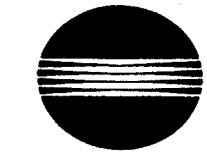
SPECTROPHOTOMETER
CM-3700d

HARDWARE MANUAL



MINOLTA

The Minolta Spectrophotometer CM-3700d is a high-accuracy benchtop spectrophotometer for measurements of spectral reflectance and transmittance. Reflectance measurements are taken using d/8 (diffuse illumination/8° viewing angle) geometry and three different measurement areas: 3×5mm, Ø8mm, and Ø25.4mm; either SCI (specular component included) or SCE (specular component excluded) measurements can be taken. Transmittance measurements are taken using d/0 (diffuse illumination/0° viewing angle) geometry. For measuring fluorescent specimens, the amount of UV included in the illumination is continuously variable.

All functions are controlled by a computer connected to the Spectrophotometer's RS-232C terminal. Switching between measurement areas, switching between SCI and SCE measurements, and adjusting the UV amount are all motorized for easy, accurate operation. The Spectrophotometer is compact enough to be placed next to the computer, and the RS-232C interface allows easy integration into virtually any system.

NOTES ON USING THESE MANUALS

The instructions for the Spectrophotometer CM-3700d are divided into two manuals:

1 *HARDWARE MANUAL* (this manual): A manual explaining the hardware of the Spectrophotometer CM-3700d itself, including:
   - Names of parts
   - Accessory information
   - Connection with a computer
   - Switching power on and off

2 *COMMUNICATION MANUAL*: A manual describing operation of the CM-3700d when not using the optional Color Control Software CM-S3w, including:
   - Notes on calibration and measurements
   - Explanation of command functions
   - Command and data formats

WARNING

- DO NOT USE THIS INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE, SUCH AS ONE CONTAINING GASOLINE FUMES. USE IN SUCH AN AREA MAY RESULT IN AN EXPLOSION.
- DO NOT DISASSEMBLE THIS INSTRUMENT OR ATTEMPT TO REPAIR IT YOURSELF. THIS INSTRUMENT CONTAINS HIGH-VOLTAGE ELECTRICAL CIRCUITS AND THERE IS A RISK OF ELECTRICAL SHOCK IF THIS INSTRUMENT IS DISASSEMBLED BY UNQUALIFIED PERSONNEL. Any necessary repairs should be performed only by a Minolta-authorized service facility.

CAUTION

Spectrophotometer

- This instrument should be used at ambient temperatures of between 13 and 33°C (47 and 91°F). Do not use in areas subject to sudden changes in temperature.
- This instrument should be powered only by the exclusive AC Adapter AC-A12 (included as a standard accessory) plugged into an AC outlet. Do not use other AC adapters to power this instrument.
- Do not install this instrument in direct sunlight or near sources of heat, such as stoves, strong lights, etc. The internal temperature of the instrument may become much higher than the surrounding area in such cases.
- This instrument is not waterproof. Do not install in areas subject to high humidity. Be careful not to spill liquid on this instrument.
- Do not install this instrument in dusty or smoky areas. Use in such areas may result in malfunction.
- Do not install this instrument near equipment which produces a strong magnetic field, such as speakers, large motors, etc.
- Do not subject this instrument to strong impact or vibration.
- Because the measurement aperture and integrating sphere, as part of the optical system, are extremely precise components, be very careful to prevent anything from entering the measurement aperture or staining the inside of the integrating sphere. When the instrument is not in use, be sure to attach one of the target masks and cover the measurement aperture.
- Be sure to switch off this instrument when it is not being used.
- This instrument may cause interference if used near a television, radio, etc.
- This instrument contains a microprocessor. Extremely strong electromagnetic noise may cause the microprocessor to operate erratically. In such cases, set the POWER switch to O (off) momentarily and then set it back to | (on)

White Calibration Plate

- The calibration data for the White Calibration Plate were measured at 23°C (73.4°F). For the highest accuracy when measuring absolute values, calibration and measurement should be performed at the same temperature (23°C/ 73.4°F).
- Handle the White Calibration Plate carefully to prevent the white surface from being scratched or stained. If the white surface becomes scratched or permanently stained, replace the White Calibration Plate with a new one.
- When the White Calibration Plate is not being used, be sure to close the cover to protect the white surface from being scratched or stained, changing color due to ambient light (which can occur even under indoor lighting), etc.

Target Masks

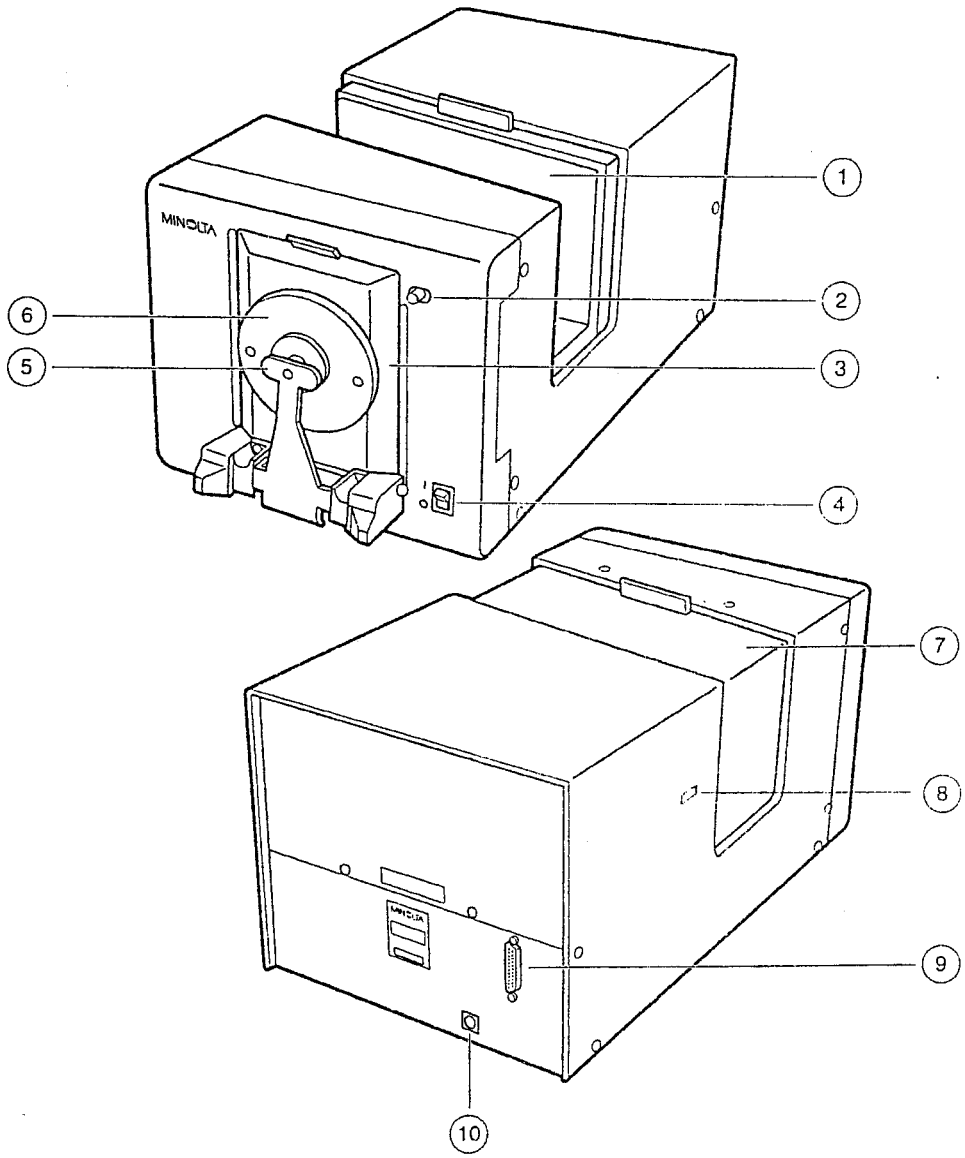
- Handle target masks carefully to prevent the white surface from being scratched or stained. Do not touch the white surface.
- When target masks are not being used, be sure to store them in their case to prevent the white surface from being scratched or stained, changing color due to ambient light (which can occur even under indoor lighting), etc.

CARE AND STORAGE

- If this instrument becomes dirty, it can be wiped with a clean, dry cloth. Do not allow alcohol or chemicals to come in contact with this instrument.
- If the White Calibration Plate or Zero Calibration Box becomes dirty, it can be wiped with a clean, dry cloth. If the stain is difficult to remove, a soft cloth moistened with lens-cleaning fluid may be used. After cleaning the surface with lens-cleaning fluid, wipe the surface with a soft cloth moistened with water and then let the surface dry before use.
- If the white surface of the target mask or the inside surface of the integrating sphere becomes stained, contact the nearest Minolta authorized service facility.
- This instrument should be stored at temperatures of between 0 and 40°C (32 and 104°F). Do not store this instrument in areas subject to high temperatures, high humidity, or rapid changes of temperature, or where condensation may occur. For added safety, it is recommended that the instrument be stored with a drying agent (such as silica gel) in an area subject to a relatively constant temperature.
- Do not leave or store this instrument inside a closed motor vehicle or in the trunk of a motor vehicle. Such areas may be subject to extremely high temperatures if the vehicle is left in direct sunlight.
- If dust enters the integrating sphere, accurate measurements will not be possible. To prevent dust, etc. from entering the integrating sphere, attach a target mask and the sample holder even when the instrument is not in use.
- To prevent the white surface of the White Calibration Plate from changing color due to exposure to light (which may occur even under normal indoor lighting), always close the cover of the white calibration plate after use.
- To prevent the white surface of the target mask from changing color due to exposure to light (which may occur even under normal indoor lighting), and to protect the white surface from scratches, dust, stains, etc., always store the target mask in the target mask case when it is not in use.
- Be sure to keep all shipping materials (cardboard box, cushioning material, plastic bags, etc.). They can be used to protect the instrument from shock and vibration during shipping.

CONTENTS

NAMES OF PARTS AND FUNCTIONS OF CONTROLS

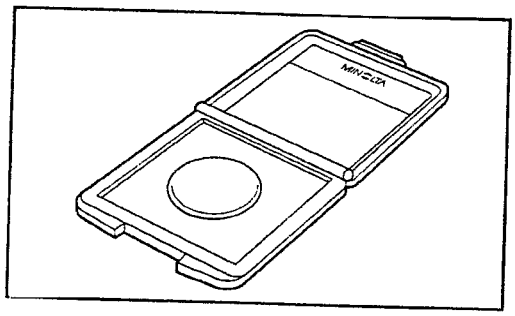


1 Transmittance specimen chamber	Chamber in which specimen is placed for transmittance measurements
2 Measurement port baseplate lock	
3 Measurement port baseplate	Can be opened to check position of specimen for reflectance measurements.
4 POWER switch	Switches power on (|) and off (○).
5 Specimen holder	Holds specimen in position for measurement; holds White Calibration Plate or Zero Calibration Box in position for calibration.
6 Target masks	Three types are included with different aperture sizes for use with the different measurement areas: 5×7mm aperture for use with 3×5mm measurement area, Ø11mm aperture for use with Ø8mm measurement area, and Ø28mm aperture for use with Ø25.4mm measurement area. Attach the selected type to the Spectrophotometer.
7 Transmittance specimen chamber cover	Covers the transmittance specimen chamber when slid closed.
8 DIP switches	Set communication parameters of Spectrophotometer.
9 RS-232C terminal	For connecting an RS-232C cable between the Spectrophotometer and a computer.
10 AC adapter input socket	For connecting included AC Adapter AC-A12 to the Spectrophotometer for supplying power.

STANDARD ACCESSORIES

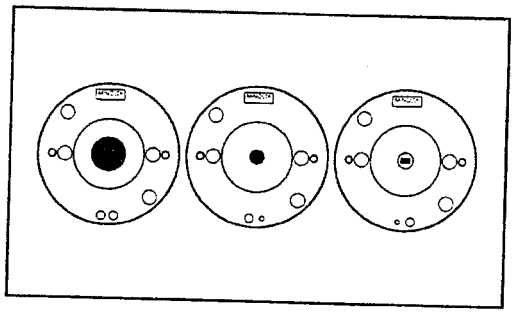
White Calibration Plate CM-A90

White Calibration Plate CM-A90 is the white calibration standard for reflectance measurements for the Spectrophotometer. The white calibration data is included stored on a 3.5-inch floppy disk and also listed on data sheets.



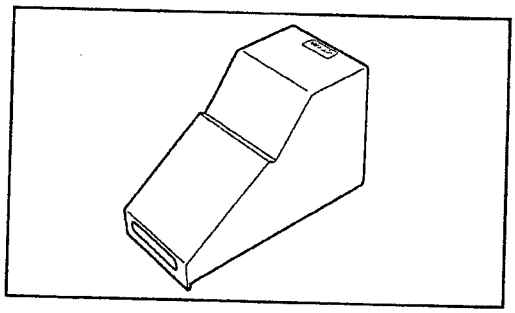
Target Mask CM-A91 (for use with 3×5mm measurement area)
Target Mask CM-A92 (for use with Ø8mm measurement area)
Target Mask CM-A93 (for use with Ø25.4mm measurement area)

Target Masks CM-A91 through CM-A93 attach to the Spectrophotometer to limit the illumination area to the area appropriate for the measurement area. Protective cases are also included.



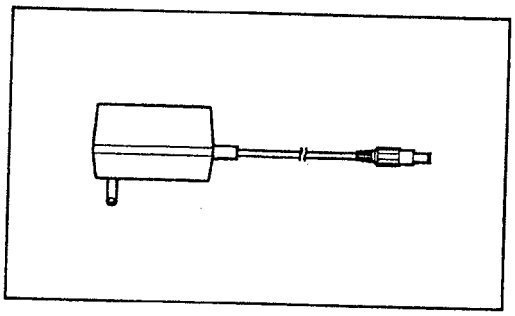
Zero Calibration Box CM-A94

Zero Calibration Box CM-A94 is for performing zero calibration for reflectance measurements.



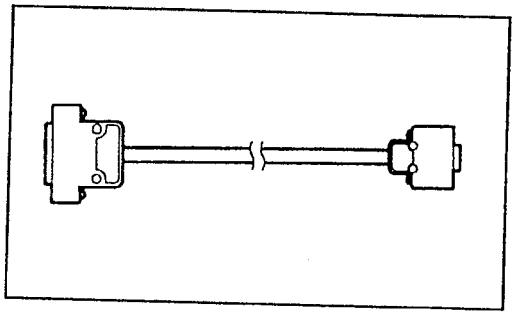
AC Adapter AC-A12

AC Adapter AC-A12 provides power to the Spectrophotometer from an AC outlet.



RS-232C Cable CM-A52

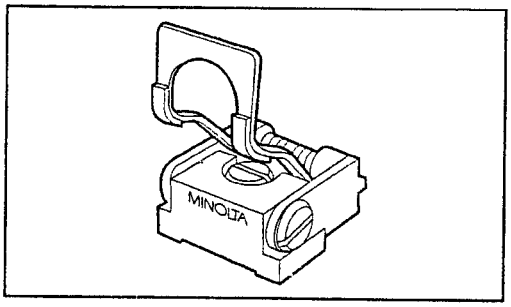
RS-232C Cable CM-A52 connects the Spectrophotometer to a computer. It has a 9-pin D-subminiature connector on the end for connection to the computer.



OPTIONAL ACCESSORIES

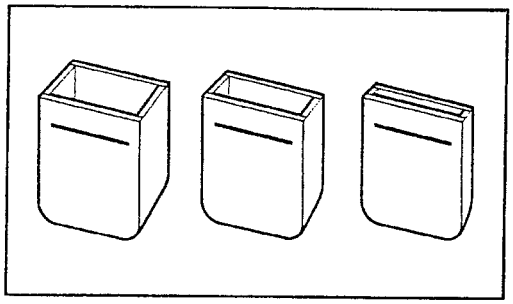
Transmittance Specimen Holder CM-A96

Transmittance Specimen Holder CM-A96 holds film- or plate-form specimens, or one of the cells described below (CM-A97 through CM-A99) containing liquid specimen, in position for transmittance measurements.



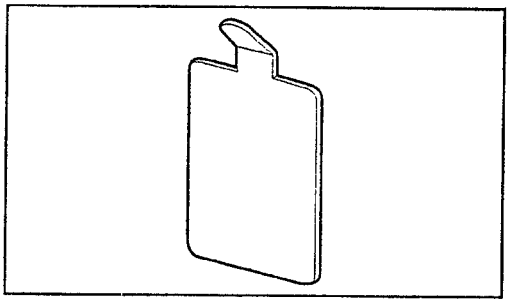
Cell CM-A97 (Optical path length: 2mm)
Cell CM-A98 (Optical path length: 10mm)
Cell CM-A99 (Optical path length: 20mm)

Cells CM-A97 through CM-A99 are glass cells for holding liquid specimens for transmittance measurements.



Transmittance Zero Calibration Plate CM-A100

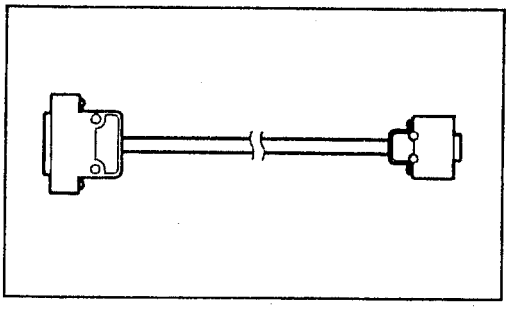
Transmittance Zero Calibration Plate CM-A100 is for performing zero calibration for transmittance measurements.



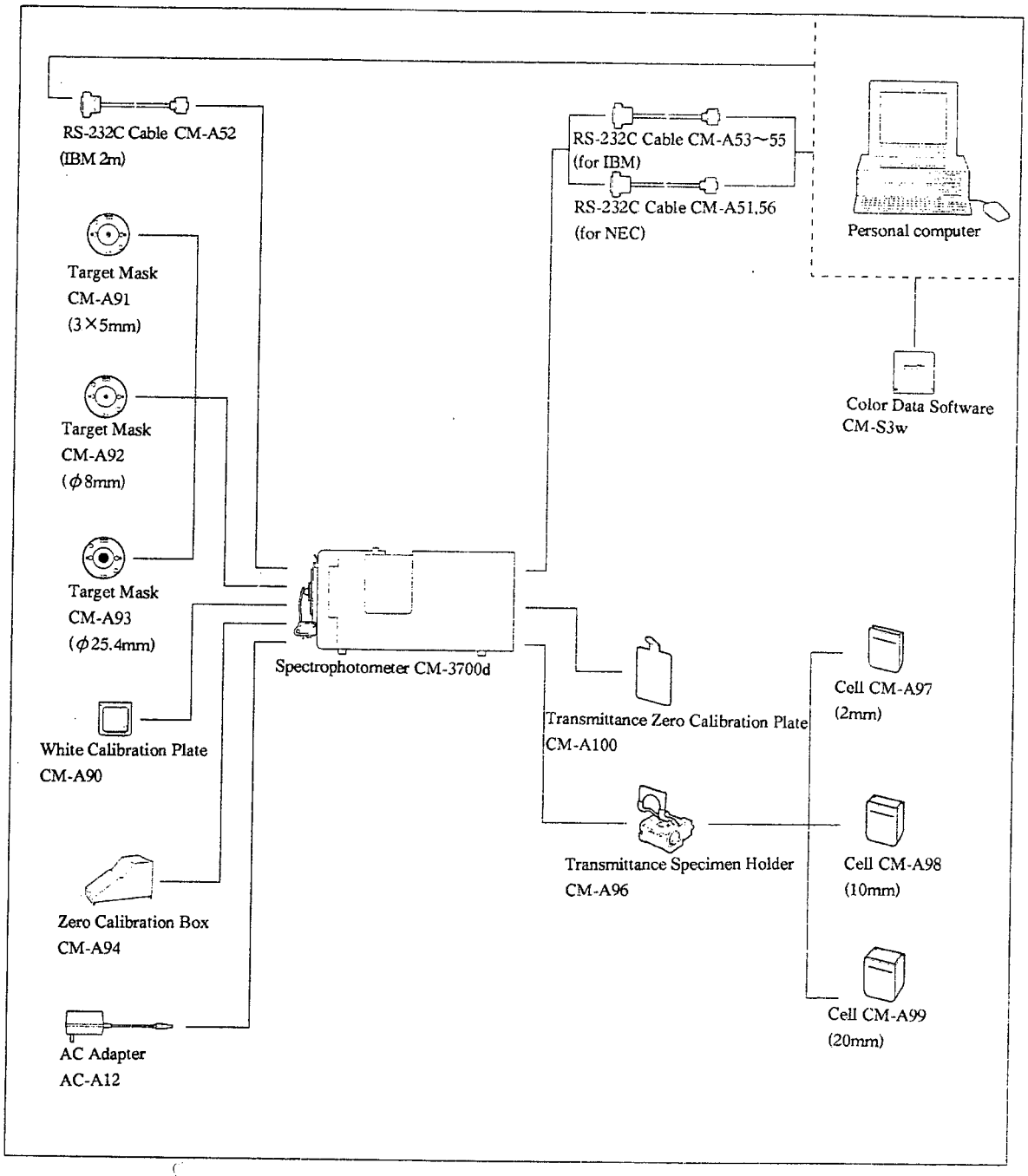
RS-232C Cables CM-A53 through CM-A56

RS-232C Cables connect the Spectrophotometer to a computer. The following types are available:

Cable	Length	Connector
RS-232C Cable CM-A53	2m/6.6 ft.	Male 25-pin D-subminiature
RS-232C Cable CM-A54	5m/16.4 ft.	
RS-232C Cable CM-A55	5m/16.4 ft.	Female 9-pin D-subminiature
RS-232C Cable CM-A56	5m/16.4 ft.	Female 25-pin D-subminiature



SYSTEM DIAGRAM



SETTING COMMUNICATION PARAMETERS

The communication parameters of the Spectrophotometer are set using the DIP switches on the side panel.

- Be sure to set POWER switch to O (off) before changing DIP switch settings.
- DIP switch settings are checked when the Spectrophotometer is first switched on.

Baud Rate

Baud rate is determined by the settings of DIP switches 1 and 2:

Baud rate	1200	2400	4800	9600
DIP switch 1	OFF	ON	OFF	ON
DIP switch 2	OFF	OFF	ON	ON

Character Length

Character length is determined by the setting of DIP switch 3:

Character length	7 bits	8 bits
DIP switch 3	OFF	ON

Stop Bits

The number of stop bits is determined by the settings of DIP switches 4 and 5:

Stop bits	1		1.5	2
DIP switch 4	OFF	ON	ON	OFF
DIP switch 5	OFF	ON	OFF	ON

Parity

The parity is determined by the settings of DIP switches 6 and 7:

Parity	None		Odd	Even
DIP switch 6	OFF	ON	ON	OFF
DIP switch 7	OFF	ON	OFF	ON

X Parameter

Whether or not the X parameter will be used for flow control is determined by the setting of DIP switch 8:

Xon/Xoff	Used	Not used
DIP switch 8	OFF	ON

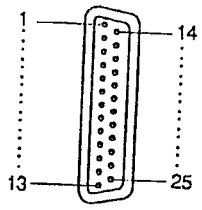
At the time of shipment from the factory, all DIP switches are set to ON, resulting in the following communication parameters:

Baud rate: 9600
Character length: 8 bits
Stop bits: 1
Parity: None
X parameter: Used

CONNECTION WITH A COMPUTER

- When connecting the cable to or disconnecting the cable from the Spectrophotometer or computer, be sure that the power of both the Spectrophotometer and the computer are switched off.
- Check that the cable connector is positioned correctly in relation to the RS-232C terminal before connecting. They can be connected in only one orientation. After connecting the cable, tighten the screws to prevent the cable from being accidentally disconnected.
- Always pull on the plug, not the cable, when disconnecting. Never pull on the cable itself, apply excessive force to the cable, or bend the cable sharply.
- Do not touch or apply excessive force to the pins or sockets of the cable connector or RS-232C terminal.
- Be sure that the cable is sufficiently long. If the cable is not sufficiently long and there is strain on the cable, connection may not be good or an internal wire may break.
- If a cable other than the RS-232C Cable included as a standard accessory or one of the RS-232C Cables CM-A53 through CM-A56 available as optional accessories is used, be sure that the cable's internal connections are as shown below. If the connections are not as shown below, data communication may not be possible and damage to the Spectrophotometer or computer may occur.

RS-232C Terminal Pin Diagram



Connections

Spectrophotometer

Pin number	Signal	Input/ Output	Purpose
2	TXD	Output	Transmitted data
3	RXD	Input	Received data
4	RTS	Output	Request to send
5	CTS	Input	Clear to send
6	DSR	Input	Data set ready
7	GND		Signal ground
20	DTR	Output	Data terminal ready

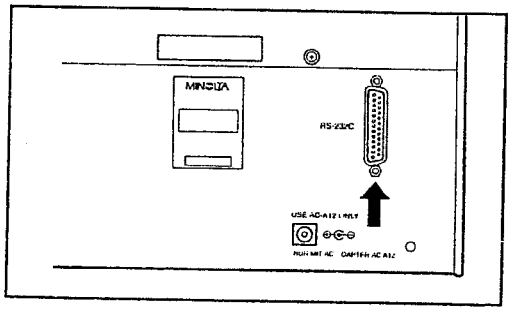
Computer

Signal	Pin number	
	9-pin connector	25-pin connector
RXD	2	3
TXD	3	2
DTR	4	20
GND	5	7
DSR	6	6
RTS	7	4
CTS	8	5

Connection Procedure

1 Check that the power of both the Spectrophotometer and the computer are switched off.

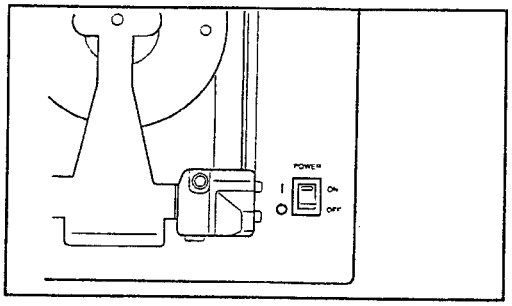
2 Connect the cable to the Spectrophotometer's RS-232C terminal and to the computer.



CONNECTING AC ADAPTER

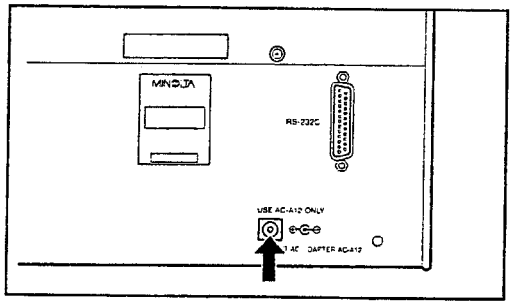
- Use only AC Adapter AC-A12 to supply power to the Spectrophotometer. Do not use other AC adapters.

1 Check that the POWER switch is set to O (off).



2 Insert the output plug of the AC adapter into the AC adapter input socket on the back panel of the Spectrophotometer.

3 Plug the AC adapter into an AC outlet



To disconnect the AC adapter, reverse the above procedure.

- When disconnecting the AC adapter, be sure that the POWER switch of the Spectrophotometer is set to O (off).
- When disconnecting the AC adapter, always pull on the plug. Never pull on the cord.

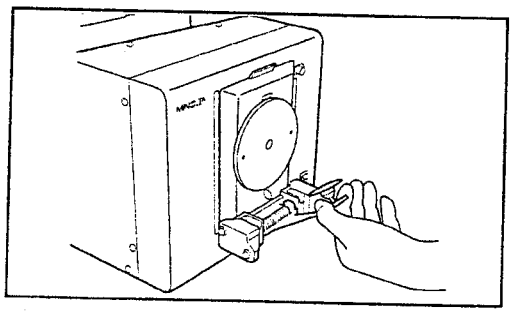
ATTACHING TARGET MASK

Three interchangeable target masks with different aperture sizes are included with the Spectrophotometer. The target masks limit the area of the specimen which is illuminated to the area appropriate for the corresponding measurement area. The three target masks and the measurement area that each mask should be used with are as follows:

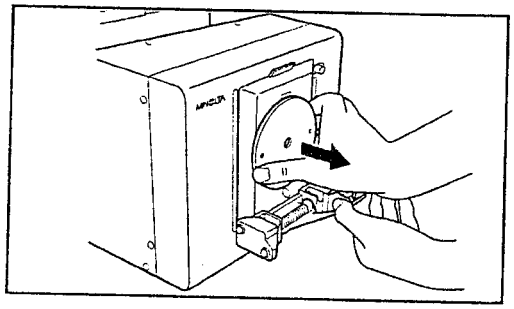
Target Mask CM-A91 (aperture size: 5×7mm): For use with SAV measurement area (3×5mm)
Target Mask CM-A92 (aperture size: Ø11mm): For use with MAV measurement area (Ø8mm)
Target Mask CM-A93 (aperture size: Ø28mm): For use with LAV measurement area (Ø25.4mm)

- Do not touch the white surface of the target masks. Protect the white surface from scratches and stains.
- The white surface of the target masks may change color due to exposure to light even under normal indoor illumination. To prevent this from occurring, always store the target masks in their cases when the masks are not being used.
- To prevent dust, etc. from entering the integrating sphere of the Spectrophotometer, one of the target masks and the specimen holder should be attached to the Spectrophotometer even when the Spectrophotometer is not being used.

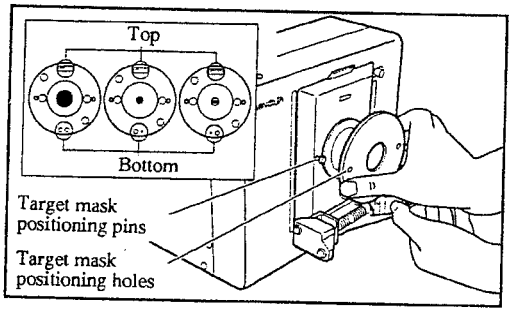
1 Pull open the specimen holder and hold it open.



2 Pull off the target mask which is presently attached to the Spectrophotometer.
   - The target mask is held in place by magnets.



3 Align the target mask positioning holes of the target mask to be attached with the target mask positioning pins of the Spectrophotometer's specimen port baseplate and slide the target mask in against the specimen port baseplate.

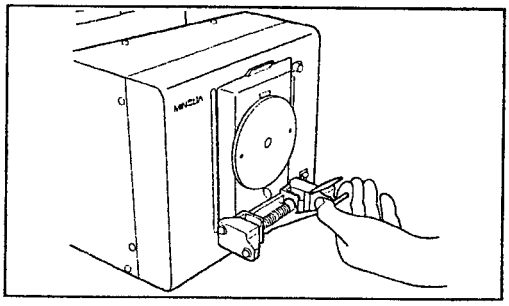


4 Let the specimen holder close against the target mask.

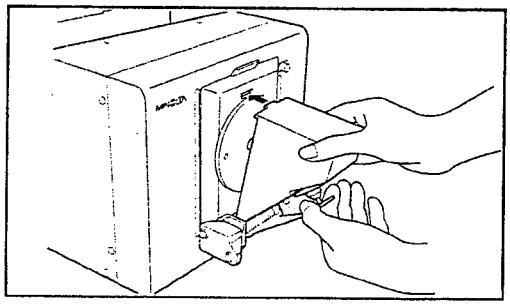
ATTACHING ZERO CALIBRATION BOX

The Zero Calibration Box is used when performing zero calibration for reflectance measurements.

1 Pull open the specimen holder and hold it open.



2 Align the protruding part of the Zero Calibration Box with the indent of the Spectrophotometer's measurement port baseplate and let the specimen holder close against the Zero Calibration Box.

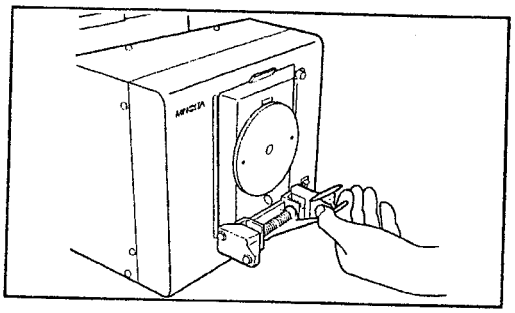


ATTACHING WHITE CALIBRATION PLATE

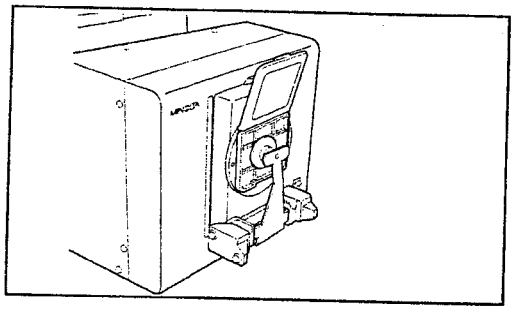
The white calibration plate is used when performing white calibration for reflectance measurements.

- Handle the White Calibration Plate carefully to prevent the white surface from being scratched or stained. If the white surface becomes scratched or permanently stained, replace the White Calibration Plate with a new one.
- When the White Calibration Plate is not being used, be sure to close the cover to protect the white surface from being scratched or stained, changing color due to ambient light (which can occur even under indoor lighting), etc.

1 Pull open the specimen holder and hold it open.



2 Align the round plate on the specimen holder arm with the round indent on the back of the White Calibration Plate and let the specimen holder close against the White Calibration Plate.

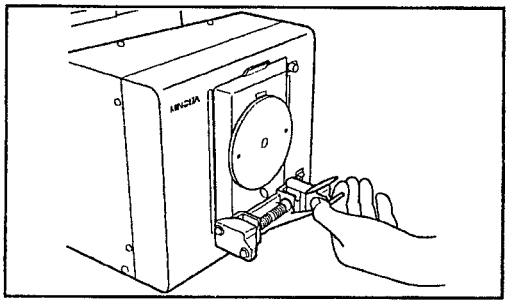


POSITIONING SPECIMENS

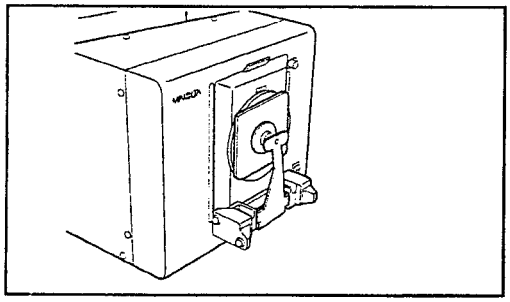
Reflectance Measurements

Thin specimens for reflectance measurements can be held in place by the specimen holder. For specimens which are too large to be held by the specimen holder, remove the specimen holder and hold the specimen against the measurement aperture yourself.

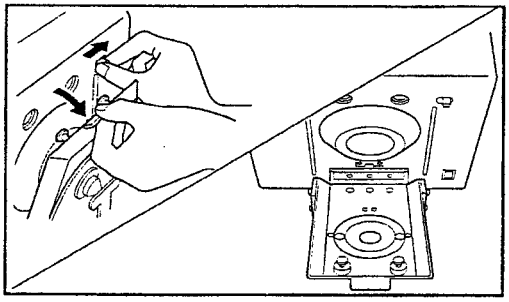
1 Pull open the specimen holder and hold it open.



2 Place the specimen against the measurement aperture and let the specimen holder close.



3 Slide the measurement port baseplate lock in the direction of the arrow, open the measurement port baseplate, and check the position of the specimen.
   - Hold the measurement port baseplate when sliding the measurement port baseplate lock to keep it from falling open.



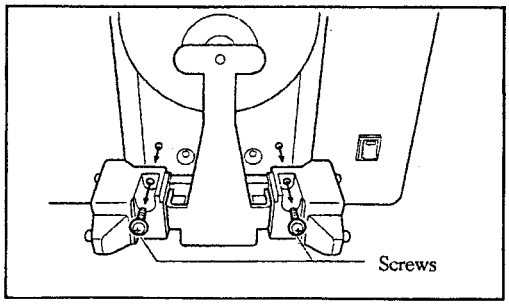
4 If necessary, pull open the specimen holder and readjust the position of the specimen until the specimen area to be measured is in the center of the measurement aperture.
   - To avoid scratching or otherwise damaging the specimen, be sure to hold the specimen holder open when adjusting the specimen position.

5 Close the measurement port baseplate.
   - When closing the measurement port baseplate, be sure that the measurement port baseplate lock is at the open position (slid in the direction of the arrow). If the lock is in the closed position, the measurement port baseplate cannot be closed.

REMOVING SPECIMEN HOLDER

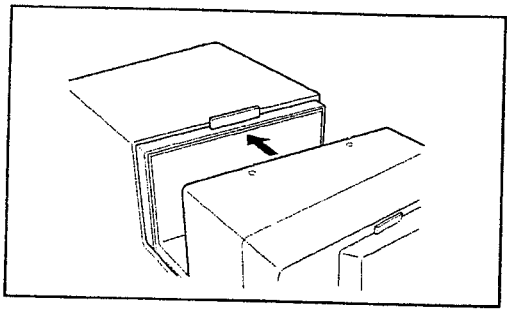
To remove the specimen holder when taking reflectance measurements of large specimens, use a crosspoint screwdriver to turn the two screws of the specimen holder counterclockwise, remove the screws, and then remove the specimen holder.

- Store the specimen holder and the screws carefully.



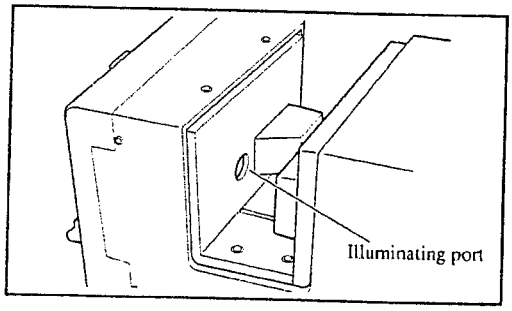
Transmittance Measurements

1 Slide transmittance specimen chamber cover open.

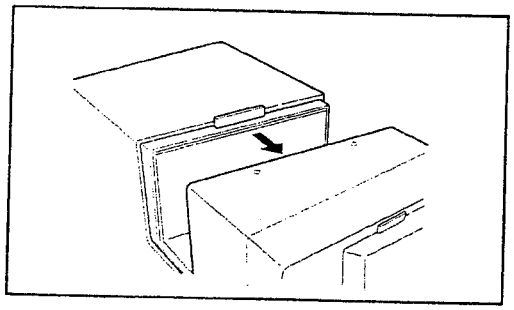


2 Place the specimen (or the container holding a liquid specimen) flat against the illuminating port.

- Be sure that the specimen or container is flat against the illuminating port.
- Containers for liquid specimens should be clear and colorless, and should have flat sides in relation to the illuminating and receiving ports inside the transmittance specimen chamber.
- Be careful not to spill liquid on the Spectrophotometer or inside the transmittance specimen chamber. If liquid is spilled, wipe it up immediately.
- NEVER MEASURE FLAMMABLE LIQUIDS!
- Transmittance Specimen Holder CM-A96 (sold separately) is recommended for holding specimens or one of the optional glass cells in the transmittance specimen chamber.
- Glass Cells CM-A97, CM-A98, and CM-A99 (sold separately) are recommended for use when measuring liquid specimens.



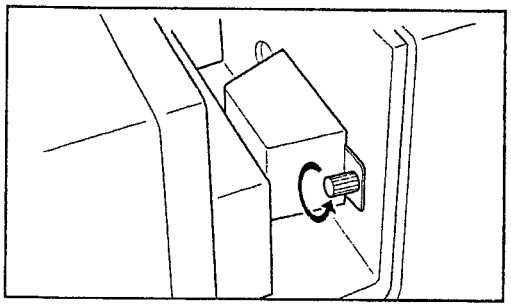
3 Slide the transmittance specimen chamber cover closed.



REMOVING LIGHT TRAP

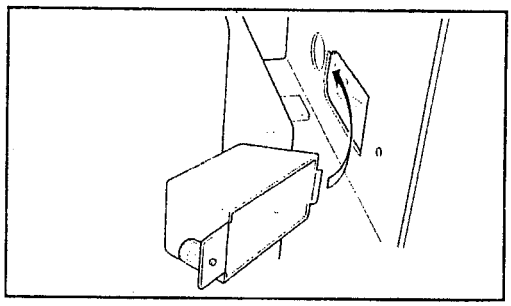
If the specimen for transmittance measurements cannot be positioned because the light trap is in the way, the light trap can be removed by turning the screw of the light trap counterclockwise, removing the screw, and then removing the light trap.

- Be sure to set the SCI/SCE setting to SCI before removing the light trap.
- Store the light trap and screw carefully.



REPLACING LIGHT TRAP

To replace the light trap, hook the flange of the light trap into the Spectrophotometer as shown, insert the screw, and turn the screw clockwise until snug.



CLEANING

Zero Calibration Box and White Calibration Plate

Wipe with a clean, dry cloth. If the stain is difficult to remove, a soft cloth moistened with lens-cleaning fluid may be used. After cleaning the surface with lens-cleaning fluid, wipe the surface with a soft cloth moistened with water and then let the surface dry before use.

- Be careful not to scratch the Zero Calibration Box or White Calibration Plate.

Target Masks

Use a blower to blow dust, dirt, etc. off the white surface of the target mask.

- Do not touch the white surface of the target mask or wipe it with a cloth. If dirt cannot be blown off the target mask with a blower, contact the nearest Minolta authorized service facility.

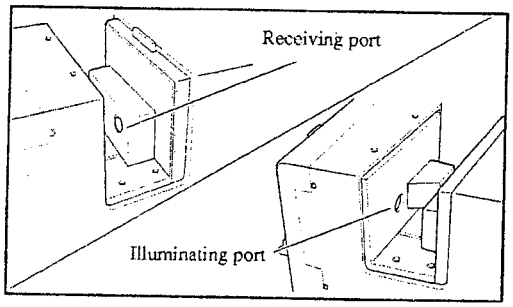
Integrating Sphere

1 Remove the light trap cover. (See p. 17.)
- Be sure to set the SCI/SCE setting to SCI before removing the light trap.
- Store the light trap and screw carefully.

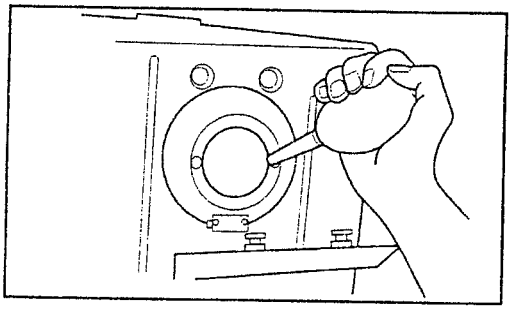
2 Set the SCI/SCE setting to SCE.

3 Check that there is nothing blocking the illumination port in the transmittance specimen chamber.

4 Cover the receiving port in the transmittance specimen chamber to prevent any dust or dirt from entering the port.



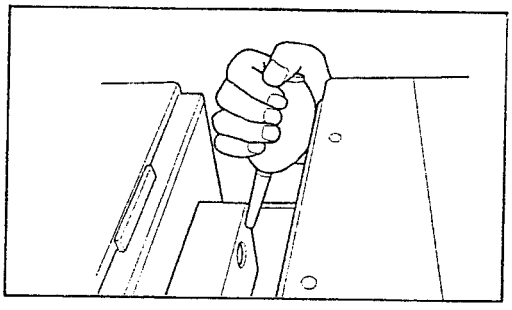
5 Open the measurement port baseplate and use a blower to blow the dust, dirt, etc. off the inside surface of the integrating sphere.
- Do not touch the inside surface of the integrating sphere or stick anything into the sphere. If dirt cannot be blown off the target mask with a blower, contact the nearest Minolta authorized service facility.



Receiving Port of Transmittance Specimen Chamber

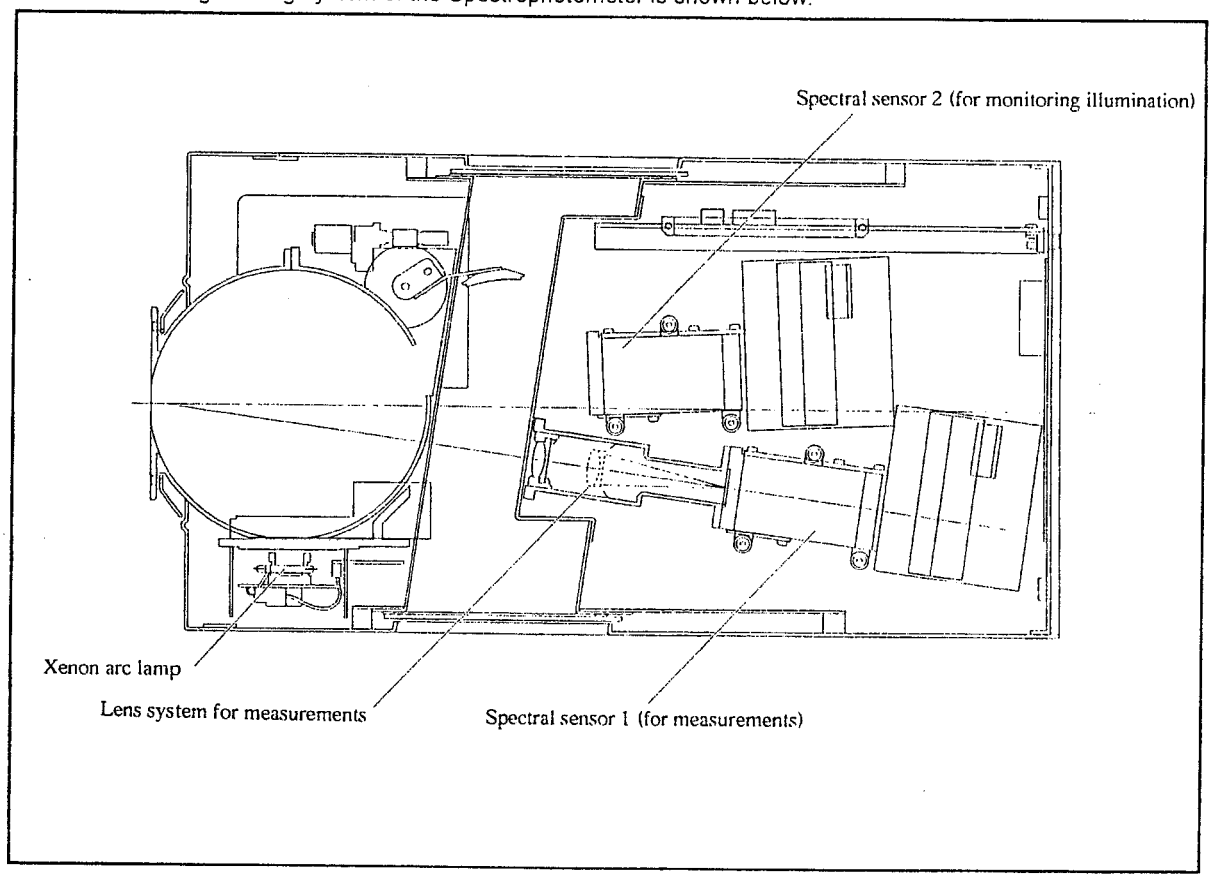
1 Set measurement area to SAV.

2 Use a blower to blow the dust, dirt, etc. off the receiving port and lens.



ILLUMINATING/VIEWING SYSTEM

The illuminating/viewing system of the Spectrophotometer is shown below.



Reflectance Measurements

For reflectance measurements, the specimen surface is illuminated diffusely and viewed at an angle of 8° to the normal to the specimen surface; this geometry is termed d/8 (diffuse/8°). The system also allows users to switch between SCI (specular component included) and SCE (specular component excluded) measurements. The illuminating/viewing geometry meets the specifications for d/8 geometry described in ISO 7724/1[1] and DIN 5033 Teil 7[1]; in addition, the system also meets the recommendations for d/0 (diffuse/normal) geometry published in CIE Publication 15.2[2] and the ASTM E 1164 specifications[3] for d/0 (diffuse/normal; SCE) and t/0 (total/normal; SCI) geometries.

1 ISO 7724/1 and DIN 5033 Teil 7 state that for d/8 geometry, the angle between the viewing beam and the normal to the specimen should be 8°±2° and that the angle between the axis of the viewing beam and any ray within that beam should not exceed 5°. The axis of the Spectrophotometer's viewing beam is at an angle of 8° to the normal to the specimen with a total beam width of less than 10° and thus meets these specifications.

2 CIE recommendations state that for d/0 geometry for reflectance, the angle between the viewing beam and the normal to the specimen surface should not exceed 10° and that the angle between the axis of the viewing beam and any ray within that beam should not exceed 5°. The axis of the Spectrophotometer's viewing beam is at an angle of 8° to the normal to the specimen with a total beam width of less than 10° and thus meets these specifications.

3 ASTM E 1164 specifies that for d/0 and t/0 geometry for reflectance, the angle between the viewing beam and the normal to the specimen surface should not exceed 10° and that the angle between the axis of the viewing beam and any ray within that beam should not exceed 5°. The axis of the Spectrophotometer's viewing beam is at an angle of 8° to the normal to the specimen with a total beam width of less than 10° and thus meets these specifications.

The basic flow of operations for a reflectance measurement is as follows:

1 Light produced by the pulsed xenon arc lamp is thoroughly diffused inside the integrating sphere and then evenly illuminates the specimen surface.

2 Light reflected from the specimen surface at an angle of 8° to the normal exits the integrating sphere through the illumination port for transmittance measurements, is collected by the lens system for taking measurements, and

enters spectral sensor 1. At the same time, the light inside the integrating sphere (the light which illuminates the specimen surface) enters the optical fiber cable for monitoring illumination and is transmitted to spectral sensor 2.

3 The light entering each spectral sensor is divided by wavelength (from 360 to 740nm at 10nm intervals) by the flat holographic grating and strikes the corresponding segments of the silicon photodiode array. The segments convert the received light into electrical currents proportional to the intensity of the light, and these electrical currents are then passed to the analog control circuits.

4 The analog control circuits convert the currents into proportional analog voltages, and then into digital signals. The digital signals are input to the CPU, which performs calculations to determine the spectral reflectance values for each wavelength range, and the results are output to the computer connected to the Spectrophotometer.

The double-beam feedback system of the Spectrophotometer utilizes two spectral sensors: one sensor receives the light reflected by the specimen surface, and the second sensor monitors the light inside the integrating sphere. By utilizing two spectral sensors in this way, the effects of slight variations in the spectral characteristics or intensity of the illumination can be eliminated by calculation.

Transmittance Measurements

For transmittance measurements, the specimen surface is illuminated diffusely and the transmitted light is viewed along the normal to the specimen surface; this geometry is termed d/0 (diffuse/0°). The illuminating/viewing geometry meets the recommendations for d/0 (diffuse/normal) geometry published in CIE Publication 15.2[1], the specifications for d/0 geometry described in DIN 5033 Teil 7[2], and the ASTM E 1164 specifications[3] for t/0 (total/normal) geometry.

1 CIE recommendations state that for d/0 geometry for transmittance, the angle between the viewing beam and the normal to the specimen surface should not exceed 5° and that the angle between the axis of the viewing beam and any ray within that beam should not exceed 5°. The axis of the Spectrophotometer's viewing beam for transmittance is along the normal to the specimen with a total beam width of less than 10° and thus meets these specifications.
2 DIN 5033 Teil 7 states that for d/0 geometry, the viewing beam shall be along the normal to the specimen and the angle between the axis of the viewing beam and any ray within that beam should not exceed 5°. The axis of the Spectrophotometer's viewing beam for transmittance is along the normal to the specimen with a total beam width of less than 10° and thus meets these specifications
3 ASTM E 1164 specifies that for t/0 geometry for transmittance, the angle between the viewing beam and the normal to the specimen surface should not exceed 5° and that the angle between the axis of the viewing beam and any ray within that beam should not exceed 5°. The axis of the Spectrophotometer's viewing beam for transmittance is along the normal to the specimen with a total beam width of less than 10° and thus meets these specifications.

The basic flow of operations for a transmittance measurement is as follows:

1 Light produced by the pulsed xenon arc lamp is thoroughly diffused inside the integrating sphere, exits the integrating sphere through the illumination port for transmittance measurements, and evenly illuminates the specimen surface.

2 Light transmitted by the specimen along the normal to the specimen is collected by the lens system for taking measurements, and enters spectral sensor 1. At the same time, the light inside the integrating sphere (the light which illuminates the specimen surface) enters the optical fiber cable for monitoring illumination and is transmitted to spectral sensor 2.

3 The light entering each spectral sensor is divided by wavelength (from 360 to 740nm at 10nm intervals) by the flat holographic grating and strikes the corresponding segments of the silicon photodiode array. The segments convert the received light into electrical currents proportional to the intensity of the light, and these electrical currents are then passed to the analog control circuits.

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Illumination Area and Measurement Area

Three different measurement areas can be selected on the Spectrophotometer: SAV (3×5mm), MAV (Ø8mm), and LAV (Ø25.4mm). Three target masks, with apertures which limit the illumination area to that appropriate for the corresponding measurement area, are included with the Spectrophotometer as standard accessories. The target mask with the aperture corresponding to the selected measurement area should be used for measurements.

TARGET MASKS

Each target mask is equipped with pins at the bottom of the target mask plate; the number and position of these pins indicate to the Spectrophotometer which target mask is attached (and thus which illumination area is being used). However, changing the target mask does not automatically change the measurement area of the Spectrophotometer.

The target mask for SAV measurements is essentially the same as the one for MAV measurements, but with a 0.3mm-thick diffusion plate attached to increase the illumination area and reduce the edge-loss error which occurs with semitransparent specimens.

The target mask surface which faces into the integrating sphere has a high-reflectance white coating. Since the reflectance of this coating affects measurements, be careful to protect the white surface from scratches and never touch the white surface.

MEASUREMENT AREA

The measurement area is controlled by a motor which moves the converging lens in the optical system for measurement according to the commands sent to the Spectrophotometer from a computer.

UV Adjustment

The Spectrophotometer is equipped with a UV cutoff filter positioned in front of the pulsed xenon arc lamp. The position of this filter is controlled by a motor and allows the amount of UV included in the illumination to be controlled. When the pulsed xenon arc lamp is completely blocked by the UV cutoff filter, all light at wavelengths below 390nm is eliminated from the illumination. The position of the filter can also be adjusted to provide illumination which closely matches CIE Illuminant D_{65}. The position of the filter (and thus the amount of UV included in the illumination) can be adjusted in 1000 steps, from 0.0 to 99.9%.

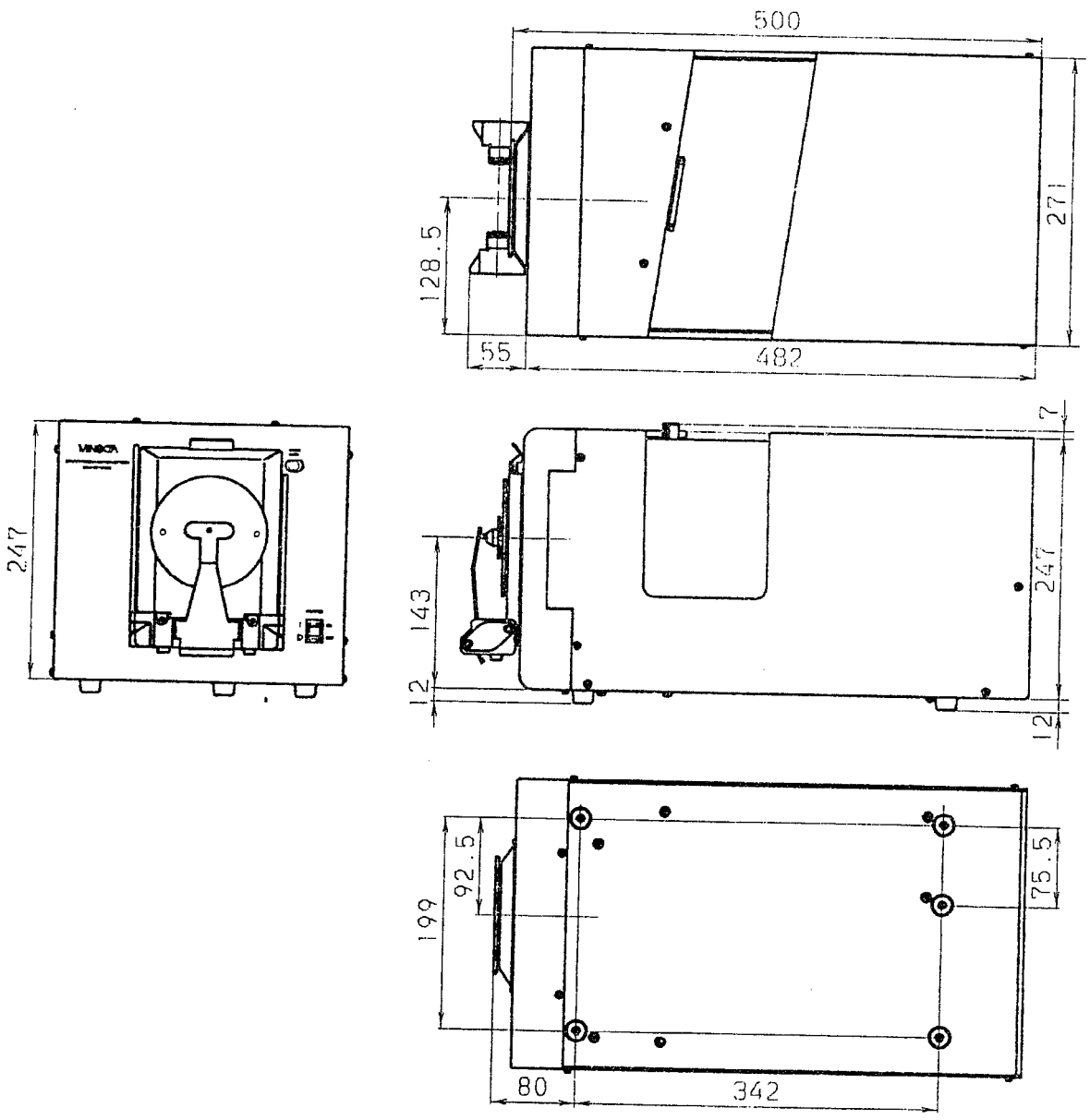
For the highest possible accuracy when measuring fluorescent specimens, fluorescent calibration using a standard specimen for which standard values should be performed by measuring the standard specimen repeatedly and the position of the UV filter adjusted so that the measured values closely match the standard values. In addition, since the xenon lamp will age and the light output by the lamp will change over time, it is recommended that fluorescent calibration be performed periodically if fluorescent specimens will be measured.

If extremely high accuracy is not required and fluorescent calibration will not be performed, it is recommended that fluorescent specimens be measured with the UV filter completely removed from in front of the xenon lamp, allowing 99.9% of UV to be included in the illumination.

- Even when the measured specimens are not fluorescent, if the position of the UV filter is changed white calibration should be performed again to ensure the highest accuracy.

DIMENSION DIAGRAM

(Units: mm)



SPECIFICATIONS

Model	CM-3700d
Illuminating/viewing system	Reflectance: d/8 (diffuse illumination/8° viewing angle); SCI (specular component included)/SCE (specular component excluded) switchable. Meets ISO 7724/1 and DIN 5033 teil 7 for d/8 geometry, CIE recommendations for d/0, and ASTM E 1164 for t/0 and d/0 for reflectance measurements. Transmittance: d/0 (diffuse illumination/0° viewing angle). Meets CIE recommendations for d/0, DIN 5033 teil 7 for d/0, and ASTM E 1164 for t/0 for transmittance measurements.
Detector	Silicon photodiode array with flat holographic grating
Wavelength range	360 to 740nm
Wavelength pitch	10nm
Half bandwidth	Approx. 14nm average
Photometric range	0 to 200%
Light source	Pulsed xenon arc lamp
Measurement/calculation time	0.6 to 0.8s (to start of data output)
Minimum interval between measurements	3s
Illumination/measurement areas	Reflectance: Changeable between SAV, MAV, and LAV SAV: 5×7mm illumination/3×5mm measurement MAV: Ø11mm illumination/Ø8mm measurement LAV: Ø28mm illumination/Ø25.4mm measurement Transmittance: Approx. Ø20mm
Inter-instrument agreement	Chromaticity: ΔE^*_{ab} within 0.3 (Average value of 12 BCRA Series II tiles compared to values measured with master body
Repeatability	White calibration plate measured 30 times at 10s intervals after white calibration was performed: Spectral reflectance: Standard deviation within 0.05% Chromaticity: Standard deviation within ΔE^*_{ab} 0.01 Black tile (reflectance: 1%) measured 30 times at 10s intervals after white calibration was performed: Spectral reflectance: 380 to 740nm: Standard deviation within 0.02% 360 and 370nm: Standard deviation within 0.04% Chromaticity: Standard deviation within ΔE^*_{ab} 0.05
Temperature drift	Spectral reflectance: Within ±0.10%/°C Color difference: Within ΔE^*_{ab} 0.05/°C
UV adjustment	Computer controlled continuously variable filter position (390nm cutoff filter); can be set to approximate D_{65} illumination
Specimen conditions for transmittance measurements	Sheet, plate, or liquid form up to a maximum thickness of approximately 50mm
Interface	RS-232C standard, 25-pin female D-subminiature connector Communication parameters: Baud rate: 1200, 2400, 4800, or 9600bps Character length: 7 or 8 bits Stop bits: 1 or 2 bits Parity: None, Even, or Odd X parameter: On or Off
Power	AC 100V/120V/230V 50/60Hz (using included AC Adapter AC-A12)
Operation temperature/ humidity range	13 to 33°C (55 to 92°F); less than 80% relative humidity with no condensation
Storage temperature/ humidity range	0 to 40°C (32 to 104°F); less than 80% relative humidity with no condensation
Dimensions (W x H x D)	271 x 259 x 500mm (10-11/16 x 10-3/16 x 19-11/16 in.)
Weight	18kg (39.7 lb.)
Standard accessories	White Calibration Plate CM-A90; Target Mask (for 3×5mm) CM-A91; Target Mask (for Ø8mm) CM-A92; Target Mask (for Ø25.4mm) CM-A93; Zero Calibration Box CM-A94; AC Adapter AC-A12; RS-232C Cable (2m/6.6 ft., 9-pin for IBM PC) CM-A52
Optional accessories	Color Data Software CM-S3w; Transmittance Specimen Holder CM-A96; Cell (2mm) CM-A97; Cell (10mm) CM-A98; Cell (20mm) CM-A99; Transmittance Zero Calibration Plate CM-A100; RS-232C Cables CM-A53 to CM-A56

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