CMS-2S
Fast Spectroradiometer

USER'S MANUAL

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Chapter 1 Summary and specification

Light is an electromagnetic wave. Its visible light wavelength is 380nm-780nm with special wavelength. Less than 380nm is ultraviolet rays ,more than 780nm is infrared. Human eye can get reaction of" bright" and" color " on 380nm-780nm wavelength. So it has a special significance for the measurement of this wavelength.

The human eye to " bright" and" color" by this wavelength is a kind of subjective quantity response in the category of psychophysics. It offers objectively and unified evaluation of the light source or the color of the object. The International Commission on illumination CIE makes a unified evaluation and value transmission method based on a large number of psychology and physics experiment.

Luminous efficiency, spectral power distribution and chromaticity parameters are the important quality index of various light sources and light emitting material . CMS-2S fast spectral analysis system is designed on the basis of the CIE standard with effective control of the quality indicators. It has a very important significance for all types of light source and luminous materials research and production.

CMS-2S fast spectral analysis system adopts the international most advanced holographic concave grating spectrophotometric technique. Its optical path design is unique with extremely low stray light. Testing accuracy and repeatability can be comparable to import similar products.

Chapter 2 main function and technical index

1, Test parameters:

(1)relative spectral power distribution: P(λ)

(2) chromaticity coordinates: (x, y), (U, V)

(3) correlated color temperature: (Tc)

(4) color index: Ra; Ri (I = 1-15)

(5) color tolerance (including the international and national standards)

(6) peak wavelength, half width

(7) red ratio

(8)photometric parameters: luminous flux, relative brightness

(9) environment temperature

(10) main wavelength, color purity

2,Measured wavelength range:

380nm-780nm (visible light), offers 200nm-1100nm for special(UV to near infrared)

3,wavelength accuracy:±0.3nm repeatability :±0.1nm

4, accuracy of chromaticity coordinates: ± 0.0005 (standard A light source), ± 0.003 (LED light source)

5, system spectrophotometric linear: ± 0.3%

6, correlated color temperature measurement range: 1500k-100000k

7, correlated color temperature accuracy:±0.3%

8, color rendering index measurement error: ±(0.3%rd+0.5)

9, requirements of working environment:

(1)working environment temperature: 0 ~ 35℃

(2) optimum temperature for normal measurements of : 25 ±2 ℃

(3) relative humidity: less than 80% (without dew, recommended to install dehumidify machine);

10, size and weight:

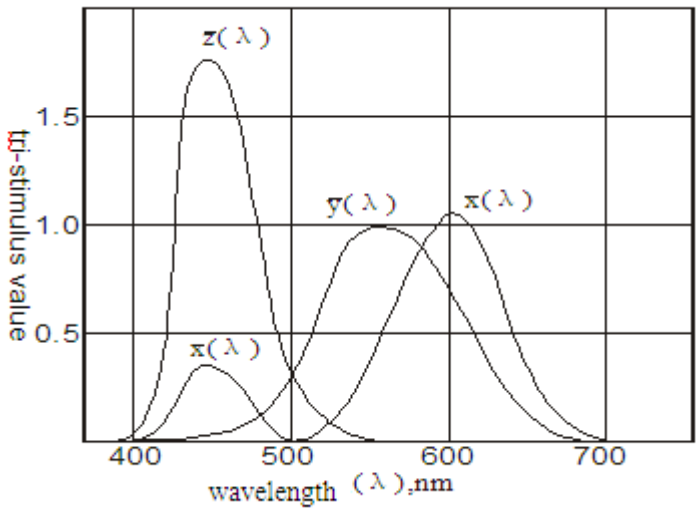
(1) size: length x breadth x height (251mm * 246mm * 106mm)

(2): weight: about 3.8kg

Chapter 3 basic principles

One basic principle

The color is subjective quantity in fact. It's objective and unified evaluation for the light source or the color of the object. The CIE (International Commission on illumination) recommend " CIE1931XYZ standard colorimetric system" on the basis of a large number of psychology and physics.Its tri-stimulus value function is as shown in figure 1:



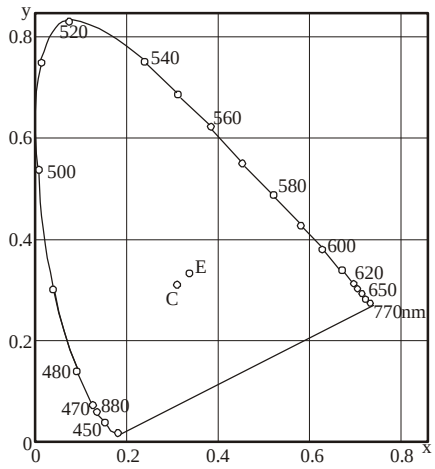
Picture 1 CIE 1931 XYZ tri-stimulus value

For a luminous object ,if the emission spectrum is P (λ), its tri-stimulus value :

$$\begin{cases} X=k\int_{380}^{780} P(\lambda)\cdot\bar{x}(\lambda)\,d\lambda \\ Y=k\int_{380}^{780} P(\lambda)\cdot\bar{y}(\lambda)\,d\lambda \\ Z=k\int_{380}^{780} P(\lambda)\cdot\bar{z}(\lambda)\,d\lambda \end{cases}$$

Chromaticity coordinates: $x=\frac{X}{Y+X+Z}$, $y=\frac{Y}{Y+X+Z}$

In nature, all colors can be found in the horseshoe chromaticity diagram of the CIE 1931 XYZ color system. And it can be shown in chromaticity coordinates (x, y), as shown in Figure 2a. Because CIE 1931 XYZ standard colorimetric system has the problem of uneven color difference tolerance etc. in practical application, CIE recommends CIE 1964 standard color system, as shown in Figure 2b.



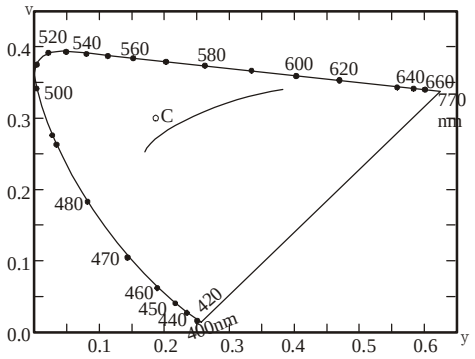


Figure 2a CIE1931XYZ Chromaticity diagram Figure2b CIE 1960 UCS Chromaticity diagram

In fact, (x, y) and (U, V) there are one one corresponding relations. They both show the position of color coordinates. They are only two different color space representation. Their coordinate transformation relation as follows:

$$\begin{cases} u = \dfrac{4x}{-2x+12y+3} \\ v = \dfrac{6y}{-2x+12y+3} \end{cases}$$

In Figure 2b, the middle curve represents a radiation light color coordinates point's path for a blackbody at different temperature. If a luminous body color and temperature of blackbody radiation light have the same color, that is to say: they have the same coordinate chromaticity diagram, we call the blackbody temperature as a luminous body temperature. In the real world, most of the luminous body, such as the three color fluorescent lamp, fluorescent powder. Their color coordinates' point is not in the blackbody locus, at this time,it can be shown with the correlated color temperature. When the luminous body color and a temperature of blackbody radiation are the closest, we call the blackbody temperature as a luminous body's correlated color temperature. In CIE 1960 UCS chromaticity diagram, vertical line can be made from the illuminant chromaticity coordinates to blackbody track. We get the blackbody temperature corresponding to the pedal point. It is the correlated color temperature of the luminous body . As long as the measured illuminant chromaticity coordinates we get, we can calculate the correlated color temperature.

When the fluorescent powder or fluorescent, in the same chromaticity coordinates, shine some object, the objective effect is not all the same. Colors show ability of

some fluorescent powder or fluorescent is strong, that is to say it has high color-rendering index. Conversely, it has low color rendering index. In order to assess color index of the luminous body (or light), CIE provides 14 kinds of Standard Test colors. Measured light and blackbody radiation of the same color temperature are calculated for illumination test. Both of the color △E. We can obtain special color rendering index Ri:

$$Ri = (100 - 4.6\triangle Ei)(i = 1–15) \qquad (4)$$

For test color 1-8 , the average value of the 8 special color index is called the general color rendering index Ra:

$$Ra=\frac{1}{8}\sum_{i=1}^{8}Ri \qquad (5)$$

15 standard test color in the check of color rendering properties by CIE

No.	Approximation of Meng	Color temperature in the light
1	7.5R6/4	grayish red
2	5Y6/4	grayish yellow
3	5GY6/8	deep yellow green
4	2.5G6/6	moderate yellowish green
5	10BG6/4	light-blue green
6	5PB6/8	light blue
7	2.5P6/8	light blue Rolland color
8	10P6/8	reddish purple
9	4.5R4/13	deep red
10	5Y8/10	deep yellow
11	4.5G5/8	deep green
12	3PB3/11	deep blue
13	5YR8/4	light yellow(the color of one's skin)
14	5GY4/4	moderate olive green (leaves green)
15		Chinese women’s skin

In all, so long as the relative spectral power distribution of light source is measured, we can calculate the chromaticity coordinate, the correlated color temperature and color rendering index. A t the same time, the photometric parameters of luminous flux and illuminance can be obtained after calibration for photometric parameters.

Two, instrument principle

According to the basic theory, as long as the measured spectral power distribution

can be obtained, we can calculate the parameters of the brightness and chromaticity through the method of photometric, colorimetric. Spectral power distribution P（λ）, is the fundamental task for CMS spectrum analysis system. Figure 3 is the principle diagram.

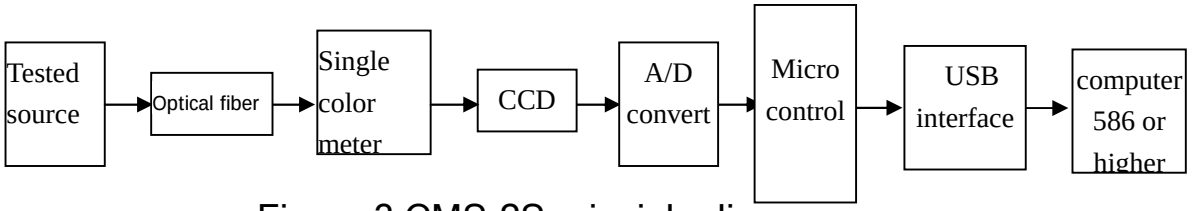


Figure 3 CMS-2S principle diagram

As shown in Figure 3, the light source is placed in the integrating sphere. It emits light, then light goes through the fiber, they are gathered in the incident slit of spectrometer. It passes the internal holographic concave grating, it forms “color band”. Then it is converted into an electrical signal by CCD .After the circuit process and A / D conversion, it is put into the micro controller. Finally digital signal can be sent to the computer through USB interface by the micro controller. Software system of the computer can calculate various parameters.

Spectral power distribution: P （λ）, integrating sphere spectral reflectance: P （λ）, spectral transmittance of optical fiber, optical system and color filter:τ(λ) , transmission efficiency of spectrometer : τ(λ), CCD spectral sensitivity: S（λ）. Then the current signal Iph（λ）is:

$$Iph(\lambda) = P(\lambda) * \rho(\lambda) * \tau(\lambda) * T(\lambda) * S(\lambda)$$
$$= P(\lambda) * K(\lambda) \qquad (6)$$

K（λ）: spectral response constant of test system, Iph (λ):it is composed of a signal amplification, processing circuit and computer system test. K (λ): It can usually be obtained through the calibration from the standard radiator (such as 2856K standard A source) of he known spectral power distribution to the measurement system. For the calibration of a standard light source: SL , electric current is Iphs (λ)

$$Iphs(\lambda) = Psl(\lambda) * \rho(\lambda) * \tau(\lambda) * T(\lambda) * S(\lambda)$$
$$= Psl(\lambda) * K(\lambda) \qquad (7)$$

Then the spectral response constant of measuring system: K（λ）=Iphs（λ）/Psl（λ）（8）.

Then in formula (6), we can obtain spectral power distribution of measured light source P(λ) :

$$P(\lambda) = \frac{Iph(\lambda)}{K(\lambda)} = \frac{Iph(\lambda)}{Iphs(\lambda)} * Psl(\lambda) \qquad (9)$$

If there is difference between Psl（λ）and P′sl（λ）,
Then the formula(7)and formula(8) are shown below:

$$Iphs'(\lambda) = P'sl(\lambda) * K(\lambda) \qquad (10)$$

$$P(\lambda) \frac{Iph(\lambda)}{Iphs(\lambda)} * Psl(\lambda) \qquad (11)$$

Because of Iph′s（λ）≠Iphs（λ）or P′sl（λ）≠Psl（λ）,there is error for the P（λ）measurement. But CMS-2 itself has good repeatability, stability and linearity. For bringing smaller error to the whole system, we should make P (λ) measurement with smaller error. It's necessary to select standard light source with better reproducibility. It's the grantee of high accuracy.

Chapter 4 system composition and installation

One Basic system composition

CMS-2S ,the basic structure of the system is relatively simple. Including the PC computer (usually configured by user, including color display, mouse, and WinXP / 2000 operating platform, USB interface), USB cable, CMS-2S host, fiber and special software.

Figure 4a is front view of the host, figure 4b is back view of the host.



Figure 4a CMS-2S front view

“POWER”：Light on, shows that USB is connected, system and computer are connected.

“USB”： Light on ,shows that the USB connection is normal, system and computer is normal.

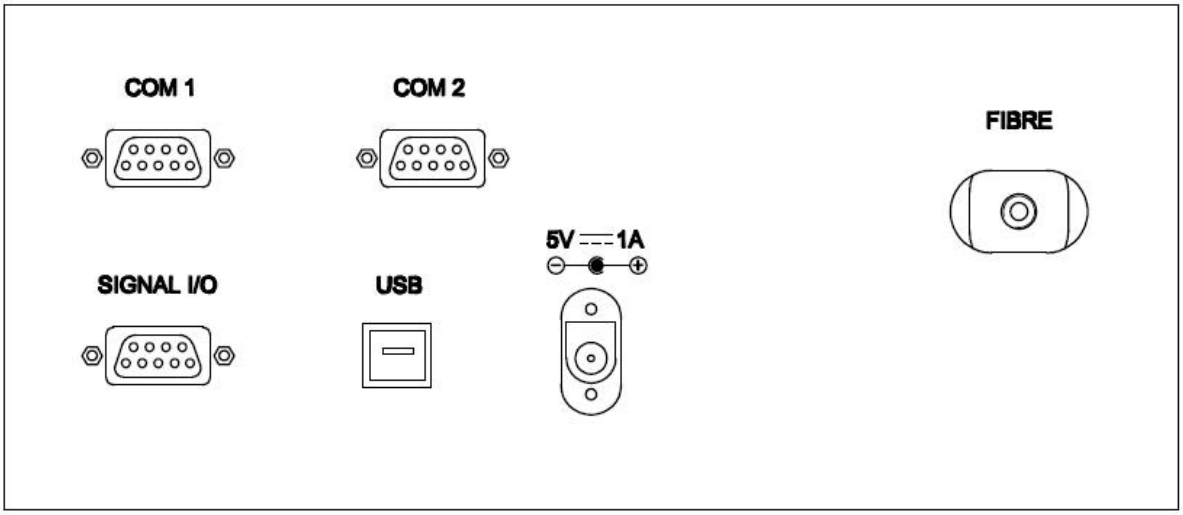


Figure 4b CMS back view

USB interface: insert USB interface communication cable, and a connection with host computer;

RS232 interface: used to the connection for other instruments, to get photoelectric

parameters;

5V / 1A interface: the external power supply interface, used to connect with power adapter (optional);

Fiber interface: interface of fiber, connect with fiber, measured light will be input to the instrument;

SIGNAL I / O: external signal input and output ports (according to customer's need);

The pin is defined as:

1-GND, 2-IN1, 3-GND, 4-IN2, 5-NA, 6-GND, 7-OUT1, 8-GND, 9-OUT2

The trigger is for the rising edge trigger.

Chapter 5 system requirement

System requirement

1, operating system is Chinese Windows98 / 2000 / XP or an upgraded version;
2, hard disk space: more than 10M;
3, display resolution: above 1024x768;
4, the host should have a USB1.1 interface.

Two software and hardware installation

1.USB driver installation

Install USB driver before USB cable is inserted into the computer. If the USB cable is already inserted into the computer, please unplug the cable and cancel the computer operation, then start the operation.

Operation: the companion CD is inserted into the disc driver, the desktop displays" found new hardware guide". select "install from a list or specific location (Advanced)".click" next", choose the companion disc " Driver "folder, then click" next" to complete the installation. USB driver is installed in the end.

2.CMS-2S software installation

CMS-2S software starts to install after a successful installation of USB driver. The companion disc (CMS-2S) is inserted into the disc driver, find the setup file :CMS-2S(plus) CS (13.6.8).exe. double click to run it, the software into installation welcome interface, according to the prompt information, click "next" to complete the installation. After installation, run the program shortcut (CMS-2S fast optical electric integrated test system), will be placed on the Windows desktop. At the same time, generate CMS-2S program folder in INVENTFINE instrument folder in Windows start menu.

3. Hardware installation

After successful installation of the software, one end of USB cable is inserted into the CMS-2S host, another end is inserted into the USB interface of the computer.

Indicator lamp" POWER" of CMS-2S host is on ," USB" lamp is on in the beginning, When USB has been successfully connected ,the light will be off. You can start with the software measurement.

If" POWER" indicator lamp is not bright, or" USB" indicator lamp is bright all the time, it shows host isn't connected successfully. Please unplug USB line of CMS-2S host, wait a few minutes and then plug it back. Let the system reinitialize again.

Three, software operation

a) Enter the system

1, click" start" button, and then point to" program \ INVENTFINE instrument \ CMS-2S \", click " CMS-2S fast light electrical integrated testing system" shortcut into CMS-2S

main program window.

2 or click CMS-2S fast light electrical integrated testing system" shortcut on the desktop to enter the CMS-2S main program window

b) Software operation

Procedures initial interface shown in Figure 1

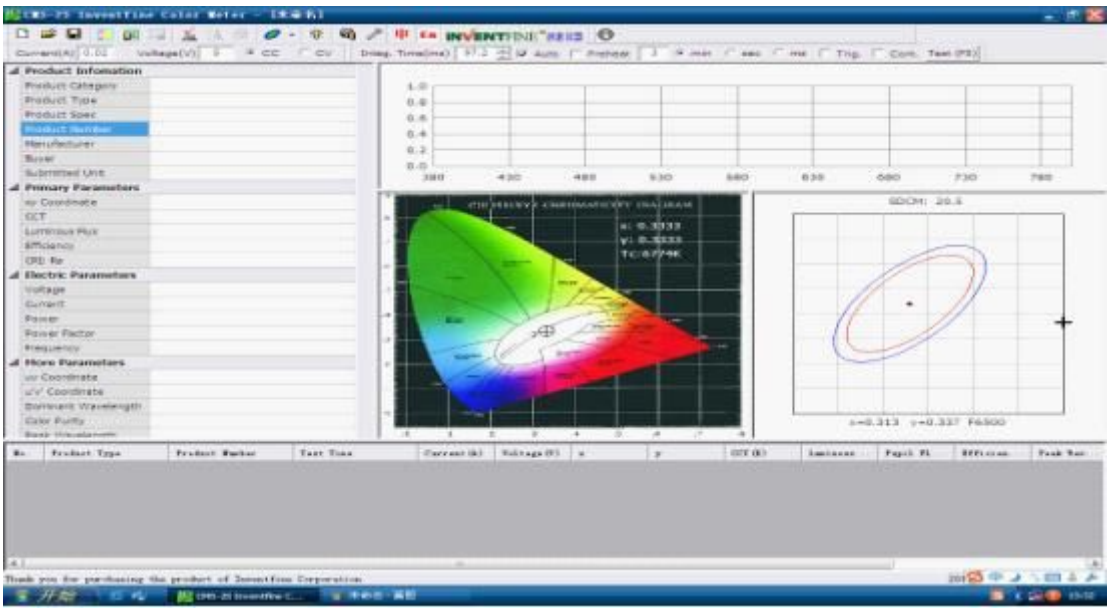


Figure 1

1 new file

For the new file, click on the button  in toolbar

2 view test report file

Click on the button  in toolbar, into view dialog box. Select the file you wnat to view. Click on the" open" button, file will open in the program (Figure 3)



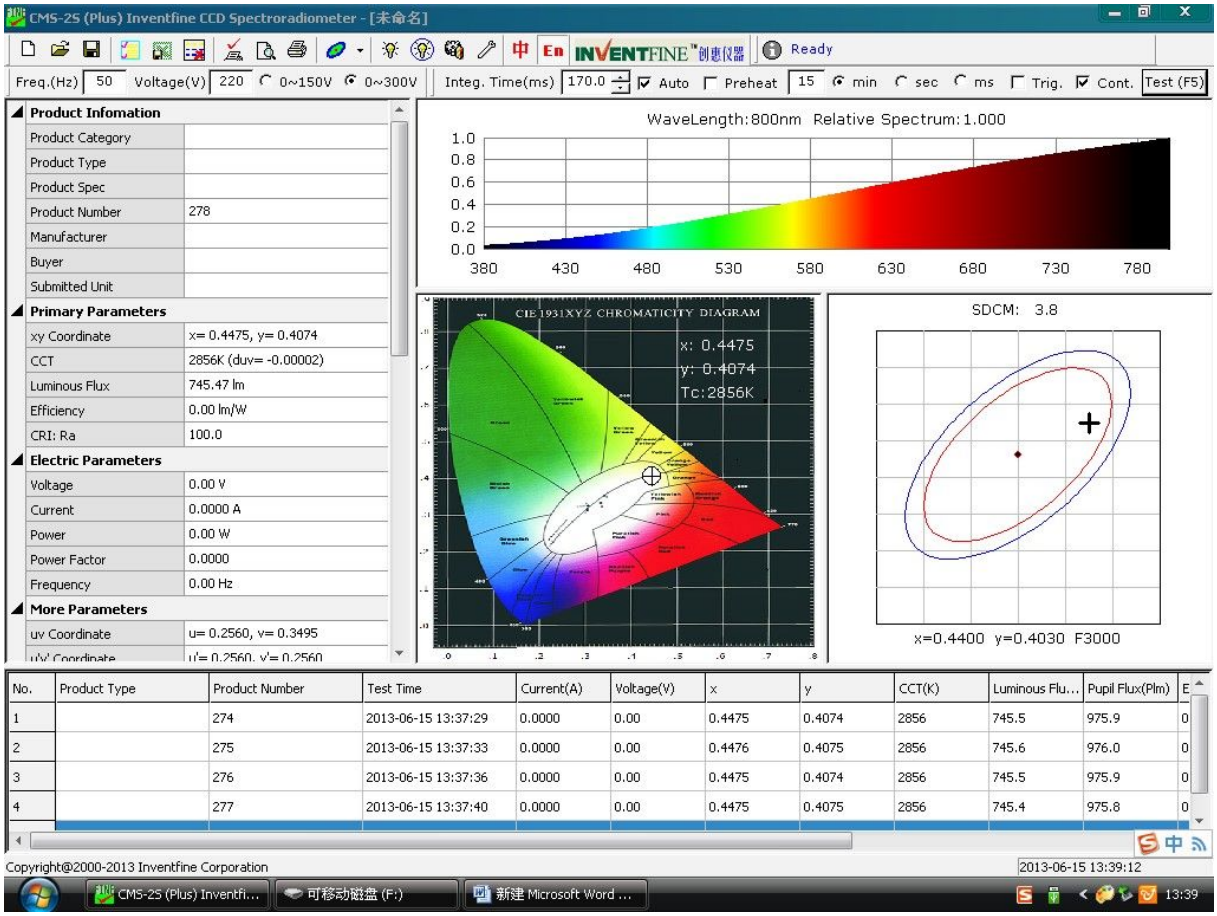


Figure 3

3 save the modified file

In the information bar, can enter the edit mode by double clicking on each of the data grid. You can modify the corresponding parameters. To save the modified file, select the file save menu or click the button  under the toolbar.



4 list item setting

Click the toolbar button , enter the setting list dialog box (Figure 3). Click the items that needs, and add them to the left side ,then make certain of it. After the add item finished, the whole items which can be used will be displayed in the list box.

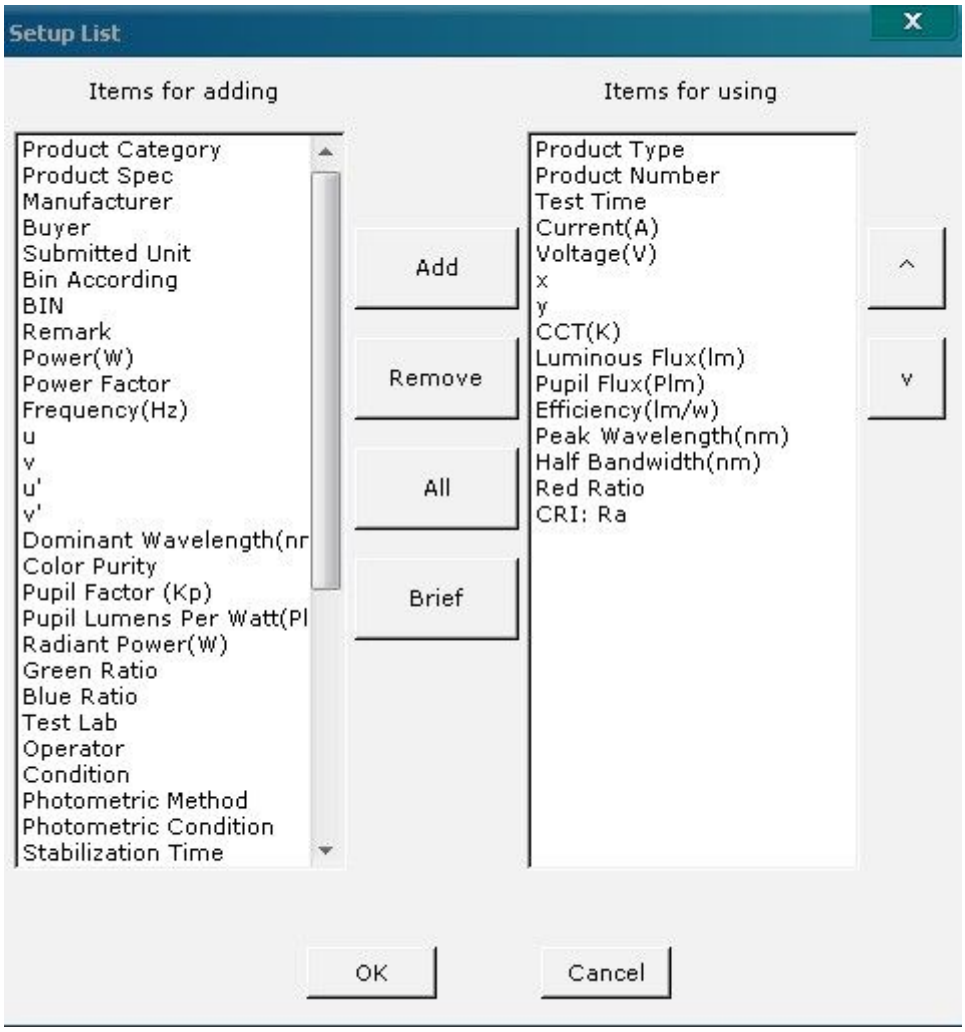


Figure 5

5 data export

If you need to export the data, click button in toolbar. Enter the export data dialog
Box(figure 6).

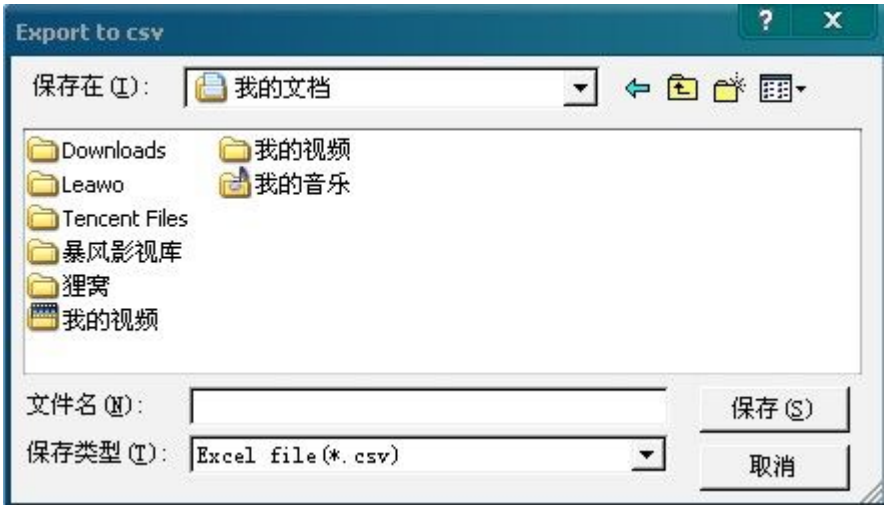


Figure 6

6 Color tolerance list setting

Click the button  in toolbar, enter the color tolerance list setting dialog box (Figure 7)

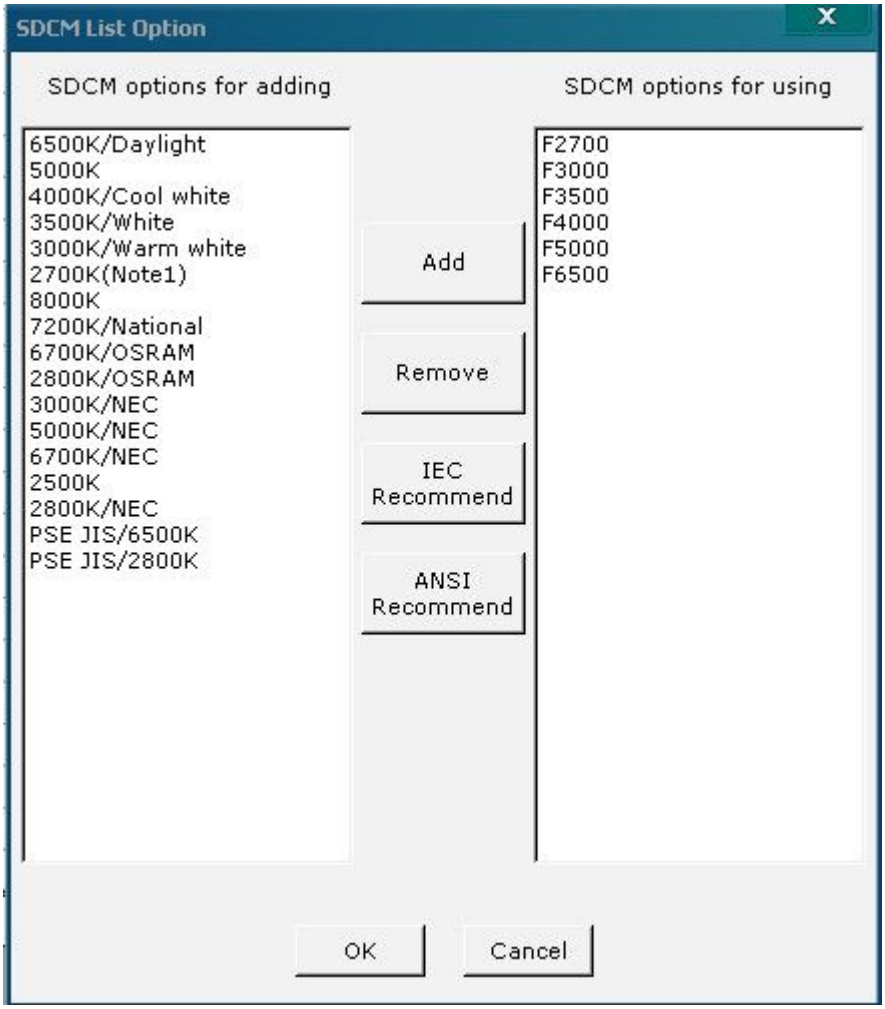


Figure 7

7 Spectrum (color temperature) calibration

1) before the first time test, must carry out spectrum calibration for the system ;

2) hardware connection: Put the spectral color temperature standard light into the integrating sphere, optical fiber is inserted into the optical interface of the integrating sphere, the wire of the integrating sphere is connected to power supply special for the standard lamps. The current of power supply can be adjustable to meet the given current value of color temperature standard light

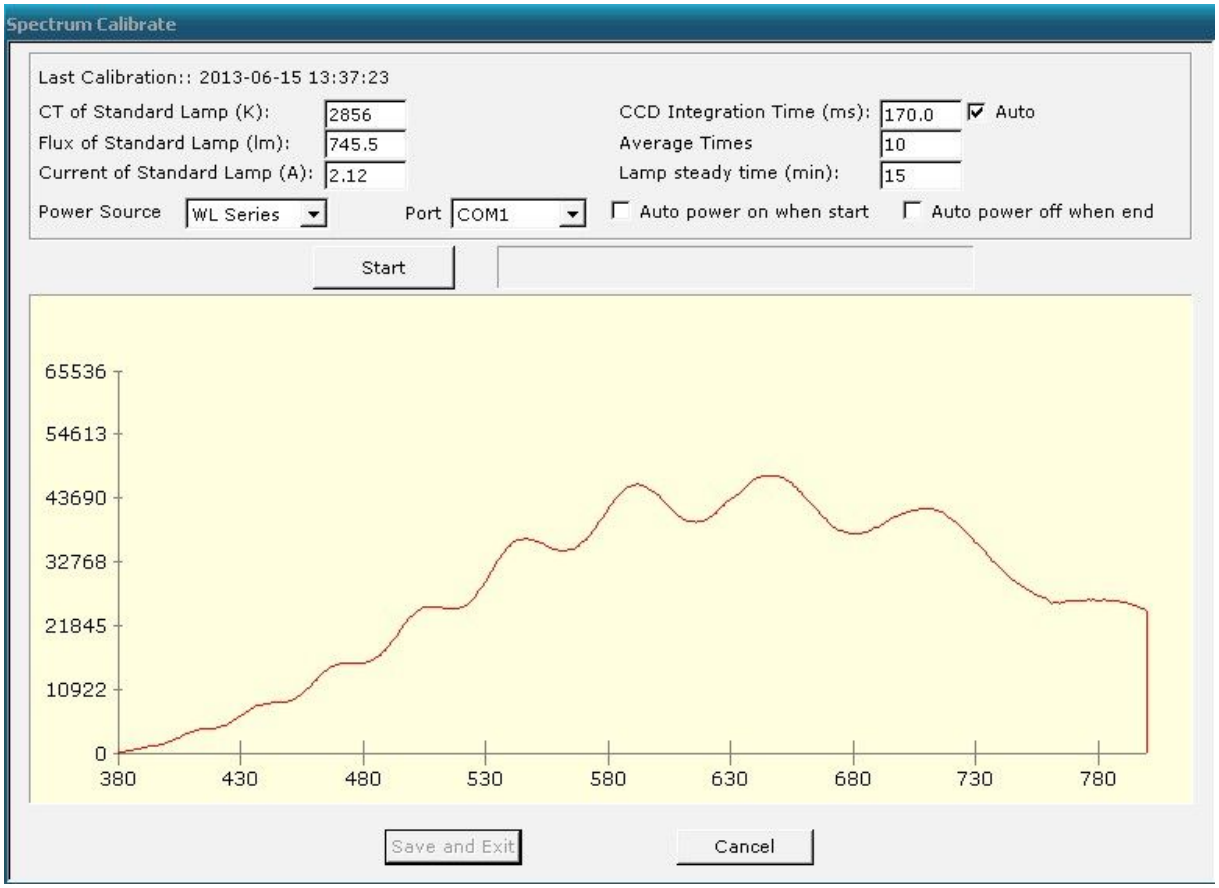


Figure 8 Spectral calibration window

8 system setting

Click the button  in toolbar; enter the system settings dialog box (Figure 6). According to the model you purchased, choose the correct power type, power meter model and photometer model. After the confirmation of correct selection, and ensure that communication lines of the test system are connected well, and then open the power of test equipment. And then click “automatic search communication port" on the test equipment column, the program will automatically find the communication port of the test equipment.

Note: In this program interface, first of all, click on the" automatic search of Communication port" .When operation is successful, we can perform other operations.

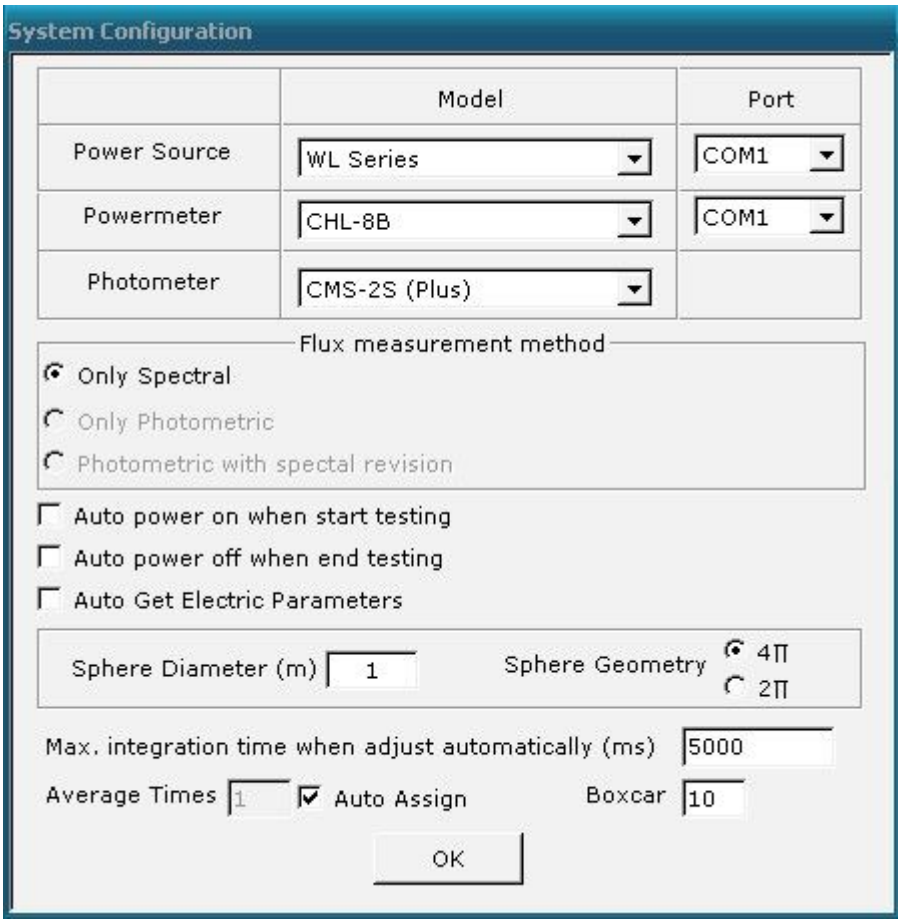


Figure 9

9 System debugging

You can contact our professional personnel to operate if needed.

10 Chinese and English software switch

Chinese and English software can be switched according to needs of users, press the button 中 to enter the Chinese software interface, press the button En to enter the English language software interface.

Four Typical report

INVENTFINE™ 创惠仪器

Inventfine Instrument Co., LTD
http://www.inventfine.com.cn
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Fax: 0571-88262100

Spectrum Test Report

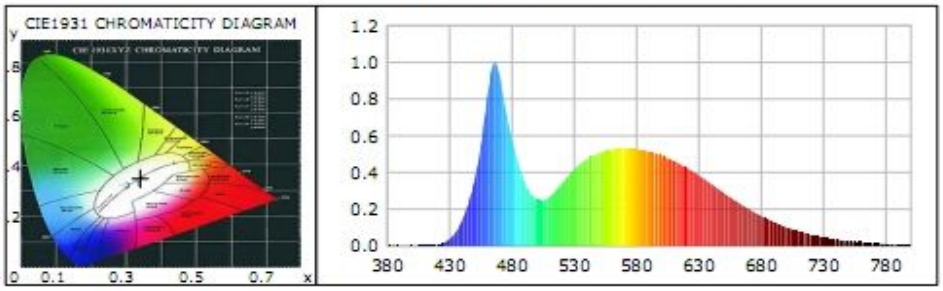
Product Infomation

Product Number: 60

CIE Colorimetric Parameters

Chromaticity coordinates: x=0.3410 y=0.3502 u(u')=0.2092 v=0.3222 v'=0.4834
CCT: Tc=5158K (duv=0.00097) Color Ratio: R=0.160 G=0.770 B=0.070
Peak Wavelength: 0nm Half Bandwidth: 28.9nm
Dominant Wavelength: 570.0nm Color Purity: 0.074
CRI: Ri: Ra= 85.6

R1 =88	R2 =98	R3 =98	R4 =72	R5 =81	R6 =89	R7 =84	R8 =77
R9 =48	R10=87	R11=69	R12=56	R13=92	R14=98	R15=87	



Photometric Parameters

Luminous Flux: 51.9 lm Efficiency: 98.49 lm/W Radiant Power: 0.173 W

Electric Parameters

Voltage: 3.51V Current: 0.1500A Power: 0.527W
Power Factor: 1.000 Frequency: 0.00Hz

Test Infomation
Scan Range: 380nm~800nm:1nm Photometric Method:
Stabilization Time: 0 Min Photometric Condition: Sphere diameter: 0.30m, 2π
Max of Signal: 43735 (3440) CCD Integration Time: 260.31 ms

Condition: Test Device: Inventfine CMS-2S
Test Lab: Test Time: 2012-08-06 09:07:08
Operator: Inspector:

Figure 10

Chapter 6 packing list

1) CMS-2S host 1 set
2) USB communication wire 1 pc
3) Sensor 1pc
4) Product manual (electronic version) 1pc
5) Product verification certificate 1 pc
6) Warranty card 1 pc
7) Product certificate 1 pc
8) Chinese and English software 1 pc

Note: Product manual(electronic version), Chinese and English installation software are all in CD!
Installation software and instrument numbers should be corresponding exactly , do not make them confused.