)

Used to set the formula for dot calculation to Murray-Davies, Yule-Nielsen, or SCTV (ISO 20654). Spot Color Tone Value (SCTV) provides tone values of colors that correlate well with visual appearance. If a tone 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 YuleNielsen formula, this can be adapted for different conditions.

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

Tone Value Increased (Density/TVI only)

Used to set up to three tint patch percentages for tint measurements. Typically, these values are 25%, 50% and 75%.

4.1 Density /TVI Measurement

The Density / TVI Tool allows you to perform solid density and tint measurements without standards, by using the automatic patch recognition for CMYK.

The instrument will auto-detect the type of process color (C, M, Y, K) patch as each measurement is taken.

Density/TVI Measurement Steps:

1. Select the basic mode in the main menu interface, and tap the "density/TVI" icon to enter the density/TVI measurement interface.
2. Edit density /TVI measurement Settings
3. According to the prompt, press the measuring key lightly to complete the measurement of paper.



Figure 19 Density / TVI interface prompts measurement of paper patches

4. According to the prompt, tap the “Test” button to complete the measurement of the solid patches.

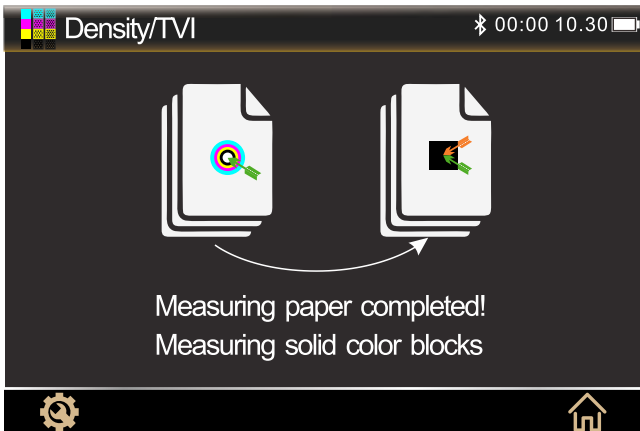


Figure 20 The density /TVI interface prompts the measurement of solid patches

5. Measure the corresponding patch or another solid patch

6. Data can be viewed after measurement (click different ink areas to view other ink values)

Note: if you touch the main menu icon, all measurements will be lost.



Figure 21 Density /TVI interface measurements

4.2 L*a*b* Measurement

The CIE-L*a*b* Tool allows you to perform spot color measurements and displays L*a*b* colorimetric data values.

L*a*b* Measuring Steps

1. Select the basic mode from the main menu interface and tap the "CIE-L*a*b*" icon to enter the L*a*b* measurement interface
2. Tap the Settings icon "⚙️" in the lower left corner. Set measurement conditions (measurement conditions/light source/observer Angle) as required.

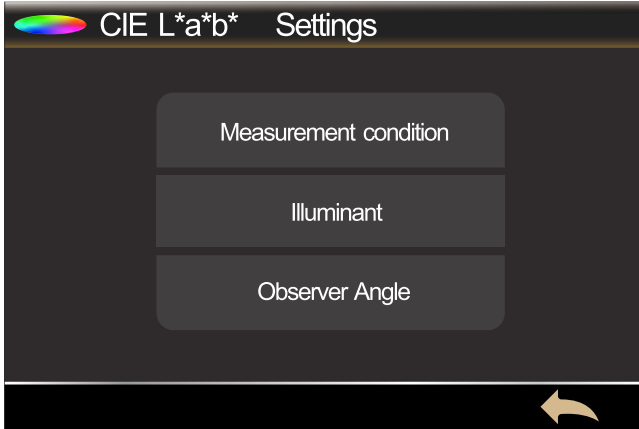


Figure 22 CIE -L*a*b* Measurement

3. Press the measuring key lightly to complete the measurement and view data.

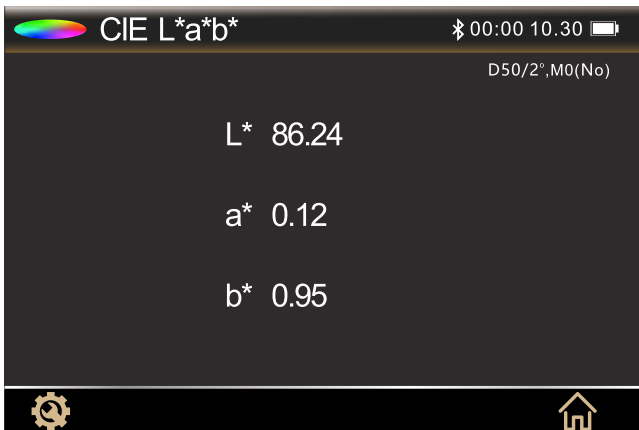




Figure 23 CIE -L*a*b*data

5 Advanced Mode

5.1 Spectrodensitometer

5.1.1 Spectrodensitometer Setting

Tap the icon “” in the lower left corner of the screen to enter the setting interface to set all functions of the spectrodensitometer. The interface for density (such as density, overprint, etc.) and color selection (CIE) is different.

The interface for setting density functions (such as density, overprint, etc.) includes: measurement condition, density status, density white base, density precision, tone value, tone value increase (dot gain) function, all densities, overprint, average measurement. Tap the icon “” at the bottom of the interface to view and edit the Settings of the density function. As shown in figure 24 and 25:

Measurement Condition

M0(No) – No Filters

M1(D50) -

M2(UVC) – UV Cut Filter

M3(Pol) – Polarization Filter

Density Status

Used to select the status for all densitometric functions. Options are: Status T, E, I, and A.

Density Basic White

Used to set a paper or absolute requirement for various density functions. If you select Paper, as white base, all subsequent measurements will refer exclusively to the printed ink layer, while the paper color effect will not be included. If you select Absolute, besides the printed ink layer, the measurement will also include the paper effect.

Density Precision

Used to select the density value display precision. Options are: Normal (x.xx) and High (x.xxx).

Tone Value

This function (also called Dot Area) provides a way to determine the absolute ink coverage (%) of a tint or halftone patch by comparing the density value of the tint patch versus known 0% (Paper/Substrate) and 100% (solid patch) density values. The result can be calculated using either the Murray-Davies, Yule-Nielsen, or SCTV (ISO 20654) methods.

Tone Value Increase Function

Set up to three tint patch percentages for tint measurements. Typically, these values are 25%, 50% and 75%, however, you can also enter custom values.

All Densities

There are CMYK and CMYK+ spot color options.

Trapping Function

Set the trapping formula. Options are: Preucil, Brunner, and Ritz.

Average Measurement

Used to set the required number of measurements to obtain an average, usually 1-99 times.

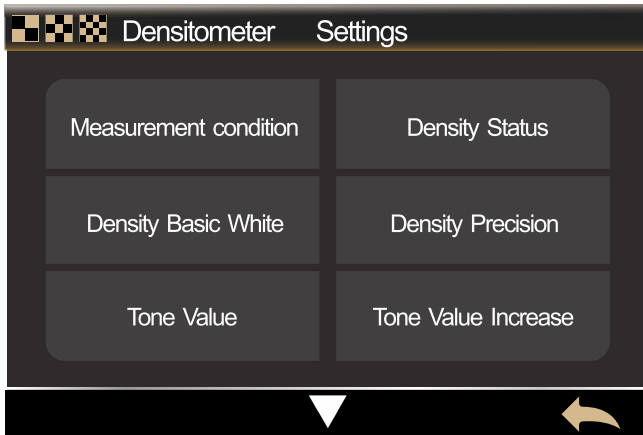


Figure24 Spectrodensitometer for density function Settings interface 1

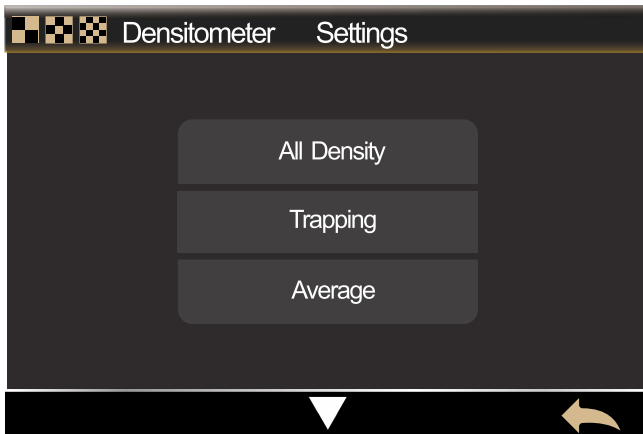


Figure 25 Setting Interface of Densitometer 2

The Settings for selecting the colorimetric function include: measurement condition, light source, observer angle, average measurement. See figure 26.

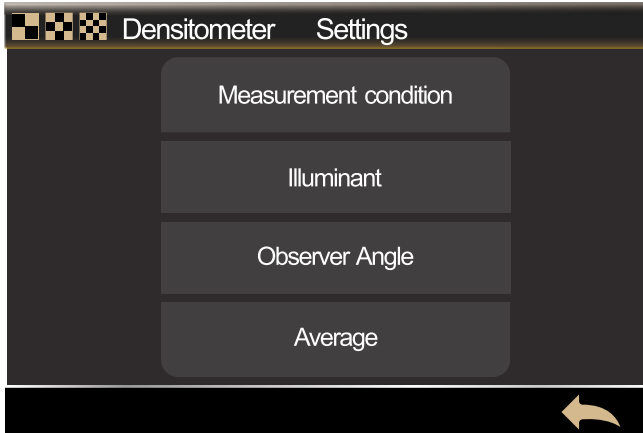


Figure 26 Setting interface for color function selection

Light Source

For selecting the light source options, the light source includes D65, D50, D55, D75, A, C, F1, F2, F3, F4, F5, F6, F7, F8, F9, F10, F11, F12. (**note:** some models only have some light source options.)

Observer Angle

The observer Angle option includes 2° and 10°.

5.1.2 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 "  " 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 27 Set the 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. Set measurement condition.
2. According to the setting of the density white base, select the light touch icon “”
 1. to measure the paper color block.
2. Select density condition.
3. Set density color (auto or spot color, etc.).
4. Measure sample.
5. Finish measurement and view data.

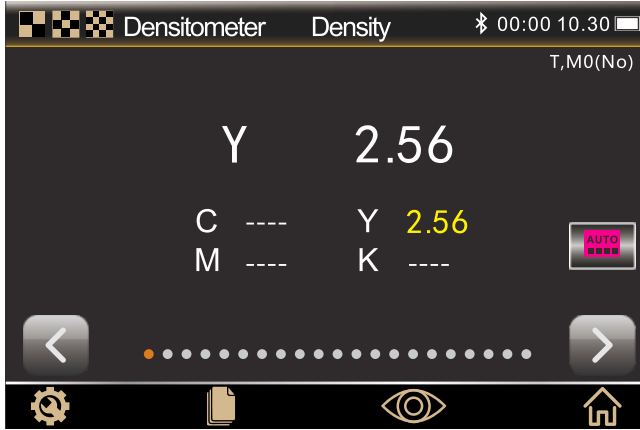


Figure 28 Density Interface

5.1.3 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.

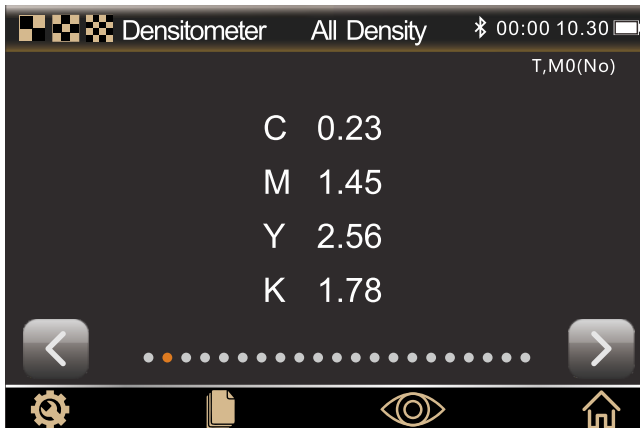


Figure 29 All Densities Interface

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 options are: CMYK and CMYK+SPOT.

5.1.4 Tone Value Function



This function is also called Dot Area. It is to point to the sum of all dot area 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, Yule-Nielsen, or SCTV (ISO 20654) methods.

Spot Color Tone Value (SCTV) provides tone values of colors that correlate well with visual appearance. If a tone 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 Yule-Nielsen formula, this can be adapted for different conditions. When Yule-Nielsen formula is selected for the color, you set the coefficient.

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

Tone Value Measurement

Displays tone value for the selected color. 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.

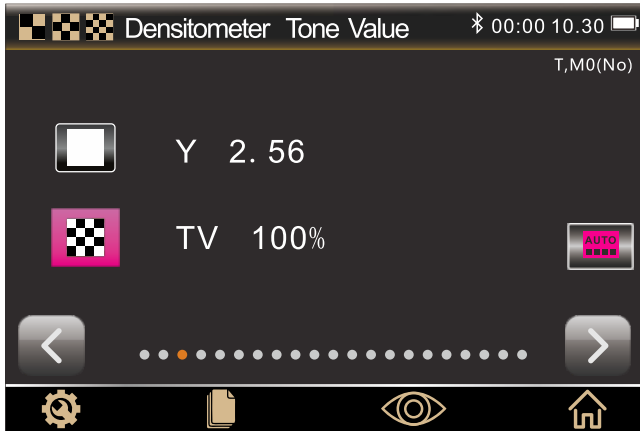


Figure 30 Tone Value Interface

5.1.5 Tone Value Increase Function

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

Tone Value Increase Measurement

Displays tone value increase for the selected color. The TVI settings define how many tint patches are used.

1. Select Tone Value increase (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 tonal value increase (dot gain) data for the tint patches.

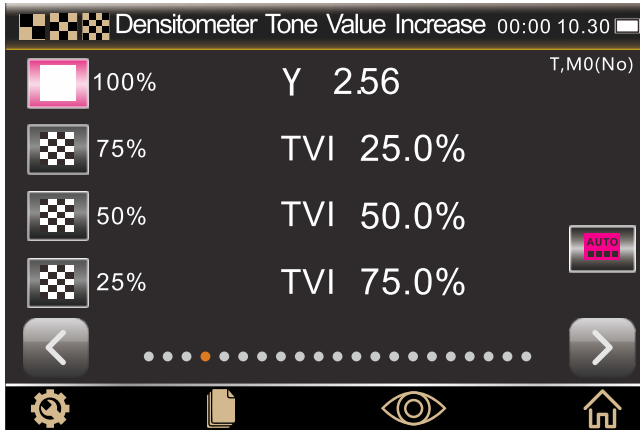


Figure 31 Tone Value Increase Interface

5.1.6 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 Spot setting 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 32 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.

5.1.7 Print Characteristics

This function plots out a series of tone 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 arrows "◀" "or" "▶" on either side of the graph, 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.

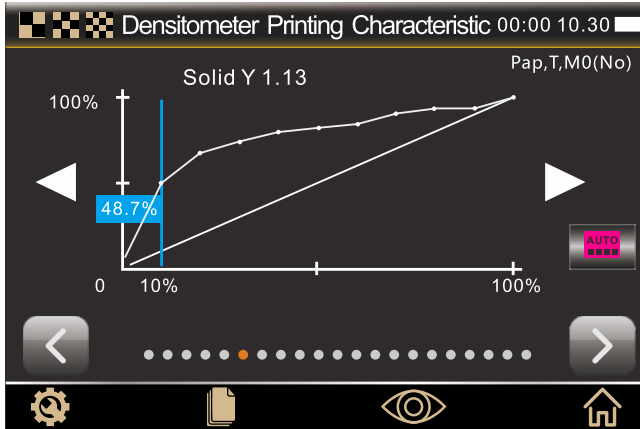


Figure 33 Print Characteristics Interface

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 “ ▶ ”

5.1.8 Print Contrast Function

This function is used to control the image to dark tone 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.

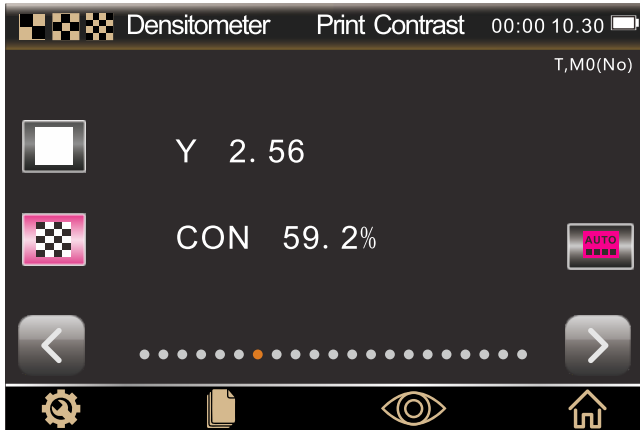


Figure 34 Print Contrast Interface

5.1.9 Hue Error and Grayness Function

Hue error is due to the ink color is not pure, so that the selection of the spectrum of malabsorption, resulting in no 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.

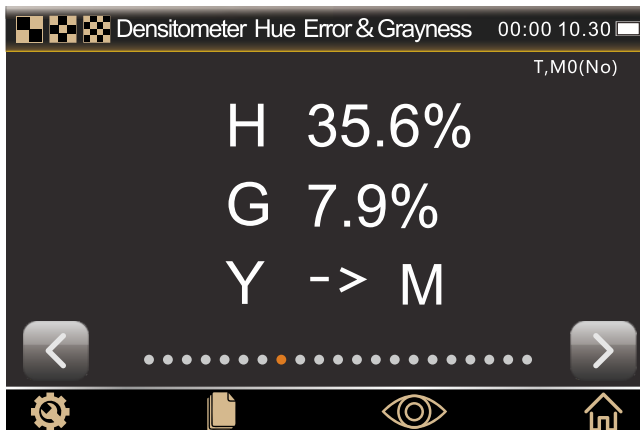


Figure 35 Hue Error and Grayness Interface

Hue Error and Grayness Measurement

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

5.1.10 CIE Chroma Function Series

CIE L*a*b*

This feature is based on how the human eye perceives color in an effort to be perceptually uniform. The date describes all the colors that a person with normal vision can see. L* indicates lightness. a* indicates the range from red to green. b* indicates the range from yellow to blue.

D+CIE L*a*b*

This function allows you to view a density result as well as L*a*b* values in the same results area. The modes (Auto and Spot) will display either the dominant process ink (C, M, Y, or K) or the dominant spectral density response.

CIE L*C*h*

This function is a colorspace equivalent to CIEL*a*b*, the main difference is that in L*a*b* the color values are plotted in a Cartesian coordinate system, while L*C*h* is polar coordinate system. L* stays the same, but C* refers to chroma and h* is the hue angle.

D+CIE L*C*h*

This function allows you to view a density result as well as L*C*h* values in the same results area. Setting density color will display either the dominant process ink (C, M, Y, or K) or the dominant spectral density response.

CIE XYZ

CIE assumes the theoretical three primary colors XYZ and accordingly forms the XYZ color space, which is based on the direct measurement of human color vision and serves as the defining basis for many other color Spaces. Y stimulus value represents the brightness of the color, also represents the chromaticity. The X and Z stimuli only represent chromaticity, not brightness. The tristimulus value of the measured color is the number of primary colors in the additive pattern required to match the test color.

CIE Yxy

This function is directly derived from XYZ values. Y still represents luminance or brightness of a color. The x and y are calculated from the XYZ values. It is color coordinate of color.

CIE Function Measurement:

1. Select colorimetric functions CIE $L^*a^*b^*$, CIE $L^*C^*h^\circ$, Density + $L^*a^*b^*$, Density + $L^*C^*h^\circ$, BestMatch, BestMatch Table or Delta E Trend.
2. Tap the setting icon "⚙️" in the lower left corner to enter the setting and editing interface (refer to section 5.1.1 for details)
3. Measure sample.
4. View data.

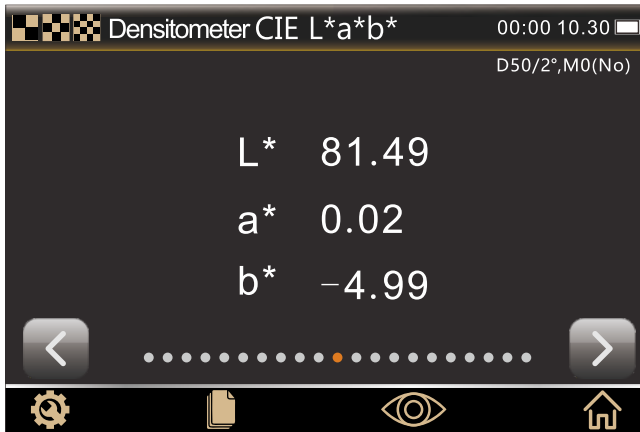


Figure 36 CIE lab Interface

5.1.11 Printing Plate Function

This function is used to determine the dot area coverage of a tint or halftone patch on a printing plate.

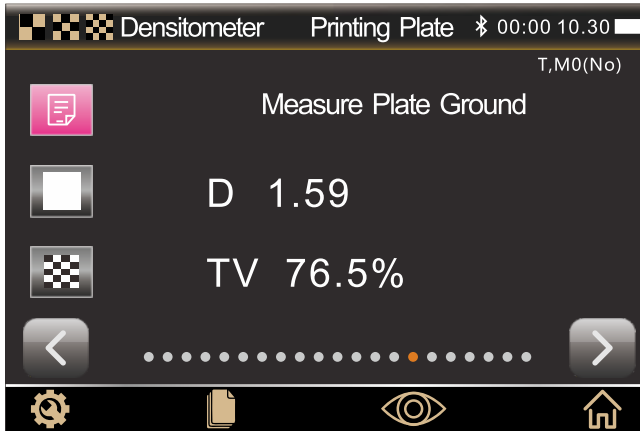




Figure 37 Printing Plate Interface

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.

5.1.12 Reflectance Graph

This function visually displays the reflectivity of measured data in the form of a graph. Sample and standard are displayed with different colors: sample in white, standard in blue.

By tapping the “” or “” button, the light wave wavelength, sample reflectance and sample reflectance difference of the current test sample (in the basic comparison module) are switched at intervals of 10nm.

Reflectance Graph Measurement

1. Select Reflective Graph function.
2. Measure sample.
3. View data.

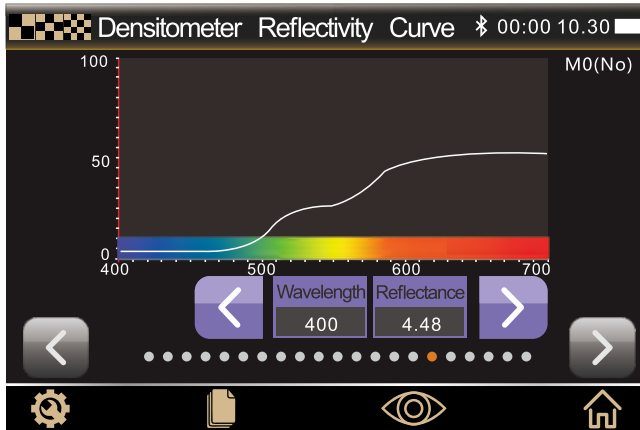



Figure 38 Reflectance Curve Interface

5.1.13 Paper Parameter (Partial Models Include)

Paper parameter (partial models include) this function can report yellowness, whiteness data. Display 1 to 4 lines of data according to function Settings.

Paper parameter setting:

Touch the icon “” in the lower left corner of the paper parameter measurement interface to select the paper parameters that appear after the test, as shown in figure 39.

Yellowness: used to evaluate white and near-white samples. These samples yield numbers which correlate with visual rating of yellowness and near-white samples. These samples yield numbers which correlate with visual rating of yellowness.

Whiteness: used to evaluate white and near-white samples. These samples yield numbers which correlate with visual rating of whiteness.

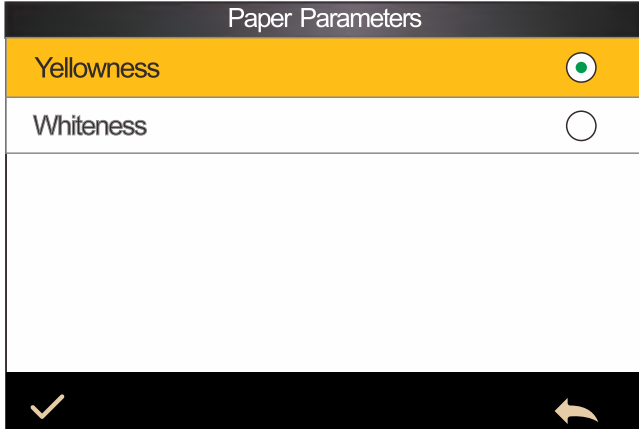


Figure 39 Paper Parameters Interface

Paper Parameter Measurement

1. Select Paper Indices function.
2. Measure paper sample.
3. View data.

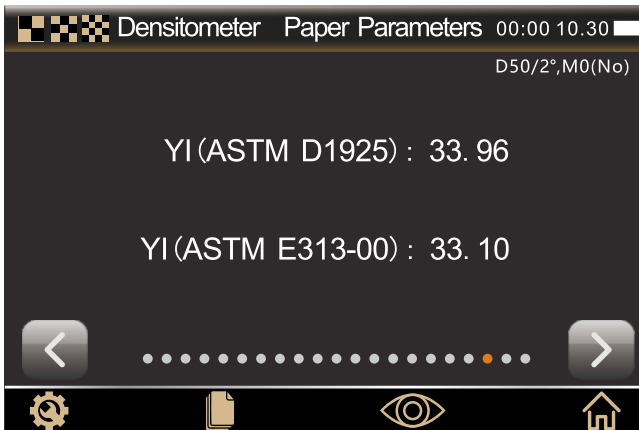


Figure 40 Paper Parameters Interface

5.1.14 Color Intensity (Partial Models Include)

The absolute color strength “K/S” is a measure for the concentration of a color.

To determine the color strength, you must first choose one of the available calculation methods:
Max K/S: K/S is calculated at Point of minimum reflectance in the spectral curve.

Mean XYZ: Calculates color strength by average mean XYZ values across the visible spectrum.

Next, select the type of ink that is used to determine the color strength. You can choose Transparent ink, Opaque ink or Textile dye.

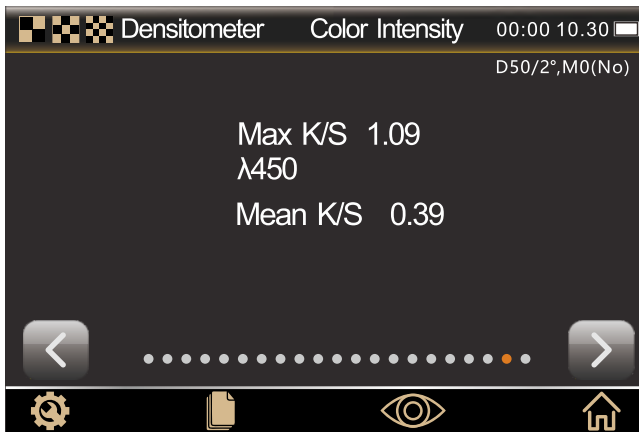


Figure 41 Color Intensity Interface

Color Strength measurement

1. Select color strength function
2. Measure paper if required.
3. Measure the sample.
4. View data.

5.1.15 Opacity Measurement (Partial models Include)

This function is used to determine how opaque a given ink or material is. It looks at how different the luminance (Y from CIE XYZ) of a given sample changes when printed over a white or black substrate. Once the ink is measured over both substrates, the opacity % result is provided (0 = completely transparent, 100% = completely opaque).

Opacity Measurement:

1. Select the opacity function
2. Measure the sample over the black portion of the opacity card.
3. Measure the sample over the white portion of the opacity card.
4. View data.

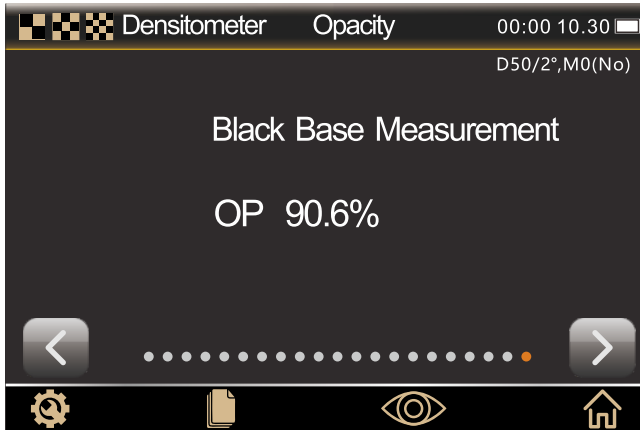



Figure 42 Opacity Interface

5.2 Basic Comparison

Basic comparison is another module of the advanced model, with one more measurement standard than the density meter. Basic comparison is a quick way to compare standard samples and samples without storing data.

5.2.1 Basic Comparison Settings

Click the icon in the lower left corner of the screen to access all the functions of basic comparison “”. Apart from the setting interface of density function (e.g.: density, overprint, etc.) and color selection function(e.g.:CIE function), the setting interface of other functions is also slightly different.

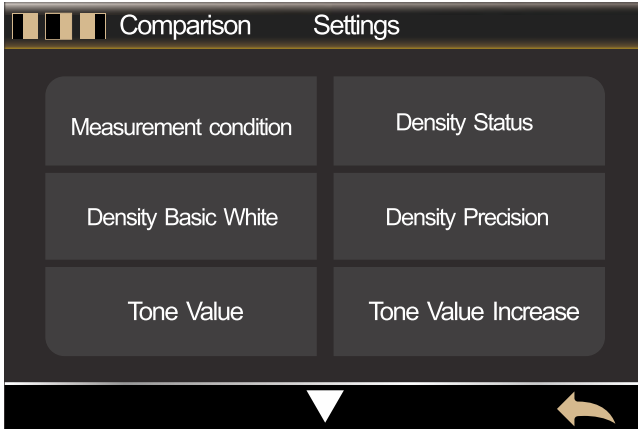


Figure 43 Comparison Setting Interface 1

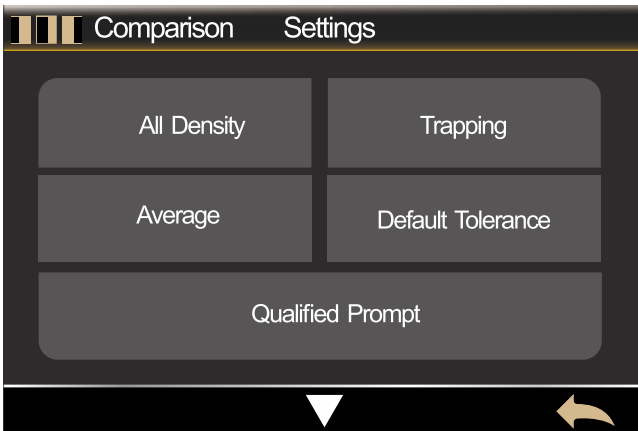


Figure 44 Comparison Setting Interface 2

The density function setting interface in basic comparison mode has two more items than that of the density meter: default tolerance and qualified and unqualified prompt.

And it has four more options than the densitometer's color selection interface:

Chromatic aberration formula, color deviation, default tolerance, qualified and unqualified prompt.

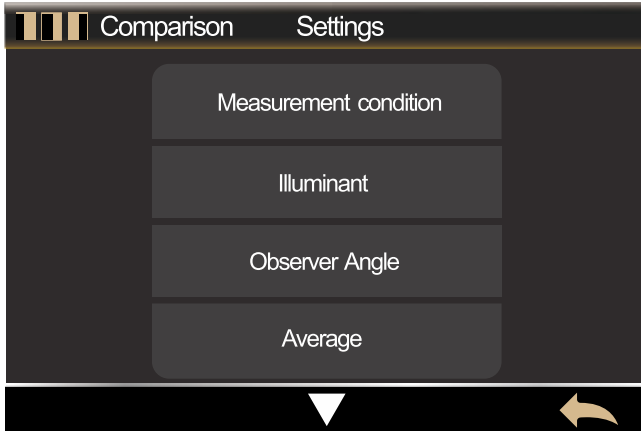


Figure 45 Comparison Setting Interface 3

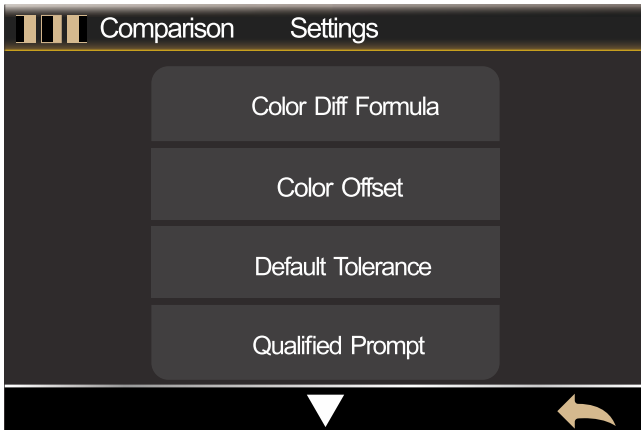


Figure 46 Comparison Setting Interface

Color difference formula: the user can choose ΔE^* , ΔE_{cmc} (2:1), ΔE_{94} formula.

Color deviation: when comparing the sample with the standard, you need to turn on the color deviation in the Settings interface, so that there will be a hint of color deviation.

Default tolerance: The default Settings ΔE^* , $-\Delta L^*$, $+\Delta L^*$, $-\Delta a^*$, $+\Delta a^*$, $-\Delta b^*$, $+\Delta b^*$ values, it provides the basis for the comparison between the sample and the standard.

Pass/Fail indication: The pass/fail prompt will show a difference depending on the type of each function and tolerance. If the currently measured sample value exceeds the incremental value of the set tolerance, "Failed" will be displayed next to it.

5.2.2 Basic comparative measurement

To make a basic comparison, the first step is to set the criteria against which each subsequent measurement will be compared. If necessary, the standard sample can be re-measured.

Basic comparative measurement:

1. Tap the "basic comparison" icon on the screen in advanced mode to enter the basic comparison interface (take density function as an example)



Figure 47 Comparison - Density interface

2. Tap "standard" to enter the measurement standard interface
3. Measure the standard or select the standard that has been measured

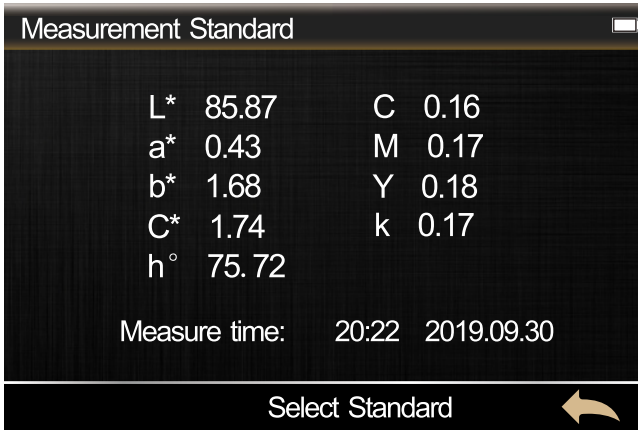


Figure 48 Measurement Standard Interface

If you need to select a standard, jump to the standard record interface, you can delete the record, edit the name, standard call, etc. for the selected standard record.

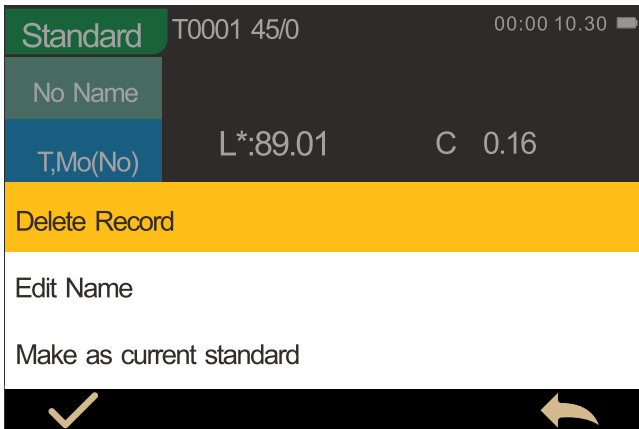



Figure 49 Select Standard record

4. After selecting the required standard, tap the return icon to return to the basic comparison interface “  ”, Return to the basic comparison interface.
5. If necessary, tap “Paper” and measure the paper.
6. Tap “View” to select the option function used for comparison.
7. Measuring samples.
8. View measurement comparison results.
9. Continue with other sample measurement comparisons or choose to change color options or criteria for comparison.

5.2.3 CMY Balance

This function is used to compare a Gray Balance Patch to a defined standard with easy to read graphical indication. This function requires a standard with target CMY density values plus a tolerance function setting.

Above the result is the absolute CMY density value and relative difference of the sample. Below the result area is a bar graph showing the delta difference for each ink compared to the target value. The center line of the graph represents the target value, and the bars in both directions indicate that the density value of the sample is higher or lower than the target value. The goal of this function is to determine that all three CMY densities of the sample meet the tolerances around the target and the sample can still be considered gray.

CMY Balance Measurement

1. Select CMY Balance function.
2. Measure paper if required.
3. Measure the gray balance standard.
4. Measure sample.
5. View data.

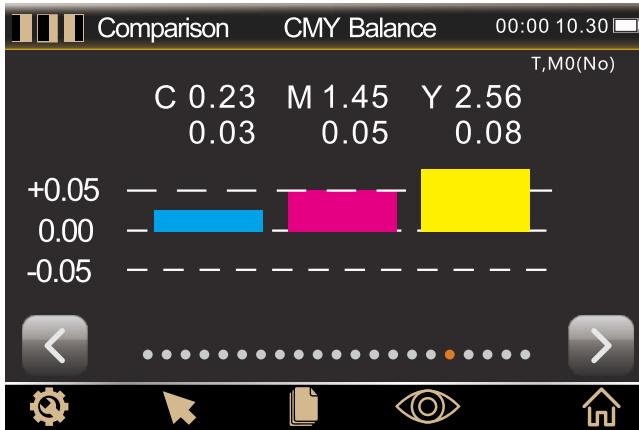



Figure 50 Comparison of CMY balance Interface

5.2.4 Metamerism

The phenomenon where two colors appear to match under one light source (ΔE deviation is small), yet do not match under different light sources (the ΔE deviation is relatively large). Two such colors are called a metamerism pair.

Metamerism Function Setting

The metamerism function setting is slightly different from the other basic comparison settings for selecting the chroma function. Touch the setting icon “” on the left side of the metamerism function interface to set the light source/view combination, as shown in Figure 51.

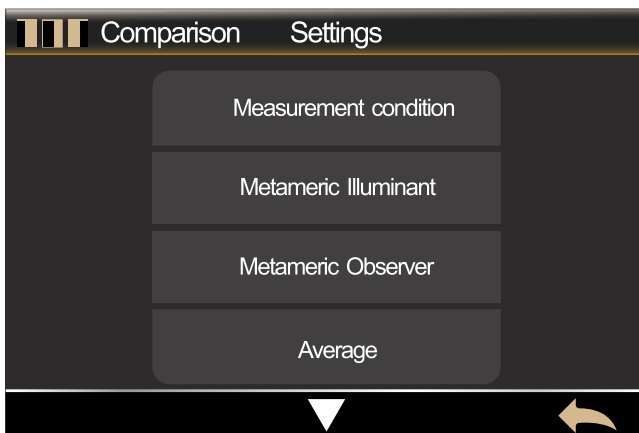


Figure 51 Comparison Setting Interface 1

Metamerism Measurement:

1. Select the metamerism function in the basic comparison mode.
2. Measure or select a standard.
3. Measure the sample.
4. View measurement results.

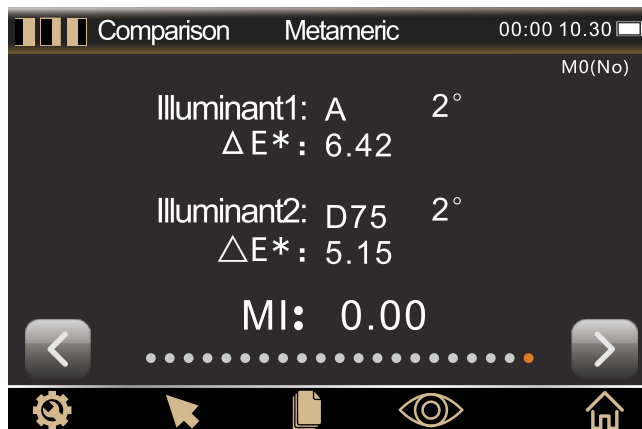


Figure 52 Metameric Interface

6 System Settings

System settings mainly include setting and calibrating two functional modules.

6.1 Setting

Set to the instrument settings here, including language settings, time settings, Bluetooth (some models are available), buzzer, calibration expiration date, factory reset, screen sleep, screen brightness, operating habits, and instrument selection.

1. Language setting: Select "Language Setting" to enter the language setting interface. Users can select the display language according to their needs, and set the instrument language to any of English, Simplified Chinese and Traditional Chinese.

2. Time setting: Select “Time Setting” to enter the time setting interface. The user selects the object to be set according to the need, then touch “ ✓ ” to enter the corresponding setting interface. If you do not want to set the modification time, date, format, touch “ ← ” to return to the instrument setting interface.

3. Bluetooth (some models have): Set the Bluetooth function by selecting Off or On.

4. Buzzer: Also set the buzzer function by selecting to turn off or on.

5. Calibration Validity Period: Select “Calibration Validity Period” to enter the calibration validity period setting interface, including three options: power-on calibration, 12 hours, and 24 hours. Users can select setting options as needed.

6. Restore factory settings: Select “Restore Factory Settings” to enter the factory reset interface, confirm this function and then touch “ ✓ ” to restore the instrument to the factory state.

7. Screen sleep: Select “Screen Sleep” to enter the screen backlight time setting interface, including five options: normally open, 5 minutes, 60 seconds, 30 seconds and 15 seconds. The user can select the setting options as needed. The instrument will automatically shut down after 5 minutes of operation.

8. Screen brightness: Select “Screen Brightness” to enter the screen brightness setting interface, and lower or increase the screen brightness by tapping “ - ” or “ + ”. The user can adjust according to the actual situation. After the adjustment is completed, touch “ ✓ ” to save the settings, and click “ ← ” to cancel the save.

9. Operating habits: Users can choose the right or left hand to operate the instrument according to their own operating habits.

10. About the instrument: Select “About the instrument”, enter the instrument interface, view the relevant information of the instrument, including product model, software and hardware version information, etc.

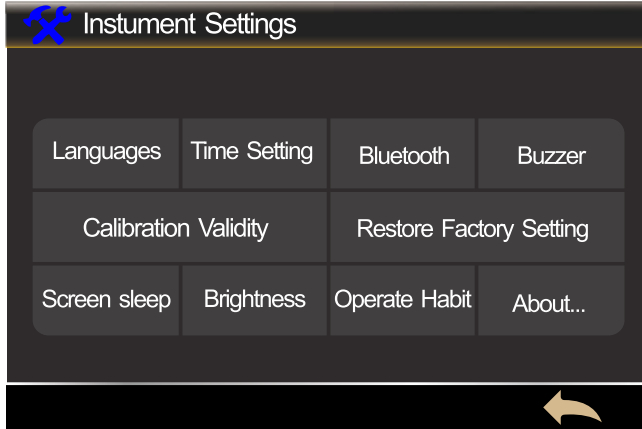


Figure 53 Instrument Settings Screen

6.2 Calibration

This instrument is equipped with a calibration box and requires calibration before measurement. Enter the calibration interface from the system settings in the main menu. For detailed calibration steps, refer to section 3.6.

7 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 color meter instrument and the whiteboard are recommended to be tested by the manufacturer or a qualified metrology institute for one year

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 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.

8 Technical Specifications

Grating Spectrophotometer Densitometer		
Model	Standard	Advanced
Measurement Geometry	45/0(45 ring-shaped illumination, 0 degree viewing angle);	45/0(45 ring-shaped illumination, 0 degree viewing angle);
	standard ISO 5-4, CIE No.15	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; able to customize single aperture $\Phi 2\text{mm}$, $\Phi 4\text{mm}$, $\Phi 8\text{mm}$.	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; able to customize single aperture $\Phi 2\text{mm}$, $\Phi 4\text{mm}$, $\Phi 8\text{mm}$.
Light Source	Combined LED Light, UV Light	Combined LED Light, UV Light
Spectral separation device	Concave Grating	Concave Grating

SPECTRODENSITOMETER OPERATING MANUAL

Detector	256 Image Element Double Array CMOS Image Sensor	256 Image Element Double Array CMOS Image Sensor
Wavelength Range	400~700nm	400~700nm
Wavelength Pitch	10nm	10nm
Half Bandwidth	10nm	10nm
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)	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	ISO Status T, E, A, I
Density index	Density value, density difference, dot area, dot enlargement, overprint, printing characteristics, printing contrast, tone error and gray level	Density value, density difference, dot area, dot enlargement, overprint, printing characteristics, printing contrast, tone error and gray scale, density scanning
Measurement aperture	Customized one aperture: Φ 2mm, Φ 4mm, Φ 8mm optional	Customized one aperture: Φ 2mm, Φ 4mm, Φ 8mm optional
Color Spaces	CIE LAB, XYZ, Yxy, LCh	CIE LAB, XYZ, Yxy, LCh, CIE LUV, Hunter LAB,
Color Difference Formula	ΔE^*ab , ΔE^*94 , ΔE^*00	ΔE^*ab , ΔE^*94 , ΔE^*00 , ΔE^*uv , $\Delta E^*cmc(2:1)$, $\Delta E^*cmc(1:1)$, $\Delta E(\text{Hunter})$
Other Colorimetric Index	/	WI (ASTM E313, CIE/ISO, AATCC, Hunter), YI (ASTM D1925, ASTM 313), MI (Metamerism Index), Opacity,
Observer Angle	2° /10°	2° /10°
Illuminants	A, C, D50, D55, D65, D75, F2, F7, F11, F12	A, C, D50, D55, D65, D75, F2(CWF), F7(DLP), F11(TL84), F12(TL83/U30), F1, F3, F4, F5, F6, F8, F9, F10(TPL5)
Measurement Time	About 1.5s	About 1.5s

SPECTRODENSITOMETER OPERATING MANUAL

Repeatability	Density: Within 0.01 D Chromaticity value: within ΔE^*ab 0.04 (When a white calibration plate is measured 30 times at 5 second intervals after white calibration) Except M3	Density: Within 0.01 D Chromaticity value: within ΔE^*ab 0.03 (When a white calibration plate is measured 30 times at 5 second intervals after white calibration) Except M3
Inter-instrument Error	Within ΔE^*ab 0.2 (Average for 12 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)	Single Measurement, Average Measurement (2-99)
Size(L*W*H)	184*77*105mm	184*77*105mm
Weight	About 600g	About 600g
Power source	Li-ion battery. 5000 measurements within 8 hours	Li-ion battery. 5000 measurements within 8 hours
Illuminant Life Span	5 years, more than 3 million times measurements	5 years, more than 3 million times measurements
Display	3.5-inch TFT color LCD, Capacitive Touch Screen	3.5-inch TFT color LCD, Capacitive Touch Screen
Interface	USB	USB, Bluetooth 4.0
Data memory	10000 pcs	20000 pcs
Language	Simplified Chinese, English, Traditional Chinese	Simplified Chinese, English, Traditional Chinese
Working Environment	Temperature: 0~40° C; Humidity: 0~85% (No Condensation); altitude: less than 2000 m	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)	Temperature: -20~50° C; Humidity: 0~85% (No Condensation)
Standard Accessory	Power Adapter, USB Cable, Built-in li-ion battery, User Manual, software (download from the website), White and Black Calibration Board, Protective Cover, Polarization filter box, Locating Plate.	Power Adapter, USB Cable, Built-in li-ion battery, User Manual, software (download from the website), White and Black Calibration Board, Protective Cover, Polarization filter box, Locating Plate.

Optional Accessory	Micro Printer	Micro Printer
Notes:	The specifications are subject to change without notice.	

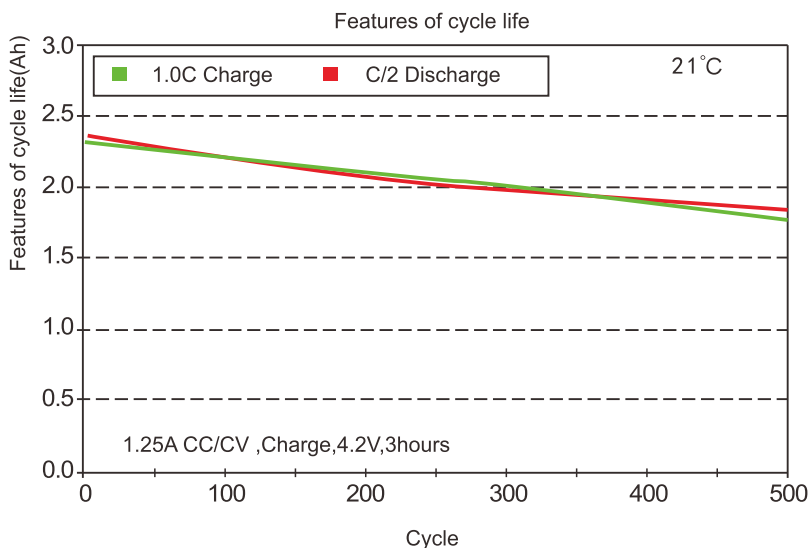
Appendix 1

Battery charging matters needing attention

The battery pack of the new instrument has a low to moderate charge, which should be charged for at least three hours before use. If you don't use a battery pack for a long time, you will eventually lose some of the charge of the battery pack. Please charge the battery frequently. If not in use, please store the battery in a cool place to maintain the battery performance.

Battery life expectancy

After 400 charge cycles, lithium-ion batteries typically lose 80% of their charge (see chart). A charging cycle can be defined as several partial charging to make the total amount of electricity reach 100%. Partial charge and discharge cycle help to extend battery life, please try to avoid the mode of full charge and discharge cycle. After about 400 charge cycles, the amount of measurement available through a full charge will be reduced. At this point, consider replacing the battery.



Waste battery treatment

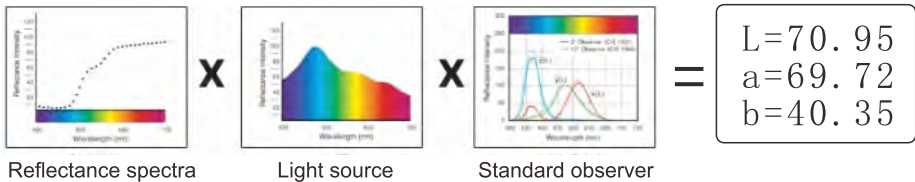
Please give the battery pack to the designated recycle bin.

Appendix 2

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.



2. Color difference formula

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

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

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

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

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

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

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

$$L' = L^*$$

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

$$b' = b^*$$

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

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. Judgment of color cast

ΔL large (positive) means white, ΔL small (negative) means black

Δa large (positive) means reddish, Δa small (negative) means greenish

Δb large (positive) means yellowish, Δb small (negative) means blueish

4. The human eye distinguishes color

The color difference unit of NBS is derived based on the unit of the color difference calculation formula established by Judd-Hunter. In 1939, the National Bureau of Standards adopted the color difference calculation formula and calculated according to this formula. The color difference

of color, when the absolute value is 1, it is called "NBS color difference unit". The new color difference formula developed later often consciously adjusts the unit to be close to the NBS unit. For example, the units of the color difference formulas such as Hunter Lab and CIE LAB and CIE LUV are roughly the same (not equal) to the NBS unit. Therefore, do not misunderstand that the color difference units calculated by other color difference formulas are all NBS.

NBS unit and sensory color difference

NBS unit	Sensory color difference
0.00~0.50	(small color difference) feels very small (Neglectable)
0.50~1.50	(small color difference) feels slightly (slight)
1.5~3	(smaller chromatic aberration) feels noticeable (noticeable)
3~6	(larger color difference) feels obvious (appreciable)
>6	(large color difference) feels strong (much)

