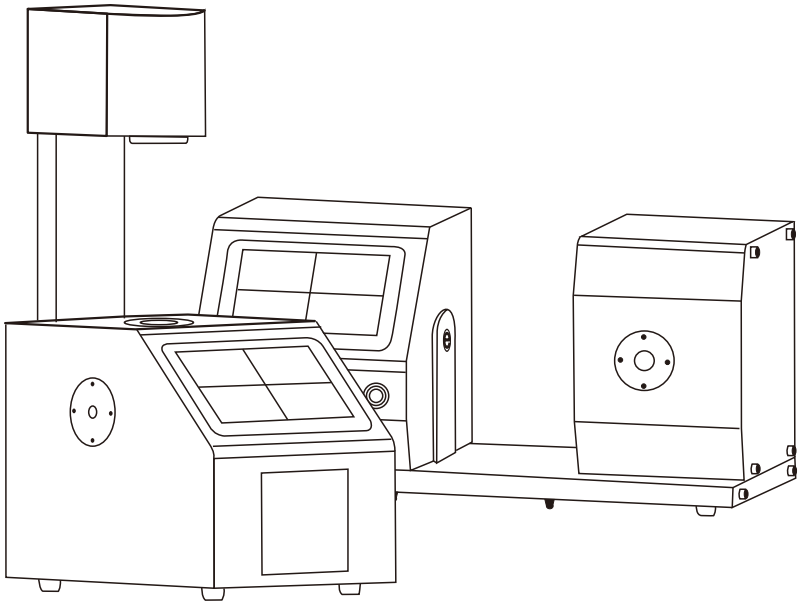
Chromatic Haze Meter

OPERATION MANUAL



V1.0

Please read the instructions carefully before using the instrument to avoid damage due to operation errors

Content

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 relating to the risk of electric shock. Read these instructions carefully to use this instrument safely and correctly.

This symbol is a description relating to fire danger. Read these instructions carefully to use this instrument safely and correctly.

Represents an operation that is prohibited. This operation must not be performed.

Represents an instruction. The instruction must be strictly performed.

Represents an operation that is prohibited.Do not dismantle the instrument.

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

Cautions

- It is strictly prohibited to copy or copy all or part of this manual without authorization of the Company.
- Contents of this manual are subject to change without prior notice.
- When compiling this manual, we have made our best efforts to ensure the accuracy of its contents.If you have any questions or find any errors, please contact your reseller or our authorized repair agency.
- The company does not assume any responsibility for any consequences caused by improper use of the instrument.

Safety Norms

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

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

	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 hands to plug and unplug the AC adapter plug, otherwise it may cause electric shock. 5.Do not continue to use the instrument if it or AC adapter is damaged, smoking or smells, or it may cause fire. In this case, turn off the power immediately, unplug the AC adapter from the AC socket, and contact the nearest authorized service provider. 6.Do not measure directly at the face at the sample measurement port, as this may damage the eye. Do not place the instrument on an unstable or inclined surface as this may cause the instrument to slip or tip over and cause injury.

	1.Be sure to always use the standard or optional AC adapter and connect it to an AC socket with rated voltage and frequency. If you use other AC adapters that are not specified, you may damage the instrument, or you may cause fire or electric shock. 2.Be careful not to get your hand stuck in the cavity of the instrument, otherwise it may get stuck and cause injury.
	1.Do not disassemble or modify the instrument or AC adapter by yourself, otherwise it may cause fire or electric shock.
	1.If the instrument is not used for a long time, please unplug the AC adapter from the AC socket.If there are dust or water stains on the AC adapter pins, clean them before use, otherwise they may cause fire or electric shock. 2.When pulling the AC adapter plug from the AC socket, be sure to hold the plug itself at all times to avoid pulling the power cord, which may damage the power cord and cause fire or electric shock.

Operating Environment

- Please use the instrument at ambient temperature between 0°C and 40°C without condensation. Do not use it in areas with drastic temperature changes.
- Do not place the instrument in direct sunlight or near a heat source such as a furnace.In this case, the internal temperature of the instrument may be higher than the ambient temperature.
- Do not use the instrument in the environment with dust, cigarette or chemical gases, otherwise it may cause performance degradation and even system collapse.
- Do not use the instrument near devices that generate strong magnetic fields such as loudspeakers.
- The instrument and its standard AC adapter are designed for indoor use only.Do not use the equipment outside because rain or other factors may damage it.

Power

- Ensure that the power switch is set to "0" when the instrument is not in use.
- Be sure to always use the standard AC adapter and connect it to an AC socket with rated voltage and frequency.

Overview

The chromatic haze meter is independently developed by 3NH, with full independent intellectual property rights. It designed with CIE regulations transmission geometry optical structure transmission 0 / D (parallel light illumination, diffuse reflection receiving), the instrument can easily achieve ASTM D1003 non-compensated method, ISO 13468 compensation method, full transmittance, haze test, clarity measurement, and chromatic data comparison.The transmittance spectral curve of transmittance samples can be accurately collected, and various chromatic data of transmittance samples can be accurately output. The instrument has two structures, vertical and horizontal, with high hardware configuration and open measurement area. It is widely used in glass processing, film processing, display processing, lens processing, liquid pharmaceutical liquid analysis, food hygiene, plastic processing, etc.

Cautions

1）This instrument is a precision optical measuring instrument. During measurement, drastic changes in the external environment of the instrument should be avoided, such as the flashing of ambient light and rapid changes in temperature, etc.

2）During measurement, the instrument should be kept stable, the measured object should be placed on the measuring platform, and the test port should be aligned to avoid moving.

3）The instrument is not waterproof, can not be used in high humidity environment or water mist.

4）Keep the instrument clean and tidy, avoid water, dust and other liquid, powder or solid foreign matter entering the integrating sphere and the instrument, and avoid the impact and collision of the instrument.

5）After the instrument is used, the power should be cut off, the instrument and accessories should be placed in the instrument case, and stored in a dry, cool environment.

6）The user must not make any unauthorised changes to the instrument, any unauthorised changes may affect the accuracy of the instrument or even irreversibly damage the instrument.

Ⅰ. System Layout

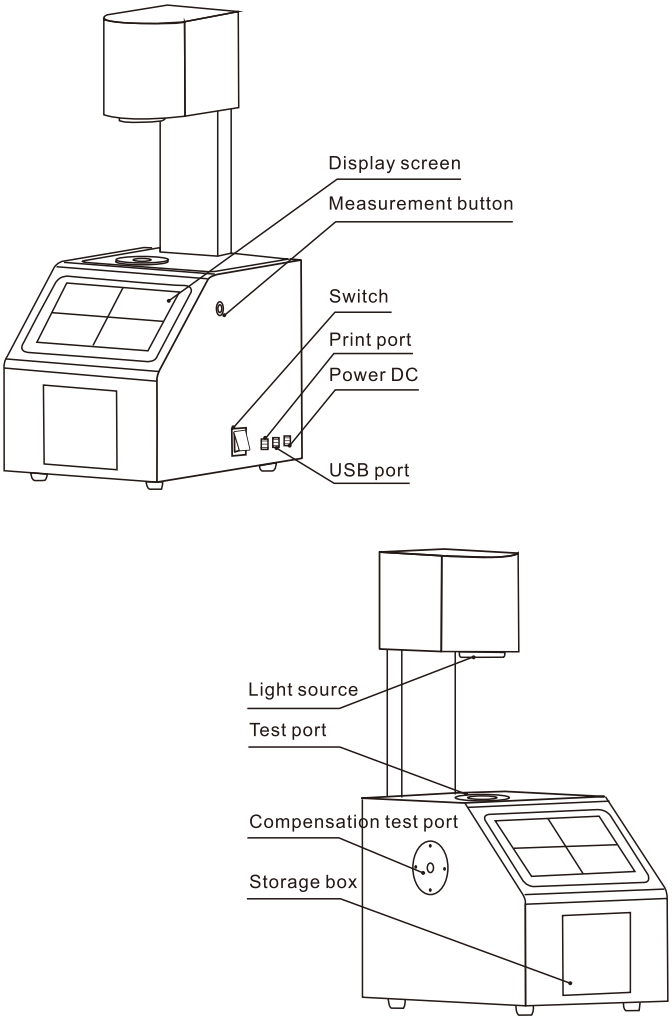


Figure 1 Keys & Ports on Vertical type

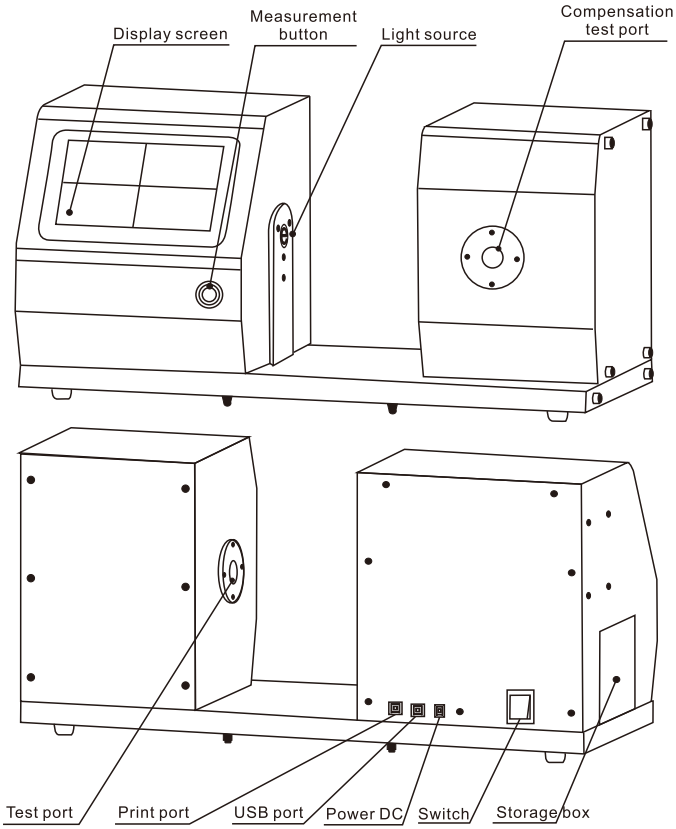


Figure 1-1 Keys & Ports on Horizontal type

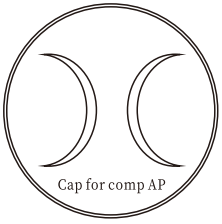


Figure 2
Cap for compensate

Figure 2-1
0% Calibration Cap

Figure 2-2
Clarity Calibrating Sheet

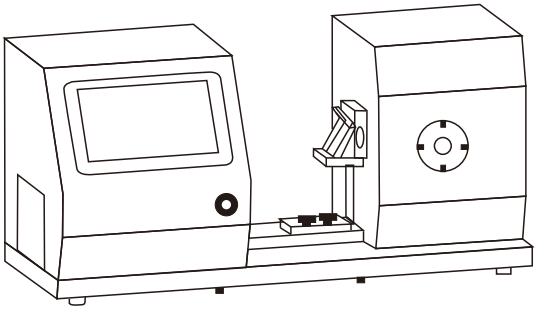


Figure 3 Cuvette Holder

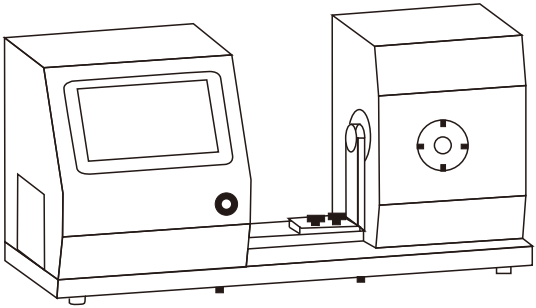


Figure 3-1 Film Holder

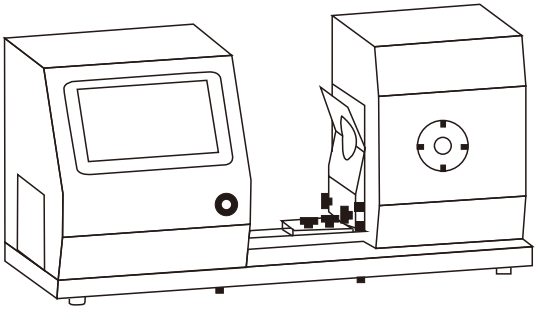


Figure 3-2 Plate Holder

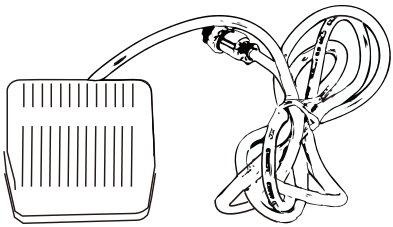


Figure 4 Pedal Switch

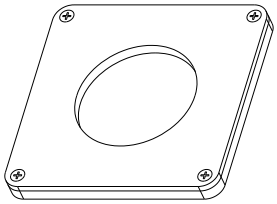


Figure 5 Standard Haze Sheet

Display: 7 inch TFT Touch Panel, Touch screen operating system.

Meas Button: In standby mode, press the Meas button to wake up the system; in working mode, press the meas button to start the measurement. The meas button is surrounded by an annular LED indicator, and the LED indicator is green. Power on the instrument (connect with the power adapter, switch toggle to "1"), the indicator light is on. The green light flashes during the measuring process and is always on when the measurement is completed.

Power switch: Set the switch to "I", power on the instrument; set the switch to "0", the instrument power off. By toggle the switch for the hard switch machine.

USB Port: USB port is used to connect with PC, and more functions can be extended through PC color management program.

Blue Tooth: It's used to connect with PC, and more functions can be extended through PC color management software.

Printer Socket: It's used to connect withe the printer.

DC port: Power supply for the instrument through the power adapter, the power adapter input AC (AC 110V-240V), output DC 24V/3A.

Light Source: The full spectrum LED light source provides an illuminating light source during calibration and measurement, and the light passes through the transmitted sample and into the integrating sphere.

Clarity Measuring Port: During the clarity calibrating or measuring, stick or remove the Clarity Calibrating Sheet or the specimen closely to the port according to the prompt.

Transmittance Measuring Port: During the calibrating or measuring, stick or remove the 0% Calibration Cover or the specimen closely to the port according to the prompt.

Compensate Port: During the calibrating or measuring, stick or remove the 0% Calibration Cover or the specimen closely to the port according to the prompt.

Clarity Calibrating Sheet: During the calibrating, stick or remove the it closely to the port according to the prompt(Just for the instrument with clarity measurement).

0% Calibration Cap: During the 0% calibrating, stick or remove it closely to the port according to the prompt; please keep the Cap on avoid dust to protect the internal of the integrating sphere.

Storage Case: Push to open and lock, Store accessories in.

Pedal Switch: Same as the Meas Button, by foot operation.

Specimen Holder: Hold the specimen for measuring.

Standard Haze Sheet: Translucent inspection plate with calibrated haze values.

Ⅱ. Operation Instructions

2.1 Power on&off

Set the power switch to position “1” to turn on the machine;
to position “0”to turn off.

When the machine is switched on, it will automatically go to sleep if no operation has been carried out for a long time.Press the "meas button" or touch the screen to wake up the machine and enter the working state. Once the power has been switched on, the machine enters the measurement interface directly(as the Figure 6 shown).

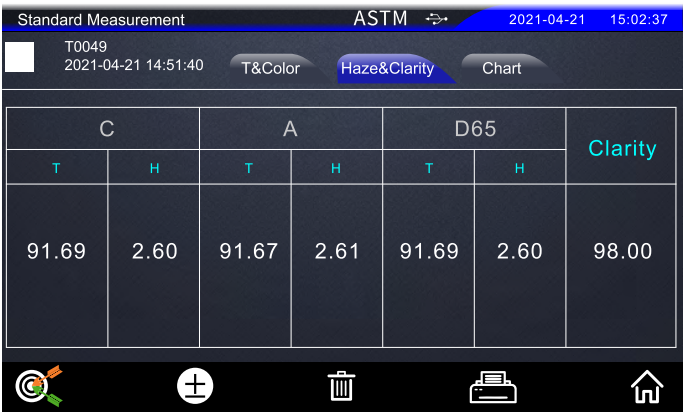


Figure 6 Standard Measurement

Caution: Please disconnect the power supply, when not using the machine for a long period of time.

2.2 Calibration

0% Calibration: Put the 0% calibration cap on the Light Source. 100% Calibration: Select different standard for different samples.
Select the air as the standard for plastic,glass,clear film etc..
Select the cuvette full of distilled water or deionized water for liquid sample.
Select the empty cuvette for the powders which in the cuvette;
Select other solution for your special need.
Clarity Calibration: cover the Clarity Measuring Port with clarity calibrating sheet,and then calibrate.
（only machine with clarity measurement)
Once correctly calibrated, the instrument system will re-timer according to the calibration expiry date set by the user.

2.2.1 Reference Standard

There are 2 criteria for the haze measurement, ASTM & ISO.
Please re-calibrate the machine when you change the criteria.
Press “ ⌂ ” in measuring interface to enter the main menu;
Press “ ✓ ” ,“ ↩ ” in other interface to enter the main menu;

Figure 7 Main Menu

Press “Reference Standards” in Main Menu to select the ASTM or ISO.
Select “ASTM”, and then click “ ✓ ” , then the machine will measuring the haze with “ASTM”;
Select “ISO”, and then click “ ✓ ” , then the machine will measuring the haze with “ISO”;
As the figure 8 shown.

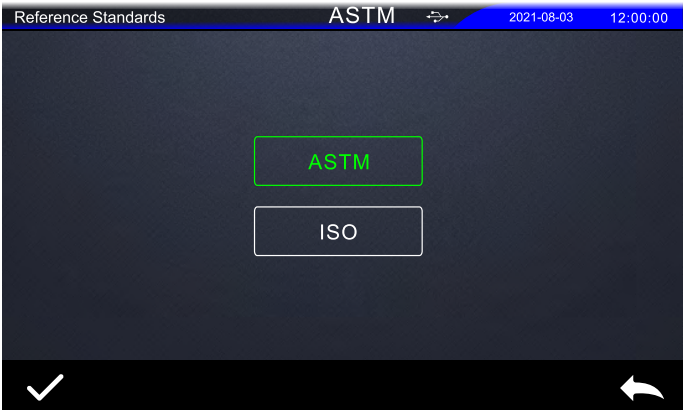


Figure 8 Select Reference Standard

Note: The difference between ASTM with ISO is the calibration method, all other process is same.

2.2.2 Calibration (ASTM)

Press “Calibration” in Main Menu to enter the calibrating interface, after select “ASTM” as the figure 9 shown.

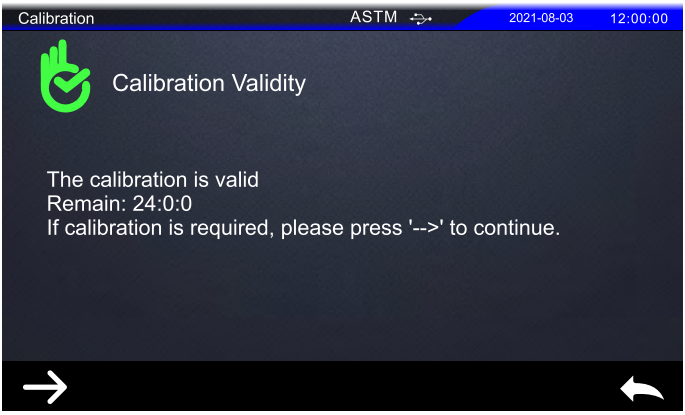


Figure 9 Calibration with ASTM mode

Press “→” to Clarity Calibration;
cover the **Clarity Calibrating Sheet on** the **Clarity Measuring Port**,
keep the **Transmittance Measuring Port** uncovered,
cover the **Cap for compensate** on the **Compensate Port**,
Press “→” or “Meas Button” to calibrate.

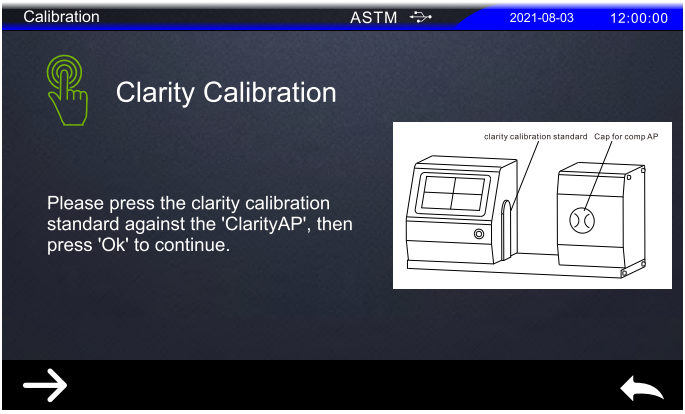


Figure 10 Clarity Calibration

Note: No need to do clarity calibration when your machine without clarity measurement.

It will automatically enter to the 0% Calibration interface when the clarity calibration is done. Please cover the **Transmittance Measuring Port & Compensate Port** with **0% Calibration Cap & Compensate Cap**, press “→” or press “Meas Button” to carry on the 0% calibration.

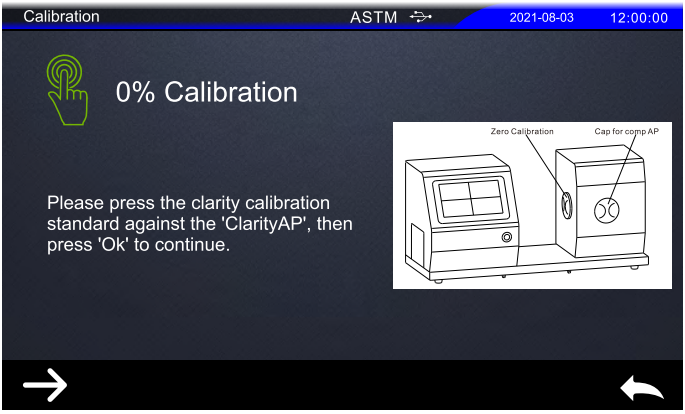


Figure 11 0% Calibration

It will automatically enter to the 100% Calibration interface when the 0% calibration is done as figure 12 shown. Please uncover the **Transmittance Measuring Port, press** "→" or press "Meas Button" to carry on the 100% calibration.

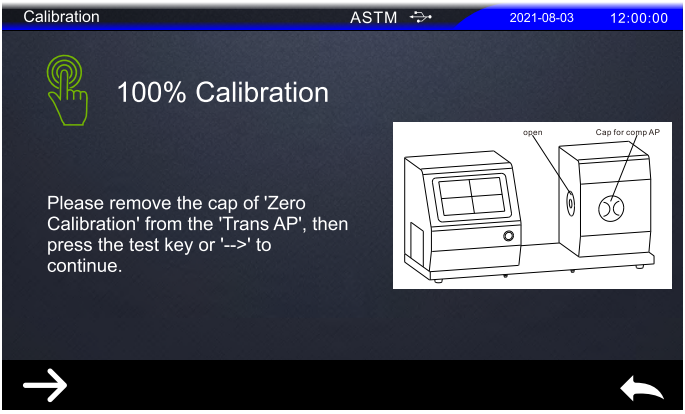


Figure 12 100% Calibration

Once correctly calibrated, the instrument system will re-timer according to the calibration expiry date set by the user.
When the correct calibration is done, figure 13 will be shown,and the machine will re-timer according to the calibration expiry date set by the user.
Press " → " to re-calibration; press " ↩ " , back to main menu.

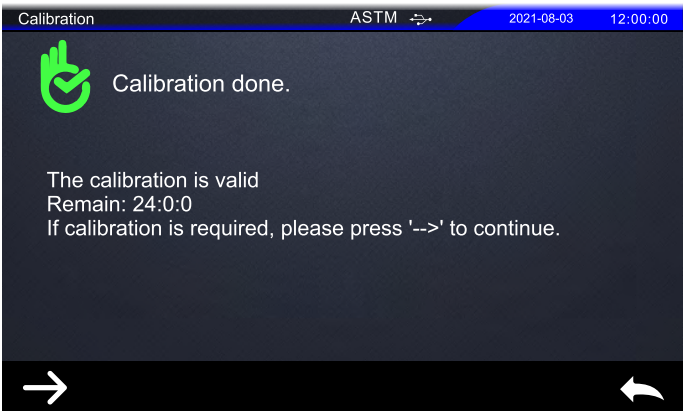


Figure13 Calibration is done

2.2.3 Calibration (ISO)

Press "Calibration" in Main Menu to enter the calibrating interface, after select "ISO" as the figure 14 shown.

Figure 14 ISO Calibration interface

Press “→” to continuiously enter Clarity Calibration(as figure 15 shown) ;
Cover the **Clarity Calibrating Sheet** on the **Clarity Measuring Port**,
Keep the **Transmittance Measuring Port & compensate Port** uncovered,
Press “→” or “Meas Button” to Clarity calibrate.

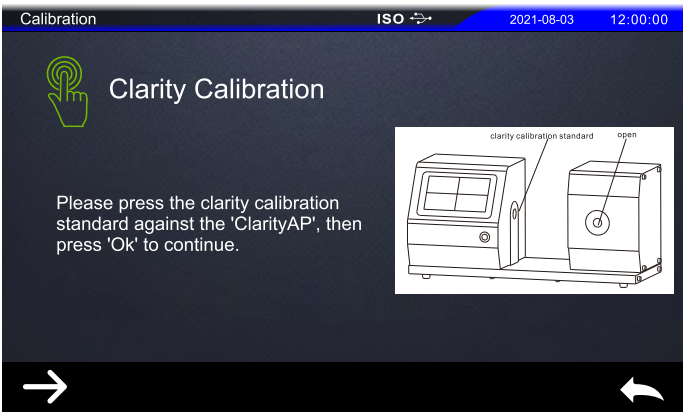


Figure 15 Clarity Calibration

Note: No need to do clarity calibration when your machine without clarity measurement.

It will automatically enter to the 0% Calibration interface when the clarity calibration is done(as figure 16 shown).

Please keep the **Compensate Port** uncover and cover the **Transmittance Measuring Port** with **0% Calibration Cap**, than press " → " or press "Meas Button" to carry on the 0% calibration(as the figure 16 shown).

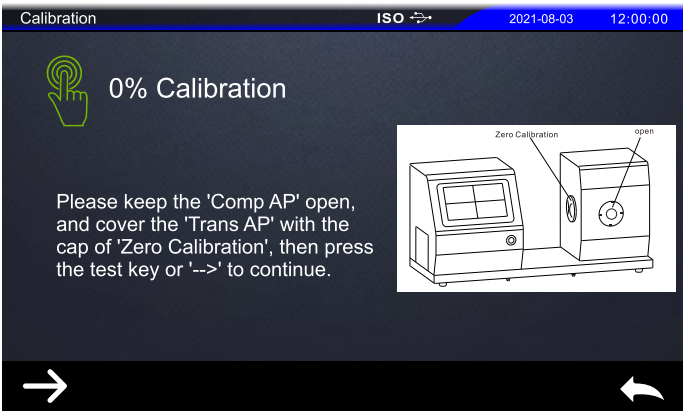


Figure 16 0% calibration

It will automatically enter to the 100% Calibration interface when the 0% calibration is done as figure 17 shown. Please uncover the **Transmittance Measuring Port**, press " → " or press "Meas Button" to carry on the 100% calibration.

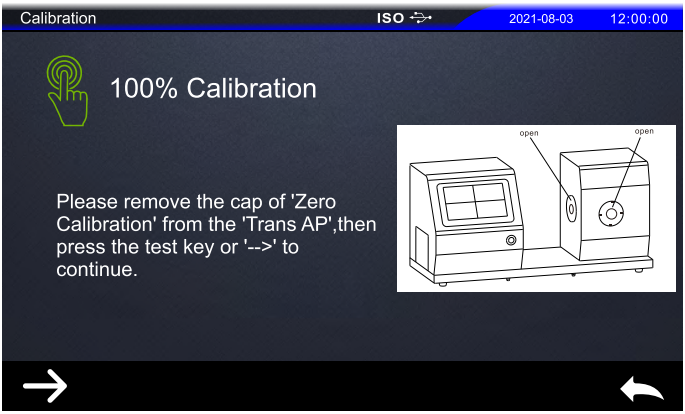


Figure 17 100% calibration

Once correctly calibrated, the instrument system will re-timer according to the calibration expiry date set by the user.

Press " → " to re-calibration;

press " ← " , back to main menu.

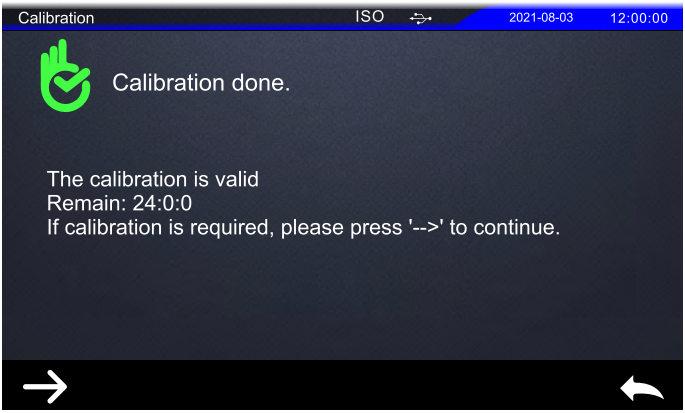


Figure 18 Calibration Done

2.3 Measurement Interface

2.3.1 Standard Measurement

Standard Measurement interface includes “T & Color”, “Haze & Clarity”, “Chart”. Press“T & Color”or“Haze & Clarity”or“Chart” to quickly switch to the corresponding interface.as the Figure 19, Figure 20, Figure 21 shown.

T & Color: Display the chromatic data of the currently measured sample；

Haze & Clarity: Display the haze,transmittance & clarity of the currently measured sample；

Chart: Display the spectrum chart & the chromaticity diagram.

Press “ ” or “ ” ,to reduce or increase the current wavelength at an interval of 10nm and switch the transmittance.You can also select a specific wavelength by clicking on it directly .

The top of the screen is the working area, which show you the current working condition including: name of the interface, ASTM/ISO, Bluetooth, USB Connection, time etc.

The middle of the screen is the data area, including chromatic, haze & clarity, wavelength,transmittance according to current measurement mode,

The bottom of the screen is the operation area, can operate the current data by clicking corresponding icon.

Standard Name: When the standard sample is measured, the instrument automatically generates the standard sample name, which is named after the serial number starting from T0001 by default。

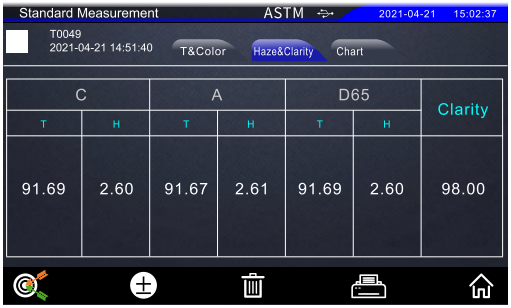


Figure 19 Standard Measurement - Haze & Clarity

Figure 20 Standard Measurement- T & Color

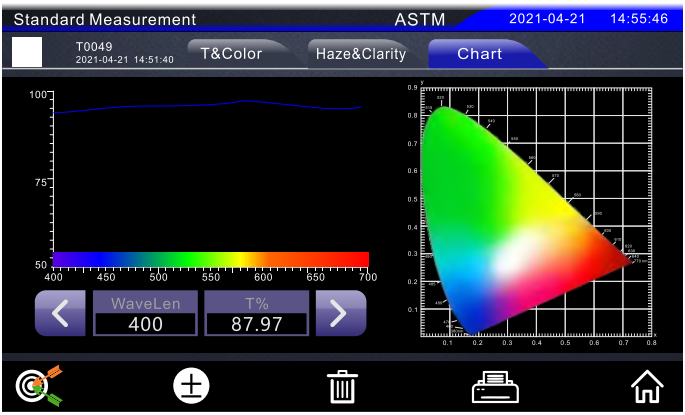


Figure 21 Standard Measurement - Chart

2.3.2 Sample Measurement

Press “ ” in the lower left corner of the standard measurement interface to enter the sample measurement associated with current standard. Sample measurement interface includes “T & Color”, “Haze & Clarity”,“Chart”. as the figure22,23,24 shown.

The sample measurement will show the test result “OK”or “NG”if you set the “Test Result”on, The Standard Measurement interface will not!

Sample Name: When the sample is measured, the instrument automatically generates the sample name, which is named after the serial number starting from S0001 by default.

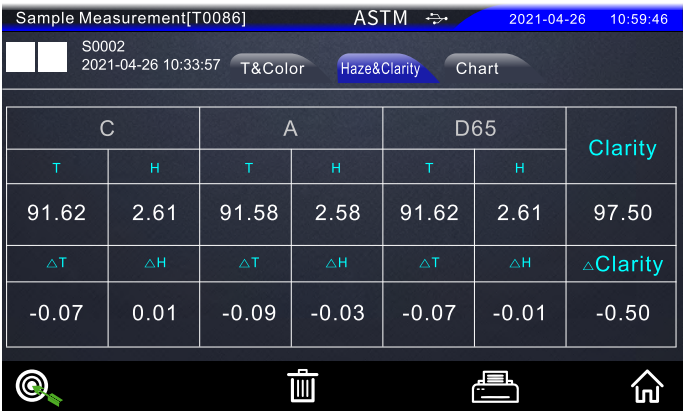


Figure 22 Sample Measurement - Haze & Clarity

Figure 23 Sample Measurement - T & Color

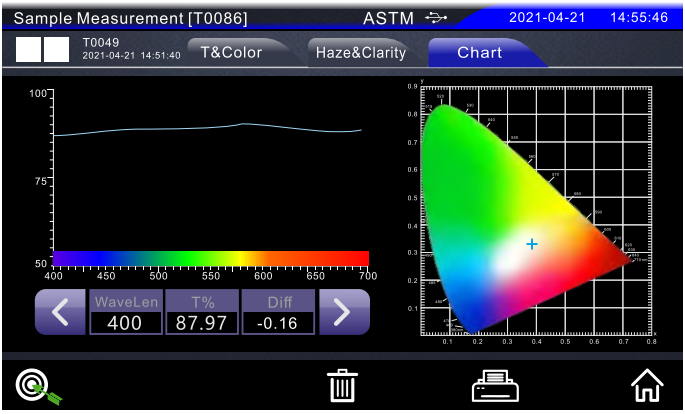


Figure 24 Sample Measurement - Chart

2.4 Measurement Setting

2.4.1 Average Measurement

When the item under test is relatively large, or the chromaticity is relatively uneven, the calculated chromaticity data is more representative of the true chromaticity data of the sample under test by measuring a representative number of test points and obtaining a multi-point average transmittance. The instrument can achieve 1~100 average measurements per group.

Select “Measure Mode” in Main Menu to enter the measure mode Setting interface, as figure 25 shown.

Click “Average Measurement”, to set the times for “Standard Measurement” and “Sample Measurement”, as the figure 26 shown.When the settings are complete, click “ ✓ ” for confirm and the machine enters the averaging mode.

Note:Average measurement and continuous measurement cannot be switched on at the same time; one is switched on and the other is switched off automatically. When the times of measurements for both average and continuous measurement is 0 or 1, the instrument is in single measurement mode.

Figure 25 Measure Mode Setting

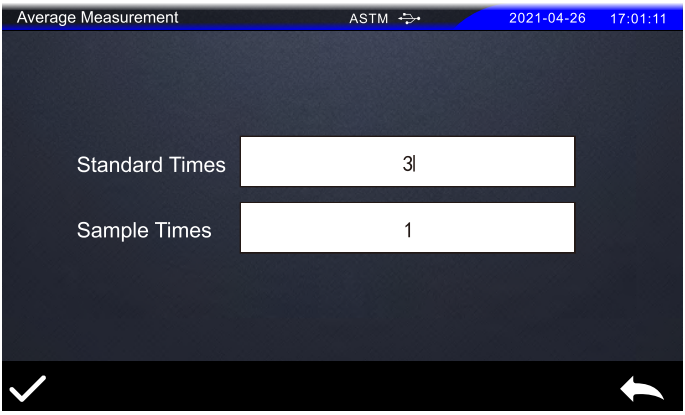


Figure 26 Average Measurement

Press the white square right to “Illuminant” to select the illuminant, as the figure 27 shown. Select the illuminant, and click “ ✓ ” for confirm.

Press the white square right to “Observer”to select the angle of 10°or 2°.observer, as the figure 27 shown. When the settings are complete, click “ ↩ ” back to Average Measurement interface.

Figure 27 Illuminant

If you have set up multiple measurements, you will need to take several measurements manually during the measurement process until the set times of measurements are all completed. The average measurement result is updated automatically for each completed measurement, the measurement is completed and an average measurement result is obtained.

2.4.2 Continuous Measuring

When measurement conditions are fixed and samples need to be measured continuously (e.g. in an automated assembly line process), continuous measurement mode can be used to reduce the number of operations and save measurement time.

The machine can achieve 1 to 10,000 consecutive measurements per group with measurement intervals between 5 and 300 seconds.

Press “Continuous Measurement” in “Measure Mode” interface to set the “Standard Times” & “Sample Times”and the measurement interval(as the figure 28 shown).When the settings are complete, click “ ” back to Continuous Measurement Mode.

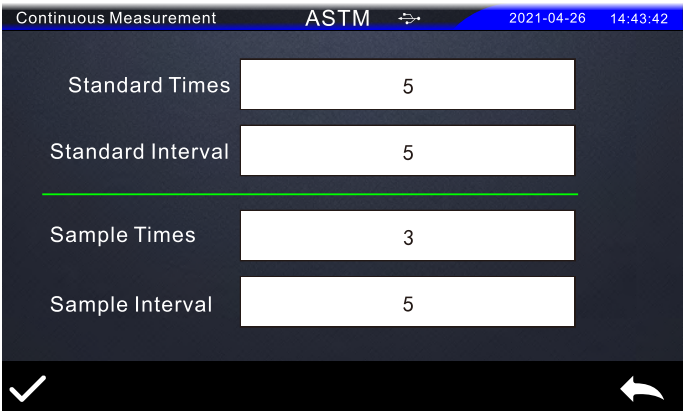


Figure 28 Continuous Measurement

When the multiple measurement is on, the instrument will prompt for the next (next sample) measurement according to the set interval until all the set times of measurements have been taken. The machine will records the result for each time completed measurement (only when auto save is on) .

2.5 ASTM Measurement

ASTM measurement is measuring the sample with ASTM criteria.

For machine with clarity, when you select “H (Haze)”and “Clarity”, it will measure the clarity first, and then measure the haze; when just select “H(Haze)” or “Clarity”, it will only measure what you selected. For the machine without clarity, it will just measure the haze.

Note：The measurement process in this manual is based on the measurement interface of the horizontal instrument, the measurement interface of a vertical instrument is based on the actual interface.

2.5.1 Standard Average Measurement

Press “Meas Button” in Standard Average measurement to start the measurement.

For the clarity measurement, cover the sample on the **Clarity Measuring Port** closely, keep the **Transmittance Measuring Port** uncovered,cover the **Compensate Cap** on the **Compensate Port**, **then press "OK" to do the measurement**(as figure 30 shown). When measuring, "Measurement in progress, please wait..." is displayed, while the indicator light of the measurement button flashes, the indicator light stops flashing when the measurement is completed.If haze measurement is not selected, the clarity measurement will be displayed, otherwise a haze measurement will be prompted(as figure 31 shown).

For the haze measurement, cover the sample on the **Transmittance Measuring Port** closely, cover the **Compensate Cap** on the **Compensate Port, then press "OK" to do the measurement**. When measuring, "Measurement in progress, please wait..." is displayed, while the indicator light of the measurement button flashes, the indicator light stops flashing when the measurement is completed (as figure 31 shown).

If multiple measurements are set, repeat the steps above and continue until all the set measurements have been taken.During standard Avg measuring, the averaging result is automatically updated every time a measurement is completed.After the measurement is completed, an average measurement result will be obtained(as the figure 32 shown).

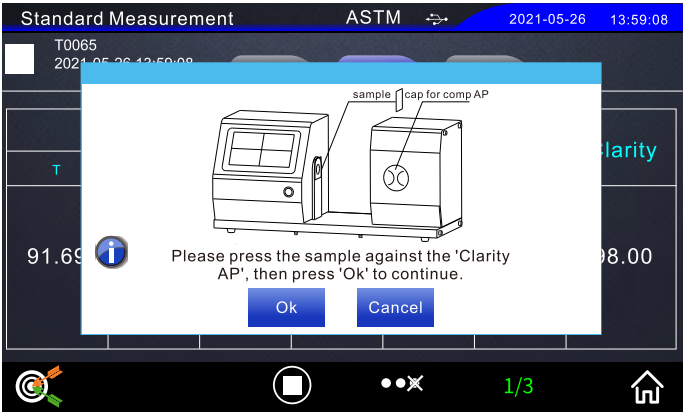


Figure 29 cover the sample on Clarity port

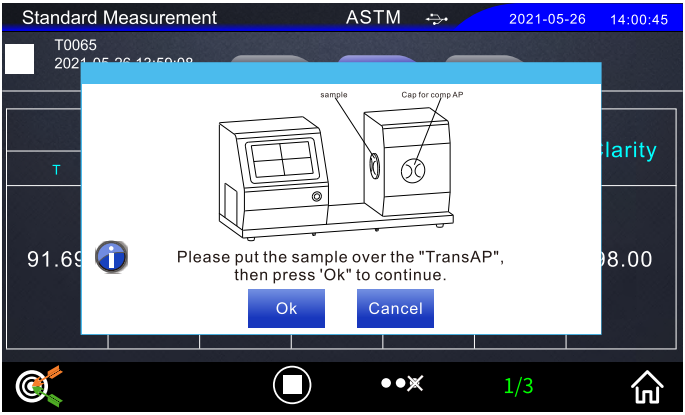


Figure 30 cover sample on Transmittance Port

Figure 31 1st time of the Avg Measurement(total 3 times) done

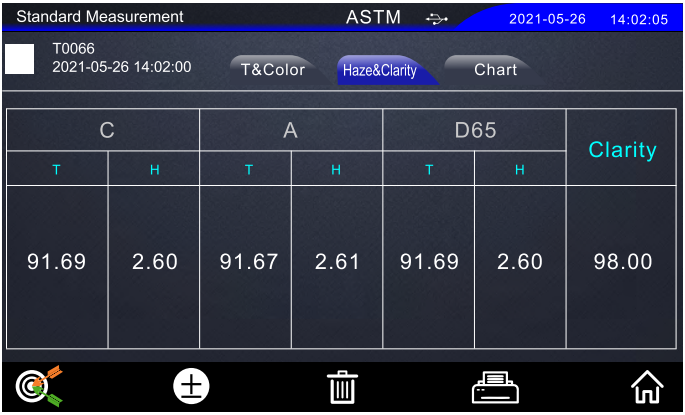


Figure 32 the whole Avg Measurement(total 3 times) done

Icons in the measurement interface:

1.Press “ ” to switch to sample measurement,press “ ” to the standard measurement；

2.In standard measurement, press “ ” to set the tolerance of the current standard (as figure 33 shown). It is set in the same way as the system tolerance (see section 3.8.6). If no changes are made to the standard tolerance, the system tolerance is used by default.

The standard tolerances can be selected from "Trans", "Haze", "Clarity" and "△E" for specimens judgement of measurement results.

When “Trans”is selected, the results are judged using the transmittance of the specimen;

When “Haze”is selected, the results are judged using the “Haze” of the specimen;

When “Clarity”is selected, the results are judged using the “Clarity” of the specimen;

When “△E”is selected, the results are judged using the “△E” of the specimen.

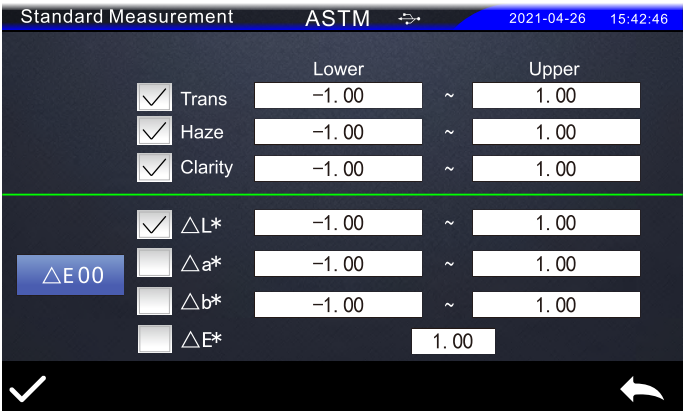


Figure 33 Standard tolerance setting

Caution: "Trans", "Haze", "Clarity" and "△E" can be selected singly or in multiples, if none of them are selected, the sample will not be prompted for tolerance judgement when measured.

3.When the measurement is completed, if the auto save is enabled (refer to section 3.8.1), the measurement result will be stored automatically; if the auto save is not enabled, a save button " " will appear, click on it to save the result(in the continuous measurement mode,only save the last measurement). After saving, the save button will automatically change to a delete button " " .

4.When the measurement is completed and the printer is available, if the current interface is standard measurement, click " " ,the standard record and it's associated sample record will be printed; if the current is sample measurement, click " " , the current sample record will be printed.Please refer to section 2.8 for the print setting method;

5.When the measurement is completed, click " " to delete the current stand record, in standard measurement, it will delete the current stand and all the associated sample; in sample measurement, it just delete the current sample record;

6.Click the name of the standard or the sample to change it;

7.During measuring, click " " to finish current measurement;

8.During continuous measurement(section 2.5.3), click " " or "Meas Button"to pause; click " " or "Meas Button"to continue; click " " to delete the last date。

2.5.2 Sample Average Measurement

Sample Avg Measurement is same as Standard Avg Measurement。

When the Standard Tolerance and the test result is on(please refer to section 3.7), “Pass” or “NG” will displayed on the screen (as figure 34 shown).

Figure 34 Sample Avg Measurement

2.5.3 Standard Continuous Measurement

Press “Meas Button” in Standard Continuous Measurement screen to start the measurement.

For the clarity measurement, cover the sample on the **Clarity Measuring Port** closely, keep the **Transmittance Measuring Port** uncovered,cover the **Compensate Cap** on the **Compensate Port**, **then press “OK” to start the measurement**(as figure 35 shown). When measuring, "Measurement in progress, please wait..." is displayed, while the indicator light of the measurement button flashes, the indicator light stops flashing when the measurement is completed.If haze measurement is not selected, the clarity measurement will be displayed, otherwise a haze measurement will be prompted(as figure 31 shown).

For the haze measurement, cover the sample on the **Transmittance Measuring Port** closely, cover the **Compensate Cap** on the **Compensate Port, then press "OK" to start the measurement** (as figure 35 shown). When measuring, "Measurement in progress, please wait..." is displayed, while the indicator light of the measurement button flashes, the indicator light stops flashing when the measurement is completed, and the date will be displayed. (as figure 37 shown).

When the multiple measurement is on, the instrument will prompt for the next (next sample) measurement according to the set interval until all the set times of measurements have been taken (as the figure 38 shown). The machine will records the result for each time completed measurement (only when auto save is on) .

Caution:During continuous measurement, if the auto save is not on, the measurement results are displayed only after each measurement and not saved. When the measurement is complete, click on Save to save the last record only.

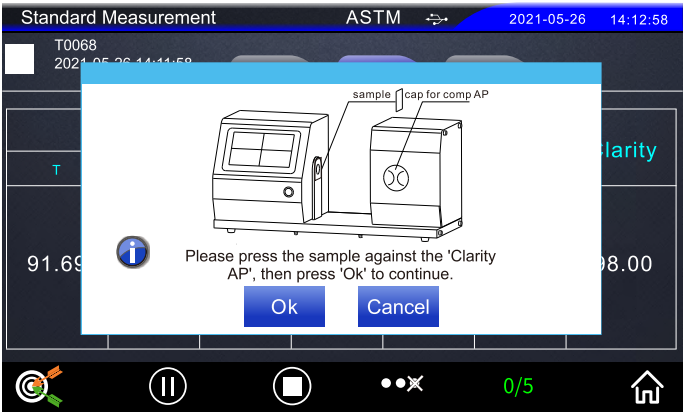


Figure 35 sample cover on the clarity port

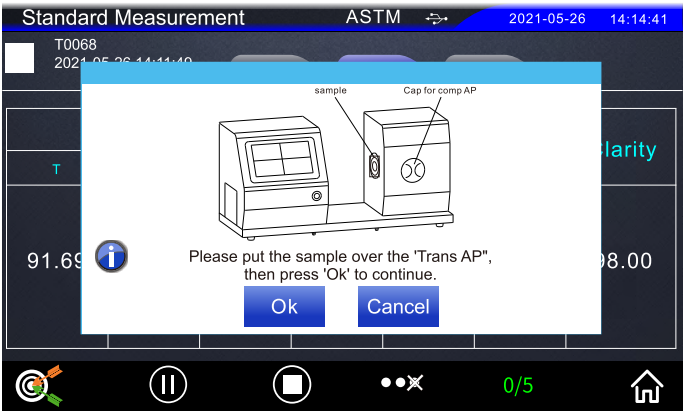


Figure 36 sample cover the Trans Port

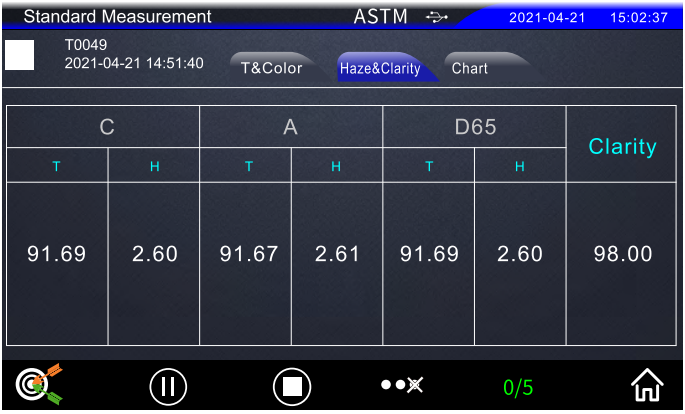


Figure 37 1st standard done of the continuous measurement(total 5)

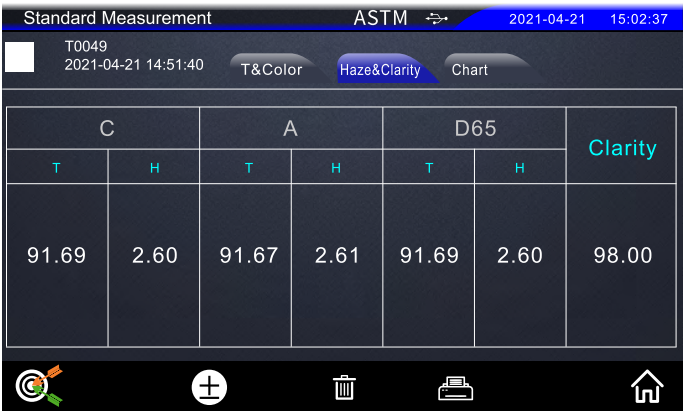


Figure 38 the whole group standard continuous measurement done

2.5.4 Sample Continuous Measurement

It's same as Standard Continuous Measurement.

When the Standard Tolerance and the test result is on(please refer to section 3.7), "Pass" or "NG" will displayed on the screen (as figure 39 shown).

Figure 39 Continuous Measurement

2.6 ISO Measurement

ISO measurement is measuring the sample with ISO criteria**.**

For machine with clarity,when you select “H (Haze)”and “Clarity”, it will measure the clarity first, and then measure the haze; when just select “H(Haze)” or “Clarity”, it will only measure what you selected. For the machine without clarity, it will just measure the haze.

Single measurement, Avg measurement and continuous measurement are all available for ASTM & ISO. Please check section 2.4 for Avg measurement & continuous measurement. When the times of measurements for both average and continuous measurements is 0 or 1, the instrument is in single measurement mode. The following is an example of a single measurement for ISO standard and sample measurement.

2.6.1 Standard Measurement

Press “Meas Button” in Standard Measurement to start the measurement.

For the clarity measurement, cover the sample on the **Clarity Measuring Port** closely, keep the **Transmittance Measuring Port & Compensate Cap** uncovered, then **press “OK” to do the measurement**(as figure 40 shown). When measuring, "Measurement in progress, please wait..." is displayed, while the indicator light of the measurement button flashes, the indicator light stops flashing when the measurement is completed.If haze measurement is not selected, the clarity measurement will be displayed, otherwise a haze measurement will be prompted(as figure 31 shown).

For the haze measurement, first measure the sample on the Compensate Cap, then measure the sample on the Transmittance Measuring Port:As the figure 41 shown, stick the sample on Compensate Cap, and keep the Transmittance Measuring Port uncover,then press “OK” to start the measurement; When measuring, "Measurement in progress, please wait..." is displayed, while the indicator light of the measurement button flashes, the indicator light stops flashing when the measurement is completed.

As the figure 42 shown, stick the sample on Transmittance Measuring Port, and keep the Compensate Port uncover,then press “OK” to start the measurement; When measuring, "Measurement in progress, please wait..." is displayed, while the indicator light of the measurement button flashes, the indicator light stops flashing when the measurement is completed, the result is displayed (as the figure 43 shown).

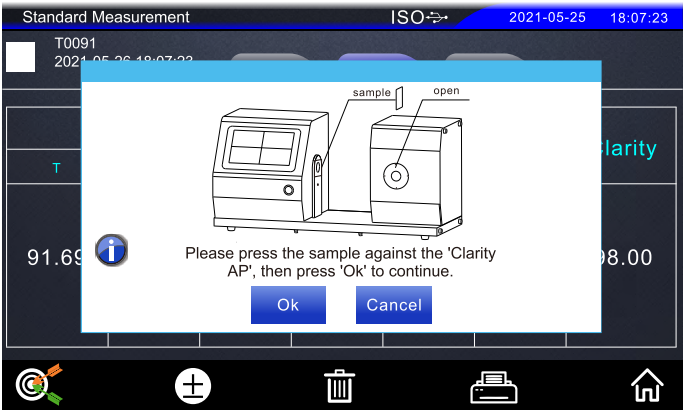


Figure 40 stick the sample on clarity port

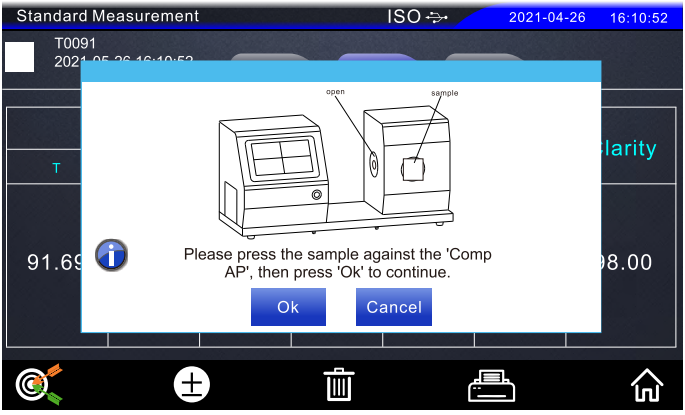


Figure 41 Stick the sample on compensate port

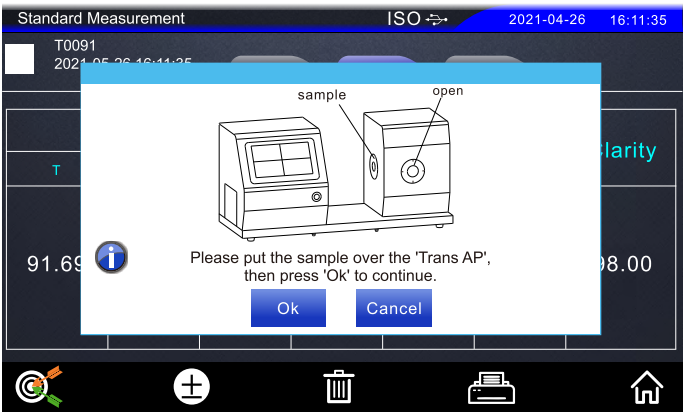


Figure 42 Stick the sample on Trans Port

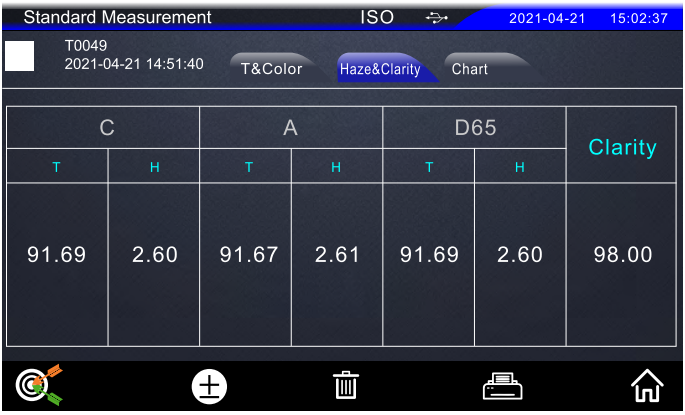


Figure 43 Standard Measurement done

2.6.2 Sample Measurement

Sample Avg Measurement is same as Standard Avg Measurement.

Figure 44 Sample Measurement done

2.7 Connect with PC

The PC software has powerful expansion function, which can realize more measurement data analysis.This series of instruments can be connected with the color management software on PC through USB cable or Bluetooth(only for the machine with BT) .

2.7.1 Via USB to PC

Install the color management software on the PC and use USB cable to connect the instrument with the PC. The software can automatically connect the instrument with the PC. After successful connection, the status bar of the instrument will display the USB connection icon.

2.7.2 Via Bluetooth to PC

For instruments with a Bluetooth module, communication with the PC-based colour management software is possible via Bluetooth.

Install the colour management software on the PC, use the Bluetooth adapter and switch on the Bluetooth function in the "system settings" of the instrument.

2.8 Printer

The micro-printer is a non-standard accessory and needs to be purchased separately. The user can first measure the chromatice data of the sample, save a record of the sample to be printed, connect the micro printer to the instrument via USB, find the date to be printed in the standard / sample record and click “ 🖶 ” on it. You can also choose to print from the measurement completion screen.

Ⅲ. System Function

Click “ ⌂ ” in measuring interface or “ ↩ ” in others to enter main menu, from the main menu, you can enter each sub-menu to achieve all system function setting (as the figure 7 shown)

3.1 Data Management

Click “Data” in the main menu to enter the data management, as the figure 45 shown.Data management allows you to view and manipulate measured records. It includes “Browse”, “Search”, “Input Standard” and “Delete”.

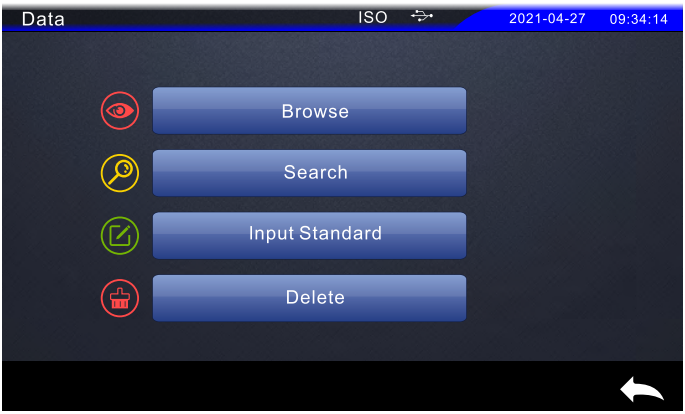


Figure 45 Data Management

3.1.1 Browse

Press “Browse” in Data Management interface and jump to the "Browse" interface, as shown in Figure 46. Click on the “ ▼ ”, “ ▲ ” Button to view all the standards by page, select the current standard with ticking the “ ☐ ” in from the name.

Figure 46 Browse standard

◆ **View Standard**

Select a standard record in the "Browse" interface, and the operation of "View Details", "Call out ", "View Samples", "Lock" and "Delete" can be carried out,and can quickly switch to “ Color” and “Haze”.

1)Select a standard record in the "Browse" interface, click "View Details", and the "Browse Standards" interface pops up to view the “T & Color”, “Haze & Clarity” & “Chart” of the current standard, as shown in Figure,47,48,49. In the “View Standard” interface, click “ ▼ ”、“ ▲ ” Button to check other standard’s detail, click the standard’s name, to modify the standard’s name.

Figure 47 View Standard - T & Color

Figure 48 View Standard - Haze & Clarity

Figure 49 View Standard - Chart

2) Click “ ” in “View Standard” interface to “Delete”, “Replace”, “Tolerance”, “Print”,“Call out” as figure 50 shown.

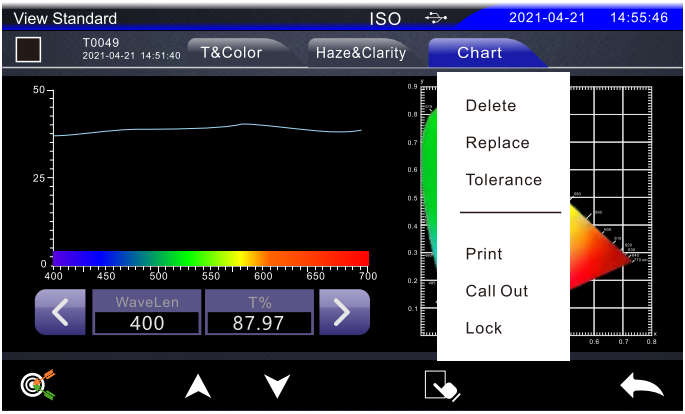


Figure 50 View Standard

1.Click "Delete" or click "Delete Selected" in the "Browse" interface to delete the standard and the associated sample record;

2.Click "Replace" to replace the current standard with measuring a new standard.

3.Click "Tolerance" to set the tolerance of the standard and make tolerance judgment only on the measurement results of the sample associated with the standard. If the standard tolerance is not set, it is used by default system tolerance for the current standard.

4.Click "Print", the current standard data and associated sample data can be printed;

5.Click "Call out" or "Call out Selected" in the "Browse Standard" interface to change the standard record being viewed to the current standard, and the associated sample measurement interface will pop up.

6.Click "Lock", or "Lock Selected" in the interface of "Browse Standard", and the standard will be locked. If the standard is locked, operations such as name modification, tolerance setting, replacement and deletion of the standard cannot be conducted. After the standard is locked, you can choose to unlock it.

3）When select multiple records in "Browse” , "Lock Selected" ,"Delete Selected" can be carried out, and quickly switch to “T & Color” & “Haze”, as shown in figure 51, 52.

1.Click “Lock Selected”, the selected standards will be locked.When the standard is locked, operations such as name modification, tolerance setting, replacement and deletion of the standard cannot be conducted. After the standard is locked, you can choose to unlock it,

3.Click “Color” switch to “Haze”.

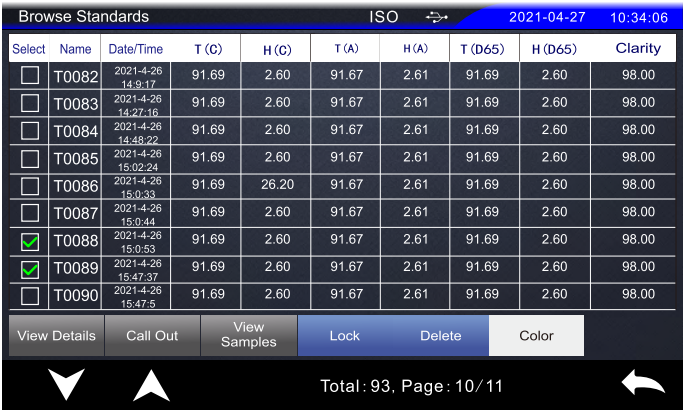


Figure 51 Brows Standards - select multiple standards

Figure 52 Delete Multiple Records

◆ Browse Sample

Select a standard in the "Browse Standard" interface and click "View Sample".If there is no associated sample record under the current standard, it is indicated that "the selected standard has no associated sample",as shown in Figure 53; If there is an associated sample record under the current standard, the sample record associated with this standard will be listed on the pop-up browsing sample interface, as shown in Figure 54.

1) In the browse samples interface, select a sample record and click "View Details" to check the “T & Color”, “Haze & Clarity” & “Chart” of the current sample. Click “ ▼ ” 、 “ ▲ ” Button to check the records of other samples associated with the standard. Click the sample name to modify the name, or delete and print the current sample data (if connected to a printer), as shown in Figure 55.

2) In the “Browse Samples” interface, select one or more sample records and click "Delete Selected" to delete the selected sample records, but the standard records associated with the sample will not be deleted.

3) In the “Browse Samples” interface, click "Color" to quickly switch to the “Haze", click “diff-value” to switch to the “Absolute Value" interface

Figure 53 Current Standard without Associated Sample

Figure 54 Browse Samples

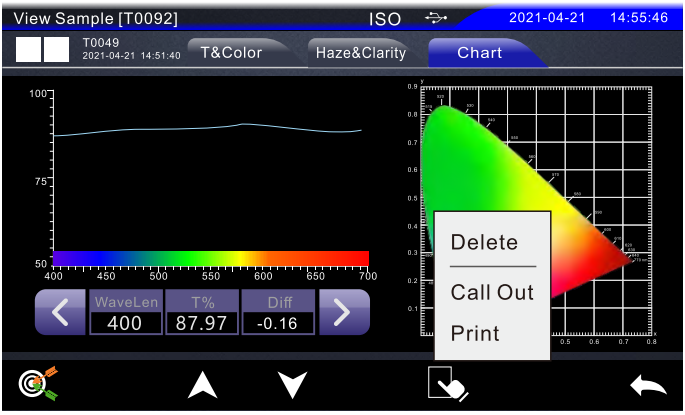


Figure 55 View Sample - Details

3.1.2 Search

Click "Search" in the DATA MANAGEMENT interface to enter the search record interface. “ Search by Name” and “Search by Color Diff.” are available.

◆ **“Search by Name”**

1）Click the text box right to "Name", to enter the full (or part) name of the standard or the sample to be searched, then click "OK", and then select "Search Standard" or "Search Sample" to find out that the standard or sample record which contains of what you input as shown in Figures56,57.

2）Input the full name of the standard or sample to be searched in the text box, tick "Full Name Match", and then click "Search Standard" or "Search Sample" to find the standard or sample record whose name is exactly the same as the name searched.

3）Input name, and tick “specified date”, select the date to search the standards or the samples during the specified period.

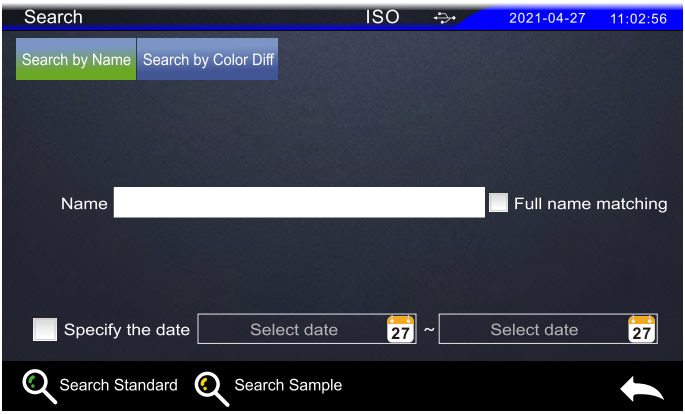


Figure 56 Search by Name

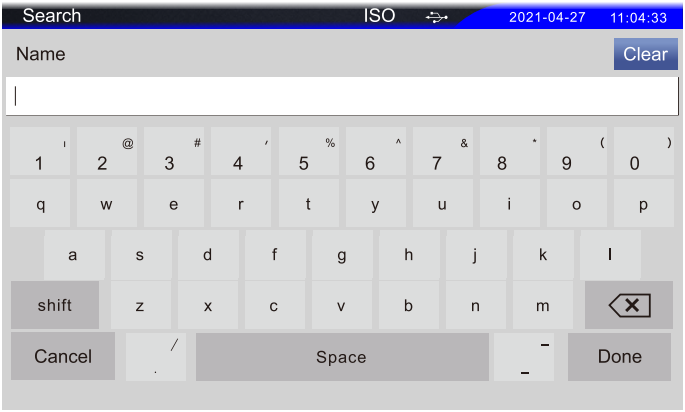


Figure 57 Search - Text Box- Input name

◆ **Search by Color Diff.**

Click “Search by Color Diff.”, select “Color Space”,” “Illuminator” and “Observer”, then input“L*”、“a*”、“b*”、“ΔE*”, select “Specified date”, press “Search Standard” to search. As figure 58 shown.

Figure 58 Search by Color Diff.

3.1.3 Input Standard

Click "Input Standard" on the DATA MANAGEMENT interface to enter the Input Standard interface, as shown in Figure 59. Enter the standard name and related parameters. When the input is complete, click OK “✓”, the standard is stored in the standard record list. The standard record can be viewed through the "Browse" of the DATA MANAGEMENT interface.

Figure 59 Input Standard

3.1.4 Delete

Click "Delete" on the DATA MANAGEMENT interface to enter the delete record interface. All samples and standards can be deleted, or samples and standards can be deleted by time, as shown in Figure 60.

Click the corresponding option to enter the delete prompt and warning interface, Click "Yes" on the warning interface to delete all corresponding records; If you do not want to delete, you can click "No" as shown in Figure 61.

When a sample is deleted, the standard associated with that sample is not deleted; when a standard is deleted, the samples associated with that standard is also deleted.

Figure 60 Delete

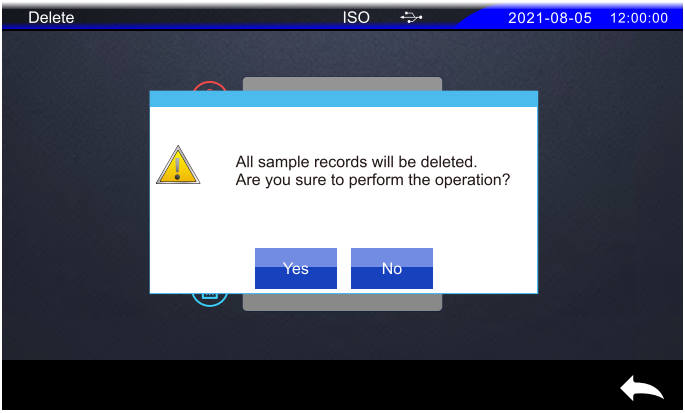


Figure 61 Delete all records

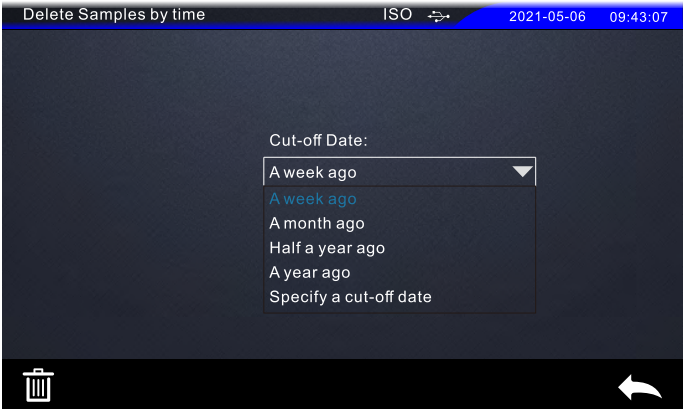


Figure 62 Delete by time

Caution:It is not possible to recover data after deletion, so please proceed with caution to prevent accidental deletion of the required history.

3.2 Calibration

Calibration is the benchmark for measurement, must be carried out accurately, otherwise the validity of the measurement data will be affected. This series of instruments require calibration in the following cases:

1）When the calibration environment differs considerably from the current sample measurement environment (e.g. drastic temperature fluctuations).

2）The instrument has exceeded the expiration date of calibration, and when measuring sample.

3）After switching between ASTM (American Standard) and ISO standards.

4）After changing the clarity setting.

Please refer to Section 2.2 for the method of calibration.

3.3 Reference Standard

There are two kinds of reference standards: ASTM (American Standard) and ISO. After switching between ASTM (American Standard) and ISO for this series of instruments, the instrument needs to re-calibration when conducting sample measurement. Please refer to Section 2.2.1 for more details.

3.4 Measurement Mode

Average measurement and continuous measurement can be set in the measurement mode. Please refer to Section 2.4 for more details.

3.5 Color Space

Click “Color Space” in main menu to select color space, as shown in figure 63. Select the color space and then tick for confirm. The default color space is CIE LAB.

Figure 63 color space

3.6 Color Index

The colour index interface allows you to select the colour difference formula and colour index currently in use, and to set the parameter factors for the colour difference formula and colour index, as shown in figure 64.

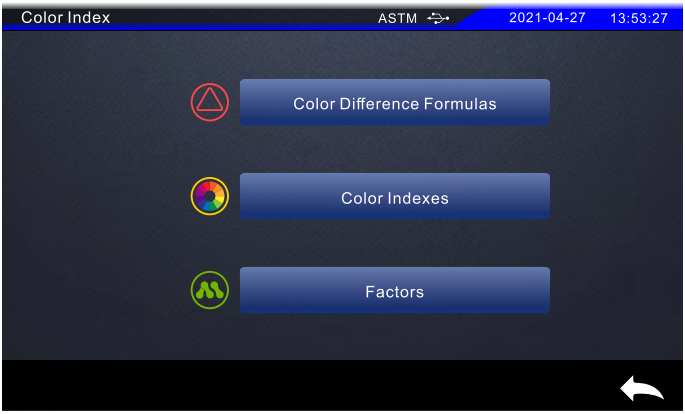


Figure 64 color index

3.6.1 Color Difference Formula Setting

Click “Color Difference Formulas” in color index interface to select Color difference Formula.

Select the Color Difference Formula, and then press “ ✓ ” to confirm, the default formula is △E*.

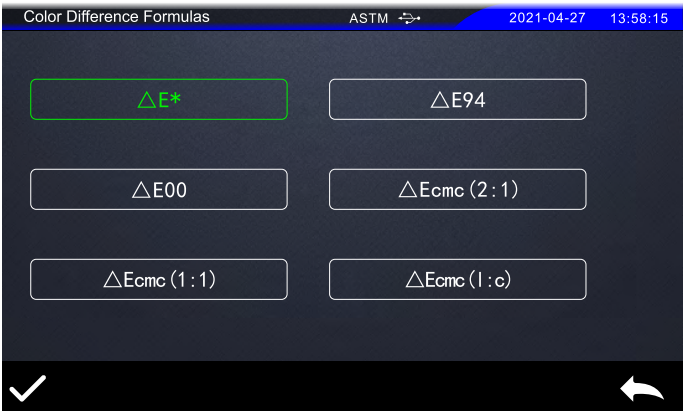


Figure 65 Color Difference Formula

The Selected Color Diff. Formula will be used to calculate the color difference, e.g. figure 66 shown the color difference calculated with ΔE*.

Figure 66 Color Difference calculated with △E*

3.6.2 Color index setting

Click “Color Index” to set the color index.

Select the color index, by click it; click it again to cancel, click “ ✓ ” to confirm the color index, as figure 67 shown.

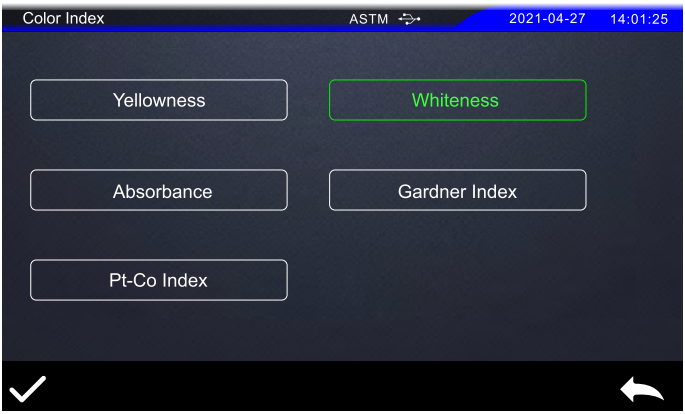


Figure 67 Whiteness selected

The selected color index will be displayed in the color index area during standard and sample measurement(some index will just show in sample measurement, e.g. figure 68 shown the whiteness

Figure 68 Whiteness in sample measurement

3.6.3 Factors

Click “Factors” in “Color Index” interface to set factors,as figure 69 shown.

Figure 69 Factors setting

1)Factors Setting

For color Diff.Formula CIE DE1994（ΔE94）、CIE DE2000（ΔE00）、CMC（ΔEcmc(l:c)）, user can set the KL、KC、KH（Only KL & KC available for ΔEcmc(l:c)）.The following is an example of the ΔE94 factors setting: Click on "ΔE94 Factor" to enter the ΔE94 factor setting interface (shown in Figure 70).

Figure 70 ΔE94 Factors

Click the text box right to “Factor KL”,“Factor KC”,“Factor KH” to set the value of the selected factor as figure 71 shown, then input the new value, press “Done” to save, “Cancel”to return previous interface without save.

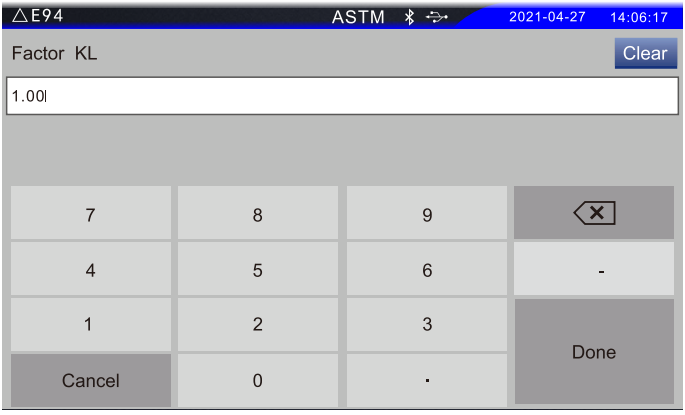


Figure 71 Input KL Value

2) Wavelength of Maximum Absorption

Click "Wavelength of Maximum Absorption" in color index setting interface to enter the absorbance wavelength setting interface, as shown in Figure 72. The value of "Wavelength of Maximum Absorption" can be set, and the value range of "Wavelength of Maximum Absorption" is 400~700. If blank is selected, only the automatically calculated maximum absorption wavelength will be displayed. After the setting is completed, click OK " ✓ " to save the setting, and click Return " ↩ " to cancel the setting.

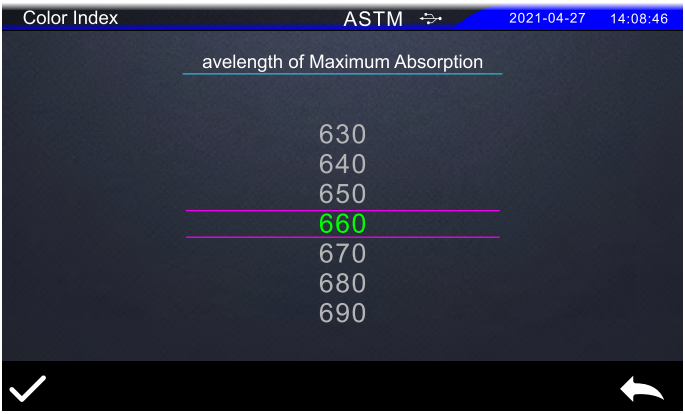


Figure 72 Wavelength of Maximum Absorption

3.7 Display Setting

Click "Display Setting" on the main menu interface to enter the display setting interface, as shown in Figure 73.

Turn on "Color Offset", when the sample is measured, it will prompt the color offset of the comparison between the sample and the standard. When it is closed, there will be no corresponding prompt.

Turn on "Test Result", when the sample is measured, if the error between the sample and the standard is within the tolerance range, the green word "Pass" is displayed, otherwise the red word "Fail" is displayed.

The instrument can be set to horizontal or vertical screen. It can be measured horizontally or vertically.

Haze and clarity can be selected at the same time, or only haze or clarity can be selected. When haze and clarity are selected, the measurement interface displays haze, transmittance (T value) and clarity value; when haze is selected, the measurement interface displays haze and transmittance (T value); when clarity is selected , the measurement interface displays the clarity value.

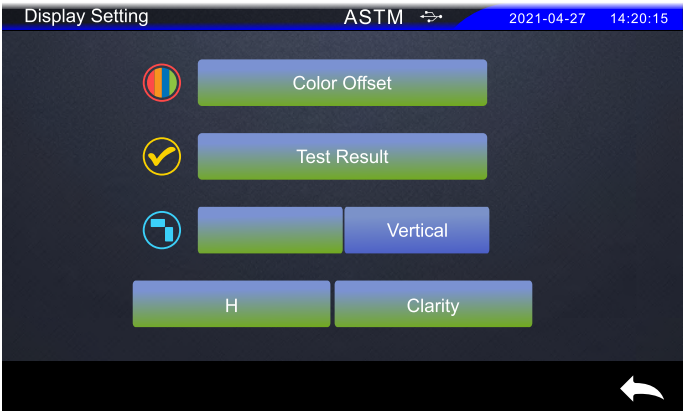


Figure 73 Display settings

3.8 System Setting

Click "System Setting" in the main menu to enter the system setting interface, as shown in Figure 74, 75, and 76.

System setting include "Auto Save", "Auto Print", "Beep", "Bluetooth", "Set System Tolerance", "Control Method", "Calibration Validity", "Languages", "Date/Time", "Backlight", "Restore Factory Setting" and "About Instrument", etc.

Figure 74 System Setting

Figure 75 System Setting

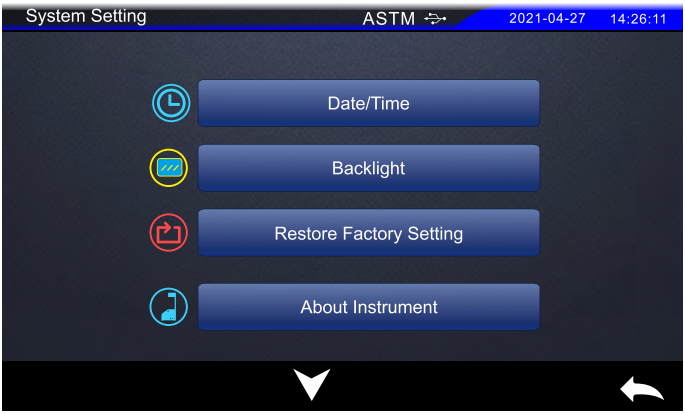


Figure 76 System Setting

3.8.1 Auto Save

When auto save is turned on, the measurement result will be automatically stored in the instrument every time a sample is measured. Otherwise, the measurement record will not be automatically saved when the sample measurement is over, and you need to manually click Save.

3.8.2 Auto Print

When auto print is turned on, the sample will be automatically printed every time it is measured. Otherwise, the sample will not be automatically printed after the measurement is completed, and you need to manually click to print. Select "Auto Print" in "System Setting" and connect to a printer to print data. Please refer to section 2.8 for specific operations.

3.8.3 Beep

The beep switch controls whether or not a beep will sound during measurement. When the beep is turned on, a reminder sound will sound every time you measure, otherwise, there will be no reminder sound during measurement.

3.8.4 Test tips

Turn on the test tips and prompt the sample placement position during measurement; turn off the test tips, if only the definition measurement or the haze measurement in the ASTM mode is selected, the sample placement position will not be prompted during the measurement.

3.8.5 Bluetooth

For instruments equipped with Bluetooth, it can communicate with PC color management software via Bluetooth. For the setting method of communication between the instrument and PC software via Bluetooth, please refer to section 2.7.2.

3.8.6 System Tolerance

The tolerance is for the standard , and the tolerance of the standard will affect the instrument's judgment on the measurement result of the sample. The system tolerance is the tolerance that the instrument assigns to the standard by default. If the standard tolerance is not set, the system tolerance is used by default.

Click "Set System Tolerance" on the system setting interface to enter the tolerance setting interface, as shown in Figure 77. In this interface, you can set the tolerance range of "Trans", "Haze", "Clarity" and the color difference formula.

Click the color difference formulas on the left, and the color difference formulas setting interface will pop up, as shown in Figure 78. Select the color difference formula, click “ ✓ ” to save after setting. You can set the default tolerance value under the corresponding color difference formula (note that this is only to set the default tolerance of the selected color difference formula. The color difference formula used for measurement will not be changed. To change the color difference formula used for measurement, you need to set the color difference formula in the main menu. Change in "Color Difference Formula Settings").

Click the corresponding tolerance value to enter the corresponding value setting interface, as shown in Figure 79. The upper tolerance limit on the right must be greater than the lower tolerance limit on the left. After setting, click Confirm " ✓ " to save. If you click Back " ↩ " , the setting will be cancelled and the tolerance setting interface will be exited.

Figure 77 System Tolerance Setting

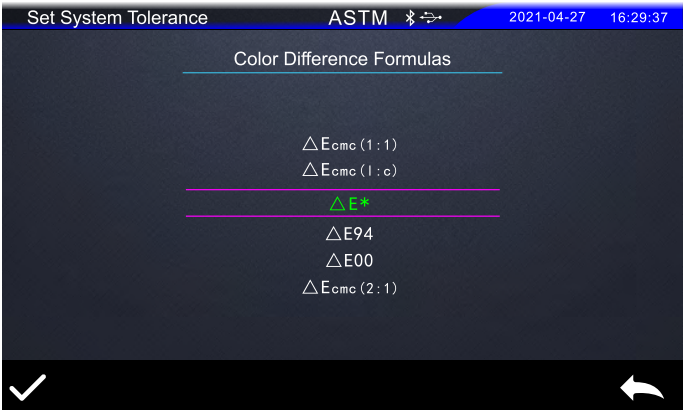


Figure 78 Color Difference Formulas Setting

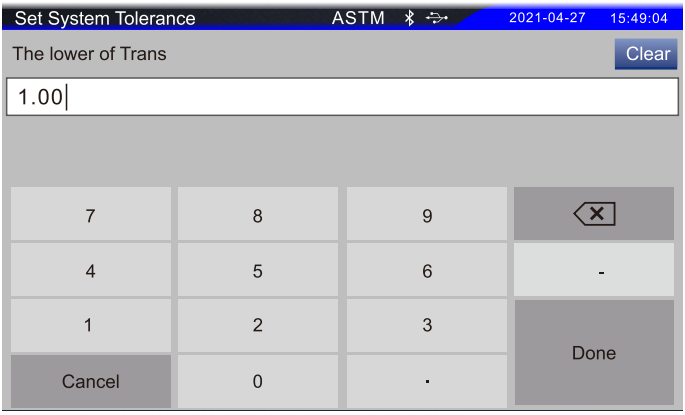


Figure 79 Tolerance Value Editing

After the tolerance setting is completed, when measuring the sample, judge whether the sample is within the acceptable range according to the tolerance type and range. If the error between the sample and the standard is within the tolerance range, it is judged as Pass, otherwise it is Fail (when the test result prompt is turned on).

3.8.7 Control Method

When the instrument communicates with the PC software, the user can set specific measurement control methods as needed. Click "Control Method" in the system setting interface to open the control method interface (as shown in Figure 80), select the corresponding method, and then click OK "✓".

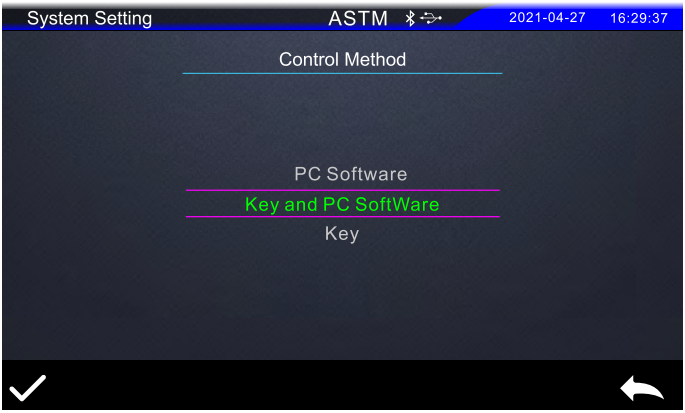


Figure 80 Control Method

PC software: select this mode, the instrument measurement is only triggered by the PC software measurement button to complete the data measurement, and upload the data to the PC software.

Key | PC software: select this mode, the customer can complete the sample test through the instrument test button or the PC software measurement button, and upload the data. This mode is the default selection mode of the instrument.

Key: Select this mode, the instrument measurement is only triggered by the instrument measurement button to complete the data measurement, and upload the data to the PC software.

Note: The control mode only takes effect when the instrument is connected to the PC software. When it is not connected, the measurement button can only be used to measure.

3.8.8 Calibration Validity

Click "Validation Validity" on the system setting interface to manage the timeliness of calibration, as shown in Figure 81.

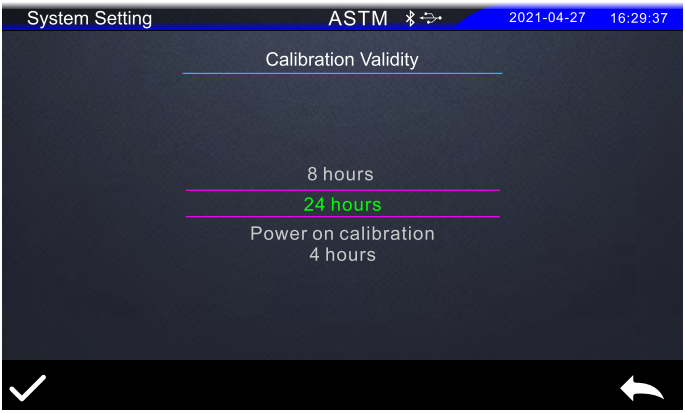


Figure 81 Calibration Validity Setting

Click "Calibration Validity " in the system setting interface to enter the calibration validity setting interface. You can choose "4 hours", "8 hours", "24 hours" and "power on calibration".

If you select 4 hours, the calibration validity of the instrument will expire 4 hours after each calibration. After the expiration, you can only view the data and not perform the measurement. After re-calibration, the validity of the calibration restarts. The meanings of "8 hours", "24 hours" and "power on calibration" are the same as above.

3.8.9 Calibration Channel

Click "Calibration Channel" to enter the calibration channel setting interface, as shown in Figure 82. Position the cursor on the channel name and click "Set as Current" to use this channel as the calibration channel. Select a channel and click "Rename" to modify the channel name; click "Delete" to delete the channel. The default channel cannot be renamed or deleted.

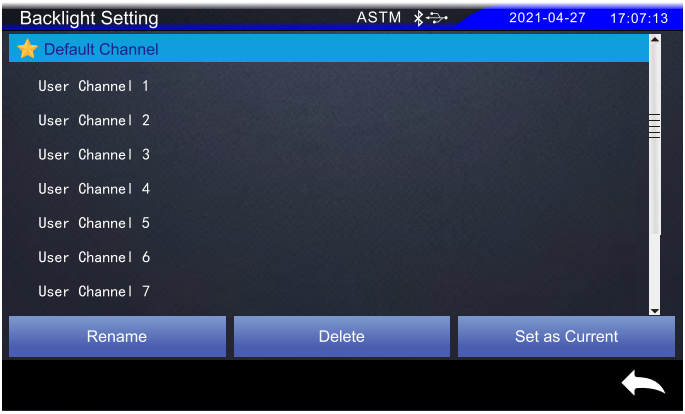


Figure 82 Calibration Channel Setting

3.8.10 Languages

Languages setting is used to set the language of the instrument interface. In the system settings interface, click "Languages", select the corresponding language and click OK “ ✓ ” . As shown in Figure 83.

Figure 83 Languages Setting Interface

3.8.11 Date / Time

When the instrument leaves the factory, the local time of the manufacturer is usually synchronized, and the user can also set the time of the instrument according to the actual situation. Click "Date/Time" on the system setting interface to enter the year, month, day, hour, minute, and second setting interface, as shown in Figure 84. After setting, click OK " ✓ " to save the settings, and click Return " ↩ " to cancel.

Figure 84 Date/Time Setting Interface

3.8.12 Backlight Setting

Click "Backlight Setting" in the system setting interface to enter the backlight setting interface. You can select the screen brightness and backlight time, as shown in Figure 85.

Move the brightness adjuster left and right in the "Brightness" setting bar to adjust the screen brightness.

The backlight time includes: "Keeps on", "1 minute", "5 minutes", "10 minutes", "30 minutes". If you choose to keeps on, the screen will not automatically turn off when there is no operation. If it is set to "1 minute", the instrument will count the time from the last operation and will go off after 1 minute, and it will enter the power saving mode. The meanings of "5 minutes", "10 minutes" and "30 minutes" are the same as above.

The instrument can turn on the display by short pressing the "measurement button" or lightly touching the screen during the backlight time. The default screen backlight time of the instrument is "5 minutes", making it in power saving mode.

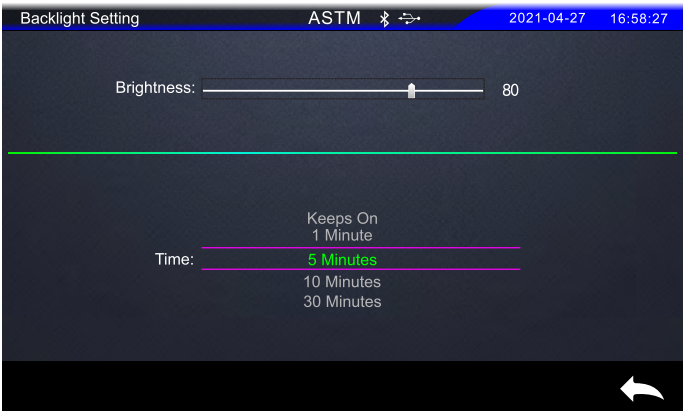


Figure 85 Backlight Setting Interface

3.8.13 Restore Factory Setting

Click "Restore Factory Setting" in the system settings interface, and you will enter the interface shown in Figure 86. Click OK “ ” to clear all measurement records and user settings and restore to the factory state. Click Return “ ✓ ” to cancel this operation.

Note: This operation will clear all data and user settings and restore to the factory default state. All data cannot be restored. Please operate with caution.

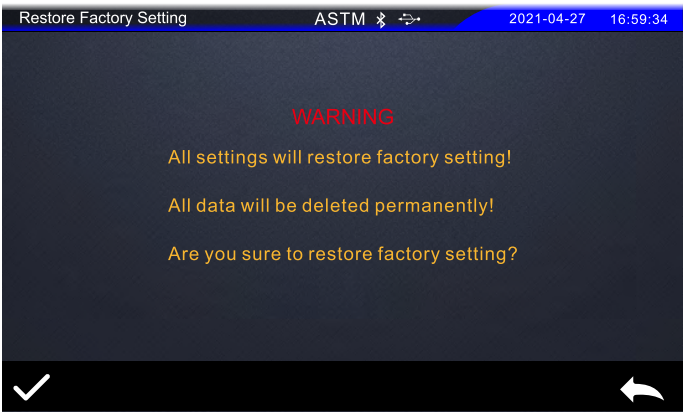


Figure 86 Restore Factory Setting Interface

3.8.14 About Instrument

Display the instrument model, SN code and current software and hardware version.

IV. Care & Maintenace

1) This instrument is a precision optical instrument. Please keep and use the instrument properly. Avoid using and storing the instrument in humid, strong electromagnetic interference, strong light, and dusty environments. It is recommended to use and store the instrument in a standard laboratory environment (temperature 20-25 degrees Celsius, 1 standard atmosphere, humidity 30-70%RH).

2) The standard haze film is a precision optical element, which should be kept and used properly, and the surface should be kept clean when using it. Avoid bumping with sharp objects, staining the haze film with dirt, and avoid exposing it to strong light. The surface of the haze film is extremely sensitive. It is strictly forbidden to wipe the surface of the haze film with anything to avoid scratches by dust.

If the surface of the haze film is covered with dust, use a balloon to blow away the dust. If the surface of the haze film is covered with stains, it can be cleaned with distilled water. Use a new soft cloth to ensure that there are no particles that may damage the surface of the haze film. Wipe gently. To remove stubborn dirt, add a small amount of acid-free household detergent to distilled water and wash in distilled water. After cleaning, dry it with oil-free compressed air to blow off residual dust or fluff.

Do not expose corrosive cleaning agents, such as solvents, alcohol, trichloroethylene, benzene, strong alcohols, acids or alkalis, polishing agents, and other destructive chemical cleaning agents to the haze film.

If the surface of the haze film is severely scratched and damaged, it is recommended to replace the haze film with a new one.

Do not refill the package with other cotton or paper dusty materials in the haze film packaging box.

3) In order to ensure the validity of the measurement data, it is recommended that the entire instrument and the haze film be inspected by the manufacturer or a qualified metrology institute for one year from the date of purchase.

4) This instrument is powered by an external power adapter. Please use the original power adapter. At the same time, 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 prolong the service life of the power supply.

5) Please do not disassemble or assemble the instrument privately. If you have any questions, please contact the relevant after-sales staff, tearing up the easy-to-tear label will affect the after-sales maintenance of the instrument.

V. Specificaitons

5.1 Features

1) High hardware configuration: 7-inch TFT color capacitive touch screen, Bluetooth 5.0, up to more than 25,000 storage capacity;

2) High optical resolution, dual optical paths, concave grating, 256-pixel CMOS detector, long-life full-spectrum LED;

3) Measure the transmission spectrum of the sample, and the chromaticity data such as Lab is accurate, which can be used for color matching and accurate color transmission;

4) Various measuring apertures: conventional aperture Φ20mm, Φ15mm, Φ8mm, Φ4mm can be customized;

5) Temperature monitoring and compensation, built-in temperature sensor to monitor and compensate the test environment to ensure more accurate measurement results;

6) Long-life, full-spectrum LED, wavelength range 400~700nm;

7) Independent light source detector, which constantly monitors the change of light source to ensure the reliability of the light source;

8) A variety of measurement modes to adapt to more customer needs;

9) A variety of accessories and fixtures (optional), suitable for more working conditions;

10) PC color management software has powerful extended functions.

5.2 Specifications

Model	Color Haze Meter
Optical Geometry	Transmittance:0/D (Parallel light illumination,diffuse viewing) Conforms to:ASTM D1003/1044,ISO 13468,ISO 14782,GB/T 2410,JJF 1303-2011,CIE 15.2,GB/T 3978,ASTM E308,JIS K7105,JIS K7361,JIS K 7136
Character	The instrument can easily achieve ASTM D1003 non-compensation method, ISO 13468 compensation method, total transmittance, haze test, clarity test. (Some models have no clarity) The instrument can accurately collect the transmittance curve of the transmission sample, and can accurately output various chromaticity data of the transmission sample. High hardware configuration, the measurement area is open, and it can be tested vertically and horizontally. It is widely used in glass processing, plastic processing, film, display processing, packaging industry, liquid chemical analysis, etc.
Integrating Sphere Size	Φ154mm
Light Source	400nm to 700nm long-life full-spectrum LED light source (wavelength can be extended, need to be customized)
Specular Component	Concave grating
Sensor	256 pixel CMOS sensor
Wavelength Range	400nm to 700nm (wavelength can be extended, need to be customized)
Wavelength Interval	10nm

Semiband Width	10nm
Transmittance measurement range	0~100%
Measuring Aperture	Φ20mm/Φ15mm/Φ8mm/Φ4mm(Select a single aperture)
Sample Size	Thickness < 105mm
Color Space	CIE LAB,XYZ,Yxy,LCh,s-RGB,βxy
Color Difference Formula	ΔE*ab,ΔE*94,ΔE*00,ΔE*cmc(2:1),ΔE*cmc(1:1),ΔE*cmc(l:c)
Other Colorimetric Index	Haze(ASTM D1003/1044,ISO13468),Transmittance T(ISO),Transmittance T(ASTM),Clarity WI (ASTM E313, CIE/ISO, AATCC, Hunter), YI (ASTM D1925, ASTM 313), Absorbance, Cobalt Platinum Index, Gardner Index
Observer Angle	2°/10°
Illuminant	D65,D50,A,C,D55,D75,F1,F2(CWF),F3,F4,F5,F6,F7,F8,F9,F10(TPL5),F11(TL84),F12(TL83/U30)
Displayed Data	Spectrogram, sample chromaticity value, transmittance, haze, color difference value/graph, chromaticity graph, color simulation, pass/fail result
Measuring Time	About 3s
Haze resolution	0.01unit
Haze repeatability	Φ20mm,within 0.2 (After preheating and calibrating the instrument, test the maximum difference of the standard haze film with a haze of about 10 at an interval of 5s for 30 times)

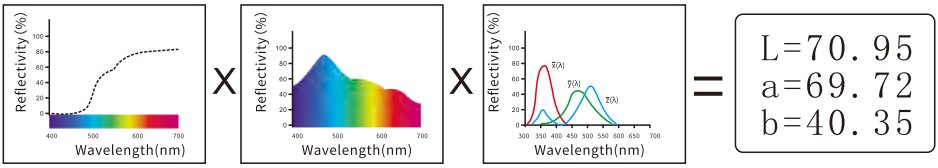
Inter-instrument Error	Φ20mm,with 0.4 （After preheating and calibrating the instrument, test the standard deviation between the standard haze film and the reference value at an interval of 5s.）
Dimension	Horizontal:L*W*H=487X260X298mm Vertical:L*W*H=290X211X511mm
Weight	Horizontal:About 8.0kg Vertical:About 7.6kg
Power	AC 24V, 3A Power adapter power supply
Illuminant Life Span	5 years, more than 3 million times measurements
Display	7-inch TFT color LCD, Capacitive Touch Screen
Data Port	USB & Print serial port, Bluetooth
Data Storage	Standard 5000 pcs,sample 30000 pcs(Different models are different)
Language	Simplified Chinese,Traditional Chinese,English
Operating Environment	0~40℃ （32~104°F）
Storage Environment	-20~50℃ （-4~122°F）
Standard Accessory	Power Adapter, User Guide,Quality Management Software (download from the official website),USB cable,aperture,clarity calibration board (only for instruments with clarity function),% calibration cover, compensation port cover
Optional Accessory	Micro-printer,Test fixture, standard haze film, foot switch
Note:	The specifications of different models of the instrument will be different, the above specifications are for reference only, pls subject to the actual sales products.

Appendix

1.What are colors

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

The object can affect the final color perception because the reflection spectrum (transmission spectrum) of the object modulates the light source spectrum. Different objects have different reflection spectrum (transmission spectrum). The light source spectrum is modulated by the reflection spectrum (transmission spectrum) of different objects to obtain different results. Because the observer does not change, it presents different colors. The principle is shown in the figure below.



2.What's the Color Difference Formular

The CIE 1976 color difference formula ΔE*ab is as follows:

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

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

The CIE 2000 color difference formula ΔE00 is as follows:

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

$$L' = L^*$$

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

$$b' = b^*$$

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

The 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.How to evaluate the color

Large △L (positive) means whitish, small △L (negative) means blackish

Large △a (positive) means reddish, small △a (negative) greenish

Large △b (positive) means yellowish, small △b (negative) blueish

4.How human eyes distinguish the 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 American National Bureau of Standards adopted the color difference calculation formula and calculated according to this formula When the absolute value of the color difference is 1, it is called "NBS color difference unit". The new color difference formula developed later often consciously adjusted the unit to be close to the NBS unit. For example, the units of Hunter Lab, CIE LAB, CIE LUV and other color difference formulas are roughly the same as the NBS unit (not equal). Therefore, do not misunderstand that the color difference units calculated by other color difference formulas are all NBS.

The approximate correspondence between human vision and NBS is shown in the following table.

NBS Unit and the Degree of Color Difference Perception

NBS unit color difference value	Degree of Color Difference Perception
0.00～0.50	(Slight color difference) It feels minimal (Minimal)
0.50～1.50	(Small color difference) It feels slight (Slight)
1.5～3	(Smaller color difference) It feels obvious (Obvious)
3～6	(Larger color difference) It feels very obvious(Appreciable)
6 or more	(Large color difference) It feels strong (Much)

5.Compensation measurement and non-compensation measurement of transmittance

1) Terms and definitions:

Haze: The ratio of the scattered luminous flux that deviates from the incident light direction through the sample to the transmitted luminous flux, expressed as a percentage (for this method, only the scattered luminous flux that deviates from the incident light direction by more than 2.5° is used to calculate the haze) .

Luminous transmittance: The ratio of the luminous flux passing through the sample to the luminous flux hitting the sample, expressed as a percentage.

According to the above definition of luminous transmittance, there are currently two different standards to measure this data. They are the American standard (ASTM standard) and the international standard (ISO standard). These two standards respectively correspond to the non-compensation method of transmittance measurement and the compensation method of transmittance measurement.

2) Non-compensation measurement method

When the standard reflectance plate is placed at the light exit port of the light path, the measurement is performed when the sample is removed. The data read by the photoelectric sensor is T1, which is the total energy of the incoming light. Place the sample in the transmission port for measurement. The data read by the photoelectric sensor is T2, which is the total energy of the incident light absorbed by the sample. Then the calculation formula for transmittance can be obtained:

$\tau = T2/T1$

The above is the transmittance of the sample, and this method is the transmittance measured by the non-compensation method.

3) Compensation measurement method

In the above non-compensation measurement method, if we study carefully, we will find that when we measure T2, the value of T2 is not only the total energy of the incident light absorbed by the sample, but also includes includes the reflected energy of the sample surface after the integrating sphere is illuminated to the sample surface, and we did not consider the reflected energy of the sample surface when measuring T1. This is a certain deviation that occurs when the non-compensation method measures light transmittance. Therefore, the International Organization for Standardization (ISO) proposed a method for measuring transmittance based on compensation.

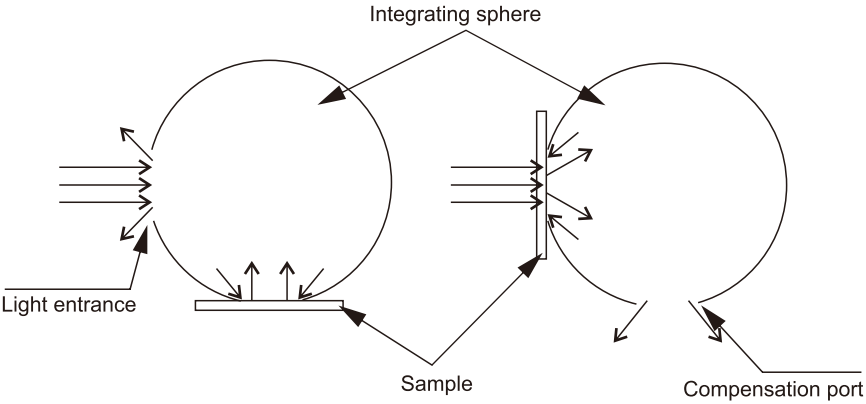


Figure 60 Schematic diagram of measurement principle of compensation method

The measurement method of the compensation port is as follows. First, place the sample surface on the compensation port and measure the total energy T1 of the incident light. At this time, the T1 value already includes the reflected energy value of the illuminated integrating sphere irradiated on the sample surface, and then place the sample at the transmission port and measure the total energy value T2 of the incident light after passing through the sample. The T2 value at this time also includes the reflected

energy value of the illuminated integrating sphere irradiated on the surface of the sample. Then the calculation formula of transmittance can be obtained:

$\tau = T2/T1$

The transmittance value at this time takes into account the reflection of the sample surface and is more accurate. This method is the transmittance measured by the compensation method.

Based on the above-mentioned test principle and formula derivation and comparison of actual test data, the transmittance measured by the non-compensation method is slightly different from the transmittance measured by the compensation method, but the difference is not large. The transmittance measured by the compensation method is more accurate.