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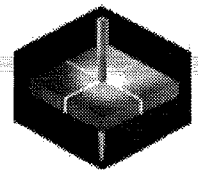
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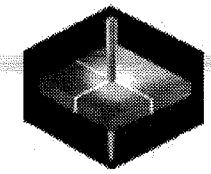
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Chapter 16



ColorQuest® II Sphere

Notice: Use of this equipment in a manner not specified by the manufacturer may impair the protection afforded by the equipment.

The ColorQuest II Sphere system consists of a ColorQuest II Sphere optical sensor and an IBM-compatible computer composed of the system unit, monitor, keyboard, and mouse. The computer may have been user-provided or purchased with the sensor and software. A printer may also be used with the system.

The ColorQuest II Sphere Sensor

The sphere sensor can measure either reflected or transmitted color of a product. The integrating sphere is a chamber six inches in diameter coated with barium sulfate ($BaSO_4$), which diffuses the light from the lamp. The light illuminates the sample and is either reflected from it or transmitted through it. A lens is located at an angle of 8° from the perpendicular to the sample surface. The lens collects the reflected or transmitted light and directs it to a diffraction grating. The grating then disperses the light into its component wavelengths. This dispersed light is reflected onto a 32-element silicon diode array which measures the light every 10 nanometers (nm) across the spectrum of 400 nm to 710 nm. The signals from the diode array are amplified using laser-trimmed operational amplifiers and processed by a 16-bit analog-to-digital converter. The computer receives the converted data and manipulates it to produce the information needed for display by the software.

The Power Switch

The sensor power switch is located on the right side of the sensor near the back.

The Reflectance Port

The reflectance port is located at the front of the sensor. The port is covered by a port plate with an opening of either 1 inch or 5/16 inch. When using the small area view lens, the 1/4-inch port plate must be installed at the reflectance port. Spring clamps can also be attached to the small holes of the port plate to aid in the placement of samples. The port plate is covered by a clamp which holds the sample in place during measurement. The clamp pulls straight back from the port and springs forward when released. The clamp also contains a damper to reduce the impact on the port when the clamp is released. The clamp can be removed from the sensor when you are measuring large or otherwise cumbersome samples.

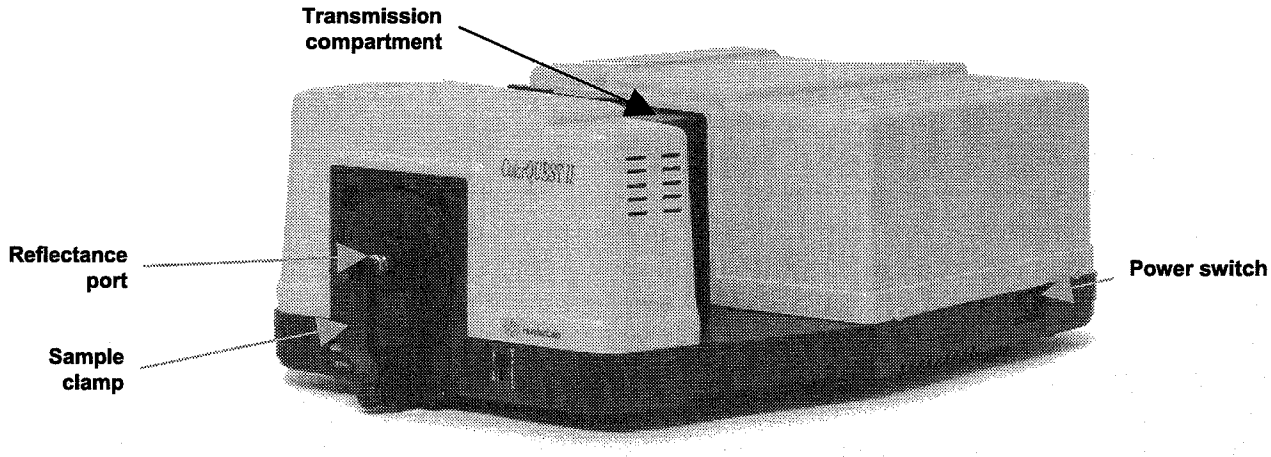
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The Specular Exclusion Port

When using RSIN, RTRAN, or TTRAN mode, you must keep the specular exclusion port door closed. However, when using RSEX, you must open the specular exclusion port door to allow the specular component to be excluded from the light collected by the receptor lens. The specular exclusion port is located on the sphere inside the transmission compartment, but is opened or closed using the knob on the left front of the sensor. Refer to the "Standardization" section of this chapter for a picture showing the location of the specular exclusion port knob and for more information on the various standardization modes.

The Transmission Compartment

The transmission compartment located in the middle of the sensor is used when measuring the transmitted color of transparent solids or liquids. In the transmission compartment you can also install the small area view lens. The transmission compartment door must be closed while standardizing and taking measurements.

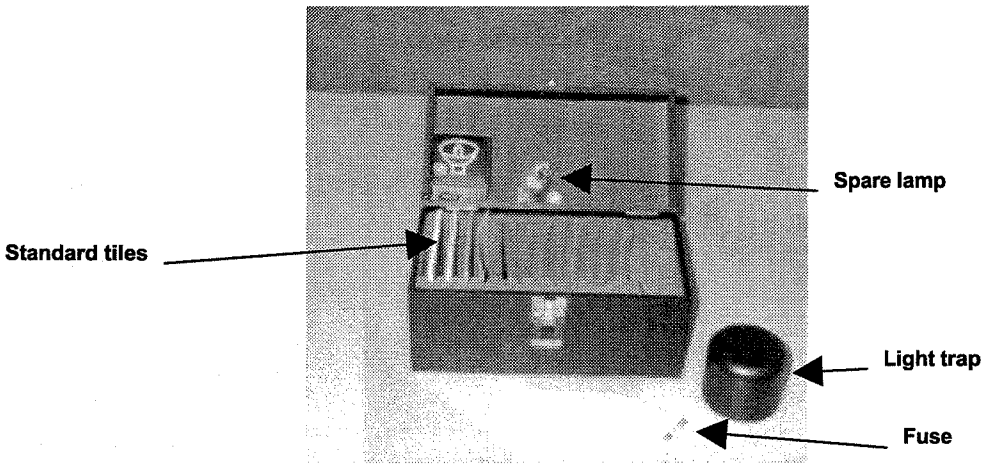


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Accessories

The following accessories are provided with the ColorQuest II Sphere system and can be found in the standards box:

- White calibrated tile - placed at the reflectance port during standardization.
- Gray calibrated tile - placed at the reflectance port during standardization in reflectance modes.
- Light trap - placed at the reflectance port during standardization in reflectance modes.
- Black card - placed in the transmission compartment during standardization in a transmittance mode.
- Green tile - used to check instrument performance. Use of the green tile is described on page 24-3.
- Tile data sheet - gives calibration information for the standard tiles.
- Standards care card - gives instructions on how to clean the standards.
- Fuse - a one-amp fuse is provided as a spare.
- Lamp - one lamp is provided as a spare.
- Certificate of traceability for the standard tile.



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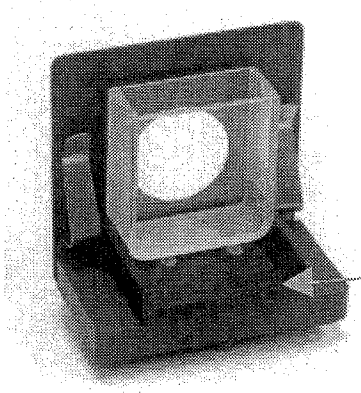
Options and Sample Devices

Any or all of the following options and sample devices may be included. HunterLab part numbers are included for your convenience.

- Transmission specimen holder and transmission cells (HL#C02-1004-009 for holder, 13-8573-20 for 50-mm cell, B04-1003-801 for 33-mm cell, 04-4592-00 for 20-mm cell, 13-8573-40 for 10-mm cell),
- Flow-through transmission cell holder and cells (HL#CMR1882 for holder, C04-1001-960 for 50-mm cell, C04-1001-959 for 20-mm cell, C04-1001-958 for 10-mm cell),
- Reflectance sample shelf and light cover (HL#L02-1004-770),
- Small area view lens, port plate, and retroviewer (HL#L02-1004-769),
- Ultraviolet-absorbing filter (HL#C02-1003-939).

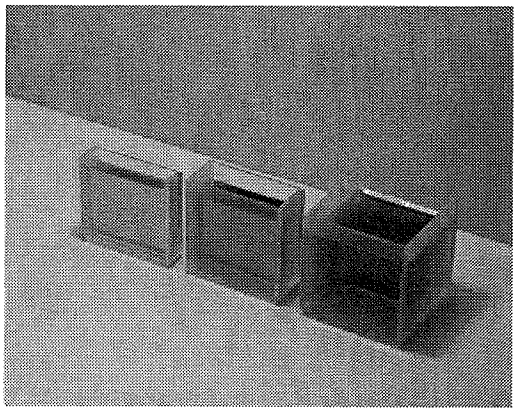
Transmission Specimen Holder and Transmission Cells

The transmission specimen holder is used to hold samples in the light path when making transmittance measurements. The pins on the bottom of the holder are placed into two of three positioning holes in the transmission compartment floor. The forward two holes are used to align samples at the sphere opening when making total transmittance measurements. The two rear holes are used to align samples at the lens when making regular transmittance measurements.



An additional platform is provided with the holder to raise the stage on which the sample sits. The platform is a different width on each side and can be placed on the platform in either orientation. Choose the orientation that best fits the type of transmission cell you are using.

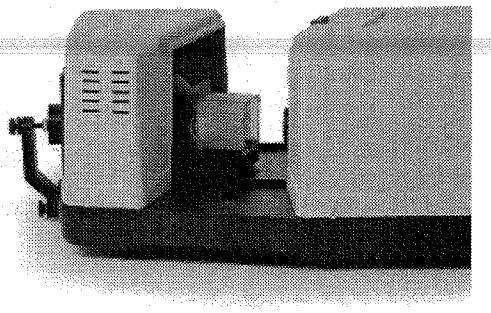
The transmission cell option provides an optically-clear glass cell with a fixed path length of 50 mm, 33 mm, 20 mm, or 10 mm. Use of cells is recommended for transmission measurements of lightly-pigmented materials and for some reflectance measurements. When used for transmission measurements of liquids, the cell filled with water or another clear solvent should be used during standardization to set the top of the scale.



For transmission measurements, use the cell size recommended by your measurement specification (such as an ASTM method), or use the general rule that smaller path lengths should be used for more concentrated colorants.

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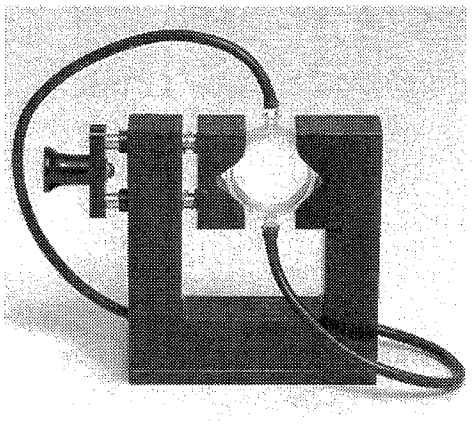
50-mm transmission cell at the transmission port



The dimensions and volumes of the various transmission cells are as follows:

Path Length (mm)	Minimum Sample Volume for Measurement (mL)	Dimensions of Measurement Face (Width x Height in mm)
10	20	55 x 57
20	40	55 x 57
33	70	55 x 57
50	100	55 x 57

Flow-Through Transmission Cell Holder and Cells



This option provides an optically-clear 2-inch diameter 10 mm, 20 mm, or 50 mm-path length flow-through cell for use with the ColorQuest II flow-through cell holder. The flow-through cell is placed in the holder at the sphere transmission port. Flexible plastic tubing with an inside diameter of 9 mm is connected from the liquid source to the inlet tube of the cell and from the outlet tube to a drain. A modification to the transmission compartment door is required to allow the liquid to drain through the tubing. Using a vacuum pump, the liquid is pumped into the cell until the cell is filled. A sample reading is then taken and the liquid pumped from the cell to the drain. The flow-through transmission cell can be used with manual or automated pumps, such as peristaltic pumps, to inject the liquid into and extract the liquid from the cell.

To install the flow-through cell and holder,

1. Place the instrument on a level surface.

2. Open the instrument transmission compartment door. If you have a transmission sample holder installed, remove it. Be sure that the specular exclusion port door is closed.

3. Place the flow-through transmission cell in the cell holder using the handle on the right side of the cell holder to open and close the holder. Orient the inlet and outlet tubes vertically.

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4. Place the cell holder in the instrument transmission compartment and orient the cell holder so that the cell is almost touching the sphere. The cell must be centered over the instrument transmission port.

5. Locate the two 8-32 tapped mounting holes inside the instrument transmission compartment and fasten the cell holder to the instrument with the two 8-32 socket-cap hex screws and a 9/64" hexagonal wrench.

To operate the flow-through cell assembly,

1. Standardize the instrument in a transmission mode. The flow-through cell should be filled with distilled water or another clear solvent to set the top of the scale.

2. Inject the sample to be measured into the cell.

3. Proceed with sample measurement.

4. Drain the sample from the cell.

The flow-through transmission cell may need to be cleaned periodically. Use a glass cleaner on the exterior of the cell and distilled water pumped through the cell for the interior.

Reflectance Sample Shelf and Light Cover

The sample shelf and light cover are used to measure small translucent objects or translucent liquids.

To use the sample shelf,

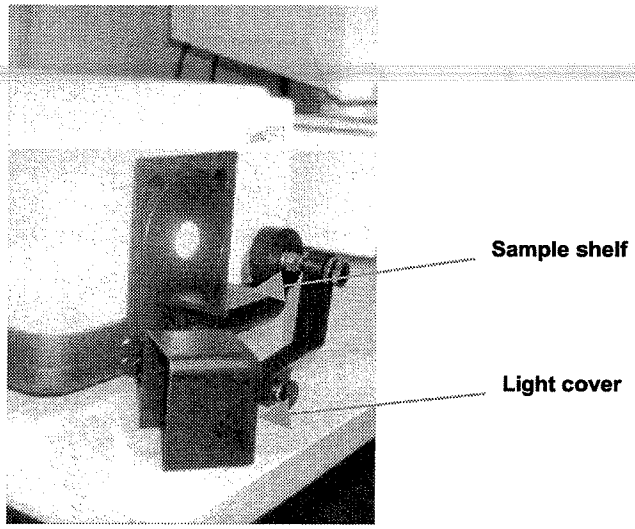
1. Pull back the sample clamp.

2. Place the pins of the shelf down into the spacer block near the sample clamp.

3. Place your sample in a glass cell and place the cell against the opening in the sphere. Be sure the level of sample is high enough to completely cover the opening.

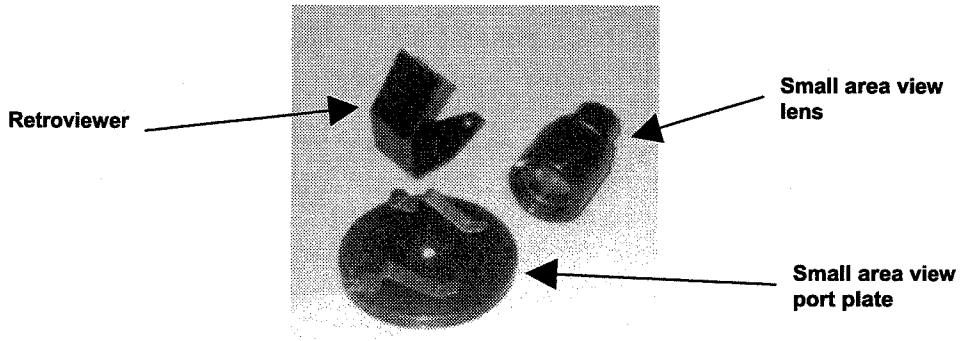
4. Place the light cover over the cell (open sides down and toward the instrument) to prevent the room light from interfering with the measurement.

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Small Area View

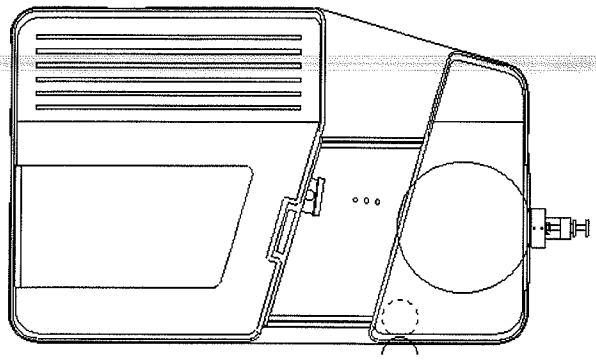
The small area view option consists of a small area view lens, a small area port plate, and a retroviewer. The small area view lens is longer than the original large area view lens and is marked with an S. The large area view lens is short and is marked with an L.



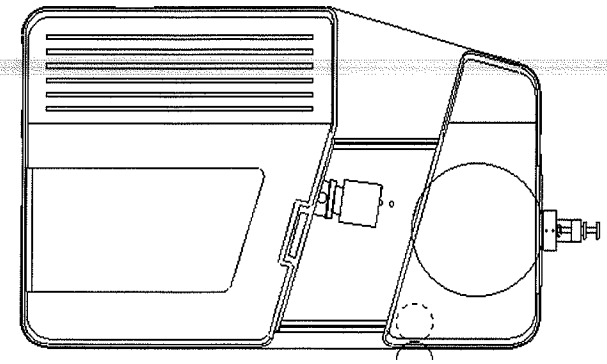
To use the small area view lens:

1. Loosen the thumb screw on the lens receptacle.
2. Pull the large area view lens forward, taking care not to touch the lens surface. Store the lens in a safe place to avoid scratches on the lens surface.
3. Place the small area lens in the lens receptacle, positioning the pin in the hole at the bottom of the receptacle. The S mark on the lens should align with the white mark on the lens receptacle.
4. Tighten the thumb screw on the lens receptacle.
5. Pull the sample clamp back and hold it out of the way.
6. Remove the 1-inch port plate and snap in the 1/4-inch port plate.
7. Release the sample clamp.

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Large area view lens in place



Small area view lens in place

UV Filter

For some applications, the elimination of fluorescence from a measurement is important. Fluorescence is caused by ultraviolet (UV) excitation of the sample, where a material absorbs nonvisible wavelengths of energy and re-emits this energy as light in the visible region of the spectrum. Since UV light is part of the normal sample illumination, measurements may include UV excitation. To eliminate fluorescence from the measurement, a UV filter is placed in the light path of the source.

With this option, a movable UV cut-off filter can be inserted in the source path. When the filter is positioned, the energy present in the lamp below 418 nm is virtually eliminated. The instrument should be standardized in this configuration before measurements are made. For optimum stability, the UV filter should be in the source path for ten minutes before standardization. The filter must be removed from the light path after use to prevent degradation.

It is necessary to know what type of fluorescence is involved for the samples being measured. Some materials fluoresce due to excitation by visible rather than ultraviolet wavelengths. The UV-absorbing filter does not eliminate this type of fluorescence.

Installation of the UV filter must be performed at the factory as a part of the manufacturing process.

The UV filter is positioned either in or out of the light path by using the switch located on the right front of the instrument. To move the filter into the light path and exclude UV light, move the switch to the IN position. Standardize the instrument. To move the filter out of the light path and include UV light, move the switch back to the OUT position. Restandardize the instrument. Refer to the "Standardization" section of this chapter for a picture showing the location of the UV filter switch.

Note: Do not leave the UV-absorbing filter in the light beam any longer than necessary. The filter material may fade with long-term exposure to high-level source illumination.

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Installation

The following instructions guide you through the initial installation of your ColorQuest II Sphere system.

1. Unpack all cartons and remove wrappings and cable ties. Inspect for damage and notify the carrier and HunterLab immediately if any is discovered. Save the packing material in case it becomes necessary to return the instrument to the factory.

2. Place the instrument on a flat working surface where the measurements will be made. Place the computer in close proximity to the sensor.

3. Connect the power cord to the sensor. Connect the AC cable to an instrument-grade power outlet, but do not supply power.

   Note: Refer to page 16-15 for recommendations concerning the power line and its conditioning.

CAUTION

Use only the power cord included with this instrument or a replacement obtained from HunterLab (HunterLab Part Number 10-0000-55 for 110V, A13-1002-656 for 220V). Be certain that the power cord is in good condition before connecting it.

The ColorQuest II is grounded using the grounding portion of this power cord. Only plug this cord into a properly grounded power outlet. Do not use an inappropriate adapter to plug the instrument into an ungrounded outlet or electric shock may occur. More information on the power cord wiring can be found on page 16-15.

4. Connect the female plug of the 25-pin signal cable to the computer. Connect the male end of the 25-pin cable to the sensor.

   Note: If you are using an IBM-compatible computer you may need to use a 25-to-9-pin conversion cable to connect the signal cable to the computer.

5. Remove the tape covering the reflectance port of the optical sensor and the exterior of the sphere in the transmission compartment.

6. Place the sample port plate at the reflectance port and snap it into place.

7. Locate the reflectance port sample clamp in the standards box and secure it to the reflectance port.

8. Place the reflectance port sample clamp against the sphere. Covering the sample port when the instrument is not in use prevents dust from accumulating inside the sphere.

9. Turn on the sensor using the switch on the right side of the sensor near the back. If you pull back the sample clamp you should see light in the sphere.

The sensor should be allowed to warm up for thirty minutes to two hours to reach optimum operating temperature for measurement stability.

Notice: Do not block the vents in the top cover of the ColorQuest II or the instrument may overheat.

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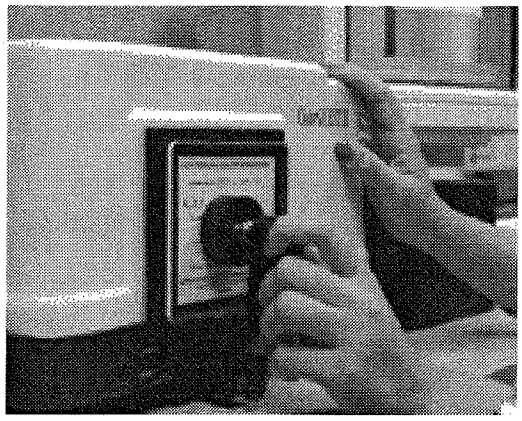
Standardization

General

Standardization sets the top and bottom of the scale for the neutral axis. During standardization the bottom of the scale is set first. For this, you simulate the case where all the light is absorbed by the sample. For this instrument the bottom of the scale is set with the light trap for reflectance modes. The black card is used to set the bottom of the scale for transmittance modes.



Standardizing on the light trap



Standardizing on the white tile

The top of the scale is then set by scaling the light which is reflected or transmitted to a calibrated standard. This is done using a calibrated white tile for reflectance measurements and air or a solvent-filled cell for transmittance measurements. On-screen messages will prompt you through the standardization procedure.

It is recommended that the instrument be standardized at least once every eight hours. To keep your instrument working accurately, it is necessary to restandardize the instrument by setting the top of scale every four hours in addition to standardizing at the start of each day or each shift. Also, standardize the instrument whenever the hardware changes, such as placement of the UV filter, or with environmental, such as temperature, changes. Then you may proceed with sample measurement.

Standardization Modes

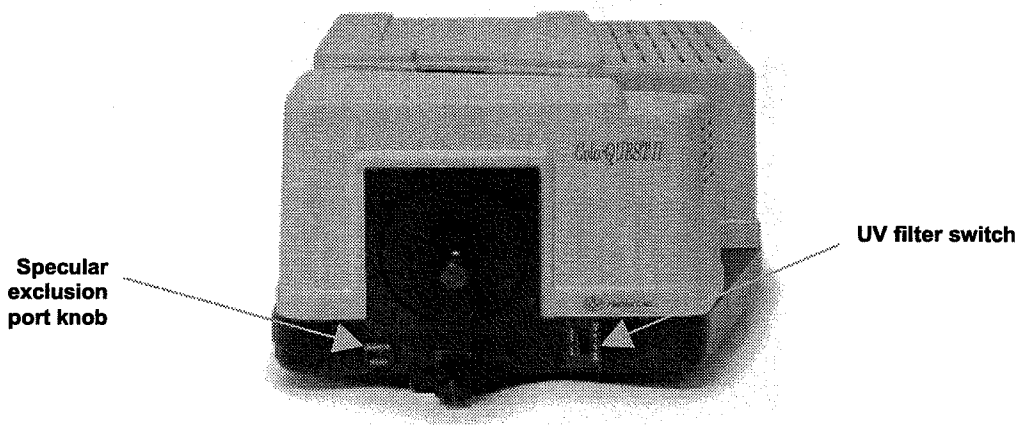
Four modes of measurement are available when you standardize the instrument:

- RSIN - Reflectance - Specular Included,

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- RSEX - Reflectance - Specular Excluded,
- TTRAN - Total Transmittance,
- RTRAN - Regular Transmittance.

Taking into account varying hardware configurations such as UV filter in/out and small area/large area view, there are many ways to standardize the instrument. The instrument can be standardized at any time by selecting **Standardize** from the **Sensor** menu or by clicking the **Standardize** button on the default toolbar. You are first prompted to indicate the instrument configuration. You must also manually adjust the hardware to specular inclusion or exclusion, UV filter in or out, and small area or large area view. (Refer to the picture below.)



Note: Be sure that the transmission compartment door is closed while standardizing.

When standardizing in transmittance modes you are prompted to place the white calibrated standard at the reflectance port. Alternatively, a plug of barium sulfate ($BaSO_4$) or magnesium oxide (MgO) may be used to more closely approximate the actual sphere wall reflectance. When taking transmittance measurements, the calibrated white tile or the plug used during standardization must be kept at the reflectance port. When the instrument is to be used for transmission measurements of liquids, a clear liquid (distilled water for water-based samples, toluene or benzene for resins, or mineral oil for oils) in a cell of the desired size should be used to set the top of the scale. Place the cell in the transmission compartment as close to the **sphere** as possible for measuring total transmittance. Place it as close to the **lens** as possible when measuring regular transmittance.

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Maintenance

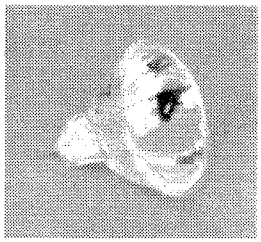
This section outlines the parts of the sensor you must maintain in order for the instrument to function properly. "Maintenance of Instrument Standards," page 24-4, applies to all instruments and should also be read and understood.

Notice: Do not disassemble the instrument and attempt to clean the optical components. Do not open the instrument or remove any covers except using the instructions given in this User's Manual or under the direction of HunterLab Customer Support.

Source Lamp

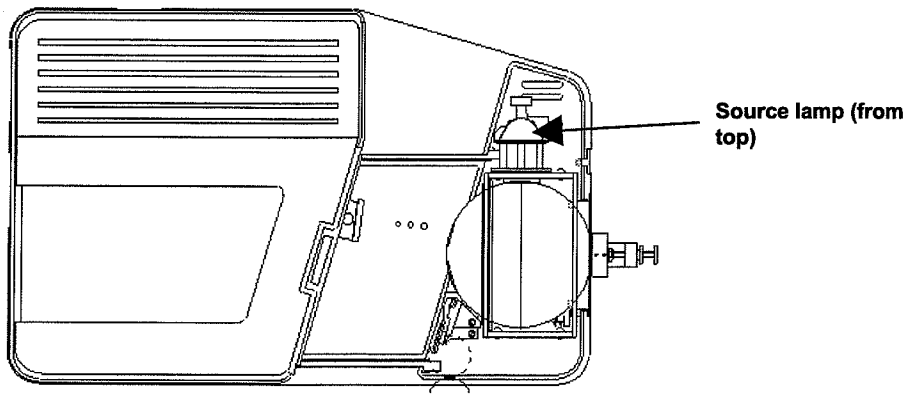
The low-voltage halogen cycle lamp used in this instrument has an operating life of approximately 1,000 hours at the full-on operating condition. When the lamp is approaching the end of its useful life, the light output may fluctuate, causing equivalent fluctuations in the instrument read-out.

CAUTION
Replace only with a specified quartz-halogen lamp, HunterLab part #15015100.



To change the source lamp:

1. Turn off the power switch located on the right side of the sensor near the back. Allow the lamp to cool prior to removing it.
2. Remove any samples from the reflectance port and the transmission compartment.
3. Loosen the three thumb screws from the sphere end of the optical sensor and lift the cover straight up.



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4. Remove the old lamp by pulling the lever toward the outside edge of the optical sensor. The lamp slides up and out of the connector and can be discarded.

5. Return the lever to its original position.

6. Insert the new lamp, making sure the two pins on the lamp fit into the socket. Push down on the lamp until the edge of the lamp rests against the alignment pins. The lamp is now held in place by spring tension. Be careful not to touch the bulb of the lamp or the reflector, as fingerprints reduce lamp life appreciably. If a fingerprint is deposited, remove it using a clean wipe and isopropyl alcohol. Note that lack of proper contact at the connector can be a major source of unsatisfactory instrument performance. Always check the lamp when unsteady operation is experienced.

   Note: Failure to insert the lamp against the pins can cause instrument instability.

7. Replace the optical sensor cover and tighten the thumb screws.

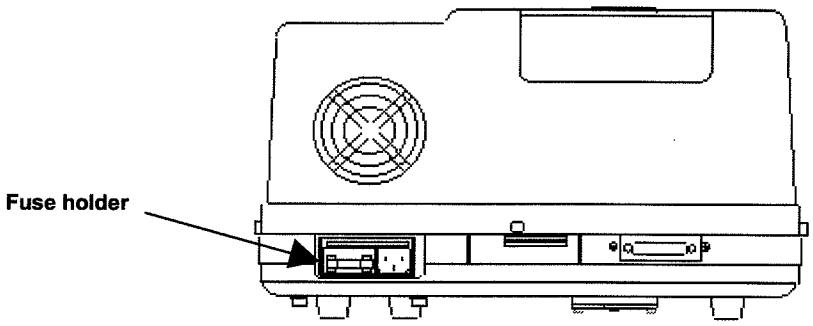
8. Turn on the power switch located on the right side of the sensor and allow the lamp to warm up for fifteen minutes to two hours to reach optimum operating temperature.

9. Standardize the instrument.

Fuse

The fuse is housed on the back of the sensor.

CAUTION
Replace only with a specified fuse, HunterLab part #13-2600-10, or equivalent. More information concerning this fuse can be found on page 16-15.



To change the fuse:

1. Remove the power cord from the sensor.

2. Slide back the plastic window in front of the fuse holder to expose the fuse pull tab.

3. Pull the tab to remove the old fuse. Replace with a new fuse.

Notice: Use only the fuse specified above for your instrument or one which is identical in type, voltage rating, and current rating. Otherwise, there may be a risk of fire.

4. Replace the plastic window in front of the fuse holder and replace the power cord.

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Lens Surface

The lens may be cleaned using photographic-quality lens solution and lens paper. Put a few drops of solution on the lens paper and gently wipe the lens in a circular motion for a few seconds. Then wipe the lens with a dry lens paper to remove streaks and any hazy film.

Sphere

Care should be taken to keep foreign materials from entering the sphere. The transmission compartment should be closed and the sample clamp placed against the reflectance port when the instrument is not in use. The sphere is coated with barium sulfate, $BaSO_4$, which can be damaged by putting any objects into the sphere. If any foreign material (dust, lint, etc.) falls into the sphere, use the following steps to remove the material.

1. Move the sample clamp away from the reflectance port.

2. Open the transmission compartment and place a vacuum cleaner hose at the sphere opening but do not insert the hose directly into the sphere. Cup your hand around the end of the hose to provide a good seal.

3. Quickly cover and uncover the reflectance port with your other hand. This creates gentle air currents to swirl the foreign matter around and out of the sphere.

When shipping the sensor, remove the sample clamp and tape a pad of foam rubber at the reflectance port. Failure to do so may cause severe damage to the instrument.

Holographic Grating

The sensor is equipped with a holographic grating. This grating is a concave piece of glass two inches in diameter that disperses light into the various wavelengths of the spectrum. It is located under two separate covers in the end of the optical sensor opposite the reflectance port. Do not remove these covers unless specifically requested by HunterLab Customer Support.

Touching the reflectance area of the grating leaves marks that cannot be removed and that affect the performance of the ColorQuest II Sphere. Warranty replacement of the grating is not considered for any damage caused by the customer.

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Specifications

For best performance, your instrument should be placed where there is ample work space with medium or subdued illumination and no drafts. For optimum results, a clean, air-conditioned area is recommended with a relative noncondensing humidity of 20-80% [10-90% for sensor only] and relatively constant temperature not exceeding 90°F (32°C) [120°F (50°C) for sensor only]. For specification performance, the recommended temperature range is 70-82°F (21-28°C).

The instrument should be connected to a stable, instrument-grade power line. If other equipment is connected to the same power line, a transient power surge may be produced when the other equipment is turned on. If this happens, restandardize the instrument before making measurements. HunterLab recommends using a line conditioner with a minimum 600 VA rating and a battery back-up system.

Physical Characteristics

Optical Sensor - 15.25" (38 cm) wide x 24" (60 cm) deep x 9.0" (22.5 cm) high, 42 lb. (19.1 kg).

Computer system - depends upon system selected. Refer to manufacturer's documentation for information.

Environmental Requirements

Operating temperature - 40°F - 120°F (5° - 50°C).

Operating humidity - up to 90% relative, non-condensing.

Power Required

Voltage - 115V ±10 at 60Hz or 230V ±20 at 50Hz. *(See the note under "Regulatory Notice.")

Note: Do not attempt to change the voltage setting.

Current - 1A at 115V or 0.5A at 230V.

Installation Category (Over Voltage) - II.

Notice: This instrument has internal fuses in the power supply assembly that are not user replaceable:

F1 - 1/4A, SB

F2 - 1/8A, SB.

Power Cord Wire Color Code:

	Color	Definition
220V Cord	Brown	LINE
	Blue	NEUTRAL
	Green/Yellow	SAFETY

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110V Cord	Black	LINE
	White	NEUTRAL
	Green	SAFETY

Instrument-Computer Ground Potential Check:

Perform this check if the power cord wiring is being changed, such as for replacement of the cord or if changing the plug.

The instrument serial port ground connection is referenced to the instrument's internal frame and safety ground. Before connecting the communication cable to the instrument serial port, apply power to the instrument and the host computer. Check the ground potential (voltage) between the serial port ground pins on the computer and the instrument. The ground connection is pin 5 on DB-9 connectors and pin 7 on DB-25 connectors. Voltages in excess of 5VAC at 110V input power, or in excess of 10VAC at 220V input power may indicate a difference in ground wiring and can damage the instrument and/or the computer. Check the wiring and take other steps as needed to reduce this difference before connecting the communications cable. You may also use a data optoisolator.

Conditions of Illumination and Viewing

Reflectance Measurements

Port size - 1.0" (25 mm) diameter.

5/16" (7 mm) diameter for small area view.

Viewed Area - 7/8" (22 mm) diameter.

1/4" (6 mm) diameter for small area view.

Maximum specimen - size unlimited.

Transmittance Measurements

Port Size - 1.0" (25 mm) diameter.

Maximum specimen - 80 mm path length.

Note that the transmission compartment is 5-3/8" (13.7 cm) high x 8.0" (20.2 cm) wide, and the center of the lens is 1-7/8" (4.1 cm) from the compartment floor.

Illumination

Diffuse 6-inch (152 mm) diameter sphere coated with barium sulfate, $BaSO_4$, illuminated with simulated CIE D65 spectral distribution filtered to eliminate infrared specimen heating.

Viewing

8° from specimen normal.

Specular component included or excluded.

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Receptor System

Concave holographic diffraction grating monochromator.

32-cell silicon diode array.

Lamp Life

Approximately 1,000 hours.

Measurement Modes

Reflectance - Specular Included.

Reflectance - Specular Excluded.

Total Transmittance.

Regular Transmittance.

Instrument Performance

All instrument performance checks should be done with the instrument in standard configuration, properly warmed up and standardized. Options such as small area view and UV filter in may affect performance.

Spectral Performance

Wavelength Range - 400 - 710 nm.

Wavelength Bandpass - Effective 14 nanometer triangular for 14 nm output.

Wavelength Interval - 10 nm.

Wavelength Accuracy - 0.2 nm.

Photometric Range - 0 - 150% Reflectance.

Colorimetric Performance

You may test the **repeatability** of your instrument as follows:

1. Turn the ColorQuest on and allow it to warm it up for 2 hours. Meanwhile, clean the white and gray tiles as described in Chapter 24 and allow the tiles to return to room temperature.

2. Standardize the instrument.

3. Configure your color data display to show DX, DY, DZ (XYZ Differences) using D65/2°.

4. Center the instrument's white standard tile at the measurement port. Do not move or remove the tile for the remainder of the test.

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5. Read the white tile as a standard.

6. Configure the timed read feature to automatically make 20 more measurements with a read interval of 7 seconds and then initiate reading of the tile as a sample.

7. When all measurements are complete, examine the Difference values. The instrument passes the repeatability test as long as no value in the DX, DY, or DZ column is greater than **0.02**. Contact HunterLab Customer Support as described on page 25-6 if the instrument fails the repeatability test.

Note: Performance specifications are subject to change without notice.

Regulatory Notice

A copy of the Declaration of Conformity according to ISO/IEC Guide 22 and EN 45014 follows on the next page.

**Note: The Declaration of Conformity shall only apply to voltage levels of 220V - 240V.*

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DECLARATION OF CONFORMITY
according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Hunter Associates Laboratory, Inc.

Manufacturer's Address: 11491 Sunset Hills Road
Reston, Virginia U.S.A. 20190

Declares that the Product:

Product Name: ColorQuest II Sphere

Model: CQII/UNI-1200

Conforms to the following Product Specifications:

Safety: EN 61010-1

EMC: EN55011 / CISPR 11 (1990-09) Class A Group 1
IEC 801-2 (1991-04), 6 KV CD, 8 KV AD
IEC 801-3 (1984), 3 V/m
IEC 801-4 (1988), 1 KV PL, 0.5 KV SL
IEC 801-5 (1991), 2 KV

Supplementary Information:

This product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC, and carries the CE marking accordingly.

(1) This product was tested using an IBM compatible computer.

European Contact: **Your local Hunter Associates Laboratory representative, or Hayden Williams,**
Suite 6, Canonbury House
Canonbury
Shrewsbury, United Kingdom
SY3 7AH
Tel: 011-44-1743-344090

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Color Measurement Notes

This instrument can be used to measure virtually any kind of product. Opaque and translucent materials can be placed at the reflectance port on the front of the sensor for measurement of reflected color. Transparent samples such as films and liquids can be placed in the transmission compartment for measurement of transmitted color.

Reflectance Measurements

There are two types of reflectance measurements available. The first type, reflectance - specular included (RSIN), measures the diffuse plus specular reflectance of the specimen at the port. These measurements are made with the specular exclusion port door closed. The specular included mode is recommended for interlaboratory measurement comparisons.

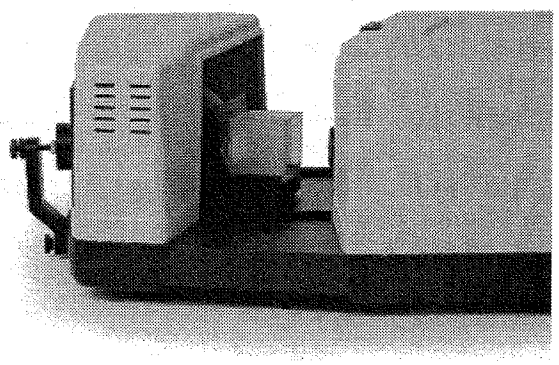
The other type, reflectance - specular excluded (RSEX), measures the sample excluding a substantial part of the specular component reflected by the sample. These measurements are made with the specular exclusion port door open.

Transmittance Measurements

There are two types of transmittance measurements available. The first, total transmittance (TTRAN), includes both the light that is transmitted directly through the sample and the light that is diffusely scattered. When measuring total transmittance, place the specimen in the transmission compartment as close to the **sphere** as possible.

The second type, regular transmittance (RTRAN), measures the light that passes directly through the sample. When measuring regular transmittance, place the specimen in the transmission compartment as close to the **lens** as possible.

Illustration of a sample being measured in total transmittance mode.



Sample measurement methods can be found on the world wide web! Visit www.hunterlab.com to see if an illustrated method is available for your application.

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