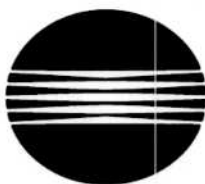


# **SPECTROPHOTOMETER CM-3500d**






**HARDWARE MANUAL**



**KONICA MINOLTA**










## Safety Symbols





The following symbols are used in this manual to prevent accidents which may occur as a result of incorrect use of the instrument.

-  Denotes a sentence regarding a safety warning or caution.  
Read the sentence carefully to ensure safe and correct use.
-  Denotes a prohibited operation.  
The operation must never be performed.
-  Denotes an instruction.  
The instruction must be strictly adhered to.
-  Denotes an instruction.  
Disconnect the AC power cord from the AC outlet.
-  Denotes a prohibited operation.  
Never disassemble the instrument.

## SAFETY PRECAUTIONS

- To ensure correct use of this Spectrophotometer CM-3500d, read the following points carefully and adhere to them. After you have read this manual, keep it in a safe place where it can be referred to any time a question arises.

 <b>WARNING</b> (Failure to adhere to the following points may result in death or serious injury.)	
 Do not use the CM-3500d in places where flammable or combustible gases (gasoline fumes, etc.) are present. Doing so may cause a fire.	 Do not disassemble or modify the AC adapter. Doing so may cause a fire or electric shock.
 Always use the AC adapter supplied as a standard accessory or specified replacement AC adapter with the CM-3500d, and connect it to an AC outlet (100 Vac, 50-60 Hz). Failure to do so may damage the CM-3500d or the AC adapter, causing a fire or electric shock.	 The CM-3500d should not be operated if the CM-3500d or AC adapter is damaged, or if smoke or strange odors occur. Doing so may result in a fire. In such situations, turn the power OFF immediately, disconnect the AC adapter from the AC outlet, and contact the nearest <u>Konica Minolta-authorized service facility</u> .
 If the CM-3500d will not be used for a long time, disconnect the AC adapter from the AC outlet. Accumulated dirt or water on the prongs of the AC adapter's plug may cause a fire and should be removed.	 Do not disassemble or modify the CM-3500d. Doing so may cause a fire or electric shock.
 Do not insert or disconnect the AC adapter with wet hands. Doing so may cause electric shock.	 Take special care not to allow liquid or metal objects to enter the CM-3500d. Doing so may cause a fire or electric shock. Should liquid or metal objects enter the CM-3500d, turn the power OFF immediately, disconnect the AC adapter from the AC outlet, and contact the nearest <u>Konica Minolta-authorized service facility</u> .

 <b>CAUTION</b> (Failing to adhere to the following points may result in injury or damage to the CM-3500d or other property.)	
 Do not perform measurement with the specimen measuring port directed towards your face. Doing so may cause damage to your eyes.	 Be careful around openings in the CM-3500d. Failure to do so may result in fingers being trapped causing injury.
 Do not place the CM-3500d on an unstable or sloping surface. Doing so may result in its dropping or overturning, causing injury. Take care not to drop the CM-3500d when carrying it.	

The Konica Minolta Spectrophotometer CM-3500d 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 changeable measurement areas: Ø8mm, and Ø30mm (standard accessories) and Ø3mm (optional accessory); 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. In addition, the top port design allows a petri dish (optional accessory) to be used for reflectance measurements of powders, pastes, or liquids.

All functions are controlled by a computer connected to the Spectrophotometer's RS-232C terminal. Switching between measurement areas and switching between SCI and SCE measurements 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-3500d are divided into two manuals:

- 1 **HARDWARE MANUAL** (this manual): A manual explaining the hardware of the Spectrophotometer CM-3500d 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-3500d 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 Konica Minolta-authorized service facility.

## CAUTION

### Spectrophotometer

- This instrument should be used at ambient temperatures of between 0 and 40°C (32 and 104°F). Do not use in areas subject to sudden changes in temperature.
- The instrument is designed for indoor use only, and should never be used outside as there is a danger that rain and other environmental factors may damage the 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 I (on).
- Do not use the instrument at altitudes of higher than 2000m.
- Use an AC power source which is within  $\pm 10\%$  of the rated voltage.
- The instrument is classified as Installation Category II (equipment which is powered by an AC adapter connected to a commercially available power source).
- Always use the AC adapter (AC-A12) supplied as a standard accessory and connect it to an AC outlet of the rated voltage and frequency.
- The instrument is classified as Pollution Degree 2 (equipment which may cause temporary electrical hazards due to contamination or condensation, or products which are used in such an environment). Do not use the instrument in such an environment.

### 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

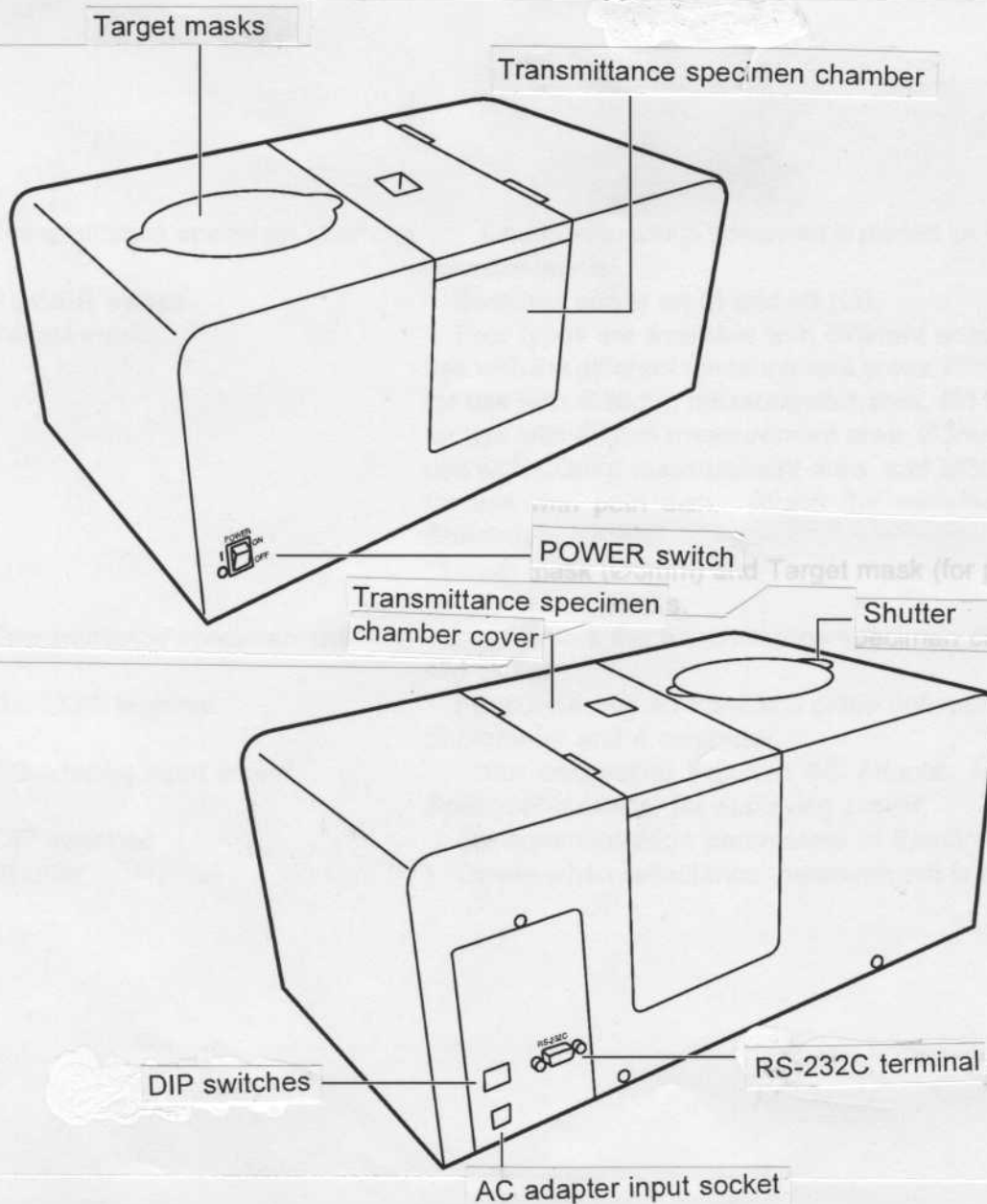
- If this instrument becomes dirty, it can be wiped with a clean, dry cloth. Do not allow alcohol or chemicals to come in contact with this instrument.
- If the White Calibration Plate becomes dirty, it can be wiped with a clean, dry cloth. If the stain is difficult to remove, a soft cloth moistened 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 Konica Minolta-authorized service facility.
- This instrument should be stored at temperatures of between -20 and 45°C (-4 and 112°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 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.
- If dust, etc. enters the Zero Calibration Box, use a blower to blow away the dust, etc. If the inside of the Zero Calibration Box is touched carelessly, wipe away fingerprints, etc. with a clean, dry cloth.

## CONTENTS

<b>NOTES ON USING THESE MANUALS</b> .....	<b>1</b>
<b>WARNING</b> .....	<b>1</b>
<b>CAUTION</b> .....	<b>2</b>
Spectrophotometer .....	2
White Calibration Plate .....	2
Target Masks .....	2
<b>CARE AND STORAGE</b> .....	<b>3</b>
<b>NAMES OF PARTS AND FUNCTIONS OF CONTROLS</b> .....	<b>5</b>
<b>STANDARD ACCESSORIES</b> .....	<b>6</b>
<b>OPTIONAL ACCESSORIES</b> .....	<b>7</b>
<b>SYSTEM DIAGRAM</b> .....	<b>9</b>
<b>COMMUNICATION PARAMETERS</b> .....	<b>10</b>
<b>CONNECTION WITH A COMPUTER</b> .....	<b>11</b>
RS-232C Terminal Pin Diagram .....	11
Connections .....	11
Connection Procedure .....	11
<b>CONNECTING AC ADAPTER</b> .....	<b>12</b>
<b>SWITCHING SPECTROPHOTOMETER ON AND OFF</b> .....	<b>12</b>
<b>ATTACHING TARGET MASK</b> .....	<b>13</b>
<b>ATTACHING ZERO CALIBRATION BOX</b> .....	<b>14</b>
Reflectance Measurements .....	14
Measurements using a Petri Dish .....	14
<b>ATTACHING WHITE CALIBRATION PLATE</b> .....	<b>15</b>
Reflectance Measurements .....	15
Measurements using a Petri Dish .....	15
<b>POSITIONING SPECIMENS</b> .....	<b>16</b>
Reflectance Measurements .....	16
Transmittance Measurements .....	16
Measurements using a Petri Dish .....	17
<b>CLEANING</b> .....	<b>18</b>
White Calibration Plate .....	18
Target Masks .....	18
Integrating Sphere .....	18
Receiving Port of Transmittance Specimen Chamber .....	18
<b>ILLUMINATING/VIEWING SYSTEM</b> .....	<b>19</b>
Reflectance Measurements .....	19
Transmittance Measurements .....	20
Illumination Area and Measurement Area .....	21
TARGET MASKS .....	21
MEASUREMENT AREA .....	21
<b>DIMENSION DIAGRAM</b> .....	<b>22</b>
<b>SPECIFICATIONS</b> .....	<b>23</b>



## NAMES OF PARTS AND FUNCTIONS OF CONTROLS



- 1 Transmittance specimen chamber
- 2 POWER switch
- 3 Target masks

- 4 Transmittance specimen chamber cover
- 5 RS-232C terminal
- 6 AC adapter input socket
- 7 DIP switches
- 8 Shutter

Chamber in which specimen is placed for transmittance measurements  
Switches power on (I) and off (O).

Four types are available with different aperture sizes for use with the different measurement areas: Ø36mm aperture for use with Ø30mm measurement area, Ø11mm aperture for use with Ø8mm measurement area, Ø3mm aperture for use with Ø3mm measurement area, and Ø36mm aperture for use with petri dish. Attach the selected type to the Spectrophotometer.

\*Target mask (Ø3mm) and Target mask (for petri dish) are optional accessories.

Covers the transmittance specimen chamber.

For connecting an RS-232C cable between the Spectrophotometer and a computer.

For connecting included AC Adapter AC-A12 to the Spectrophotometer for supplying power.

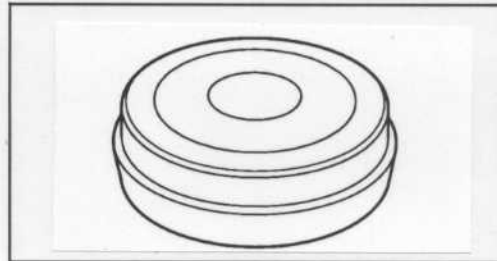
Set communication parameters of Spectrophotometer.

Opens when reflectance measurement is performed.

## STANDARD ACCESSORIES

### White Calibration Plate CM-A120

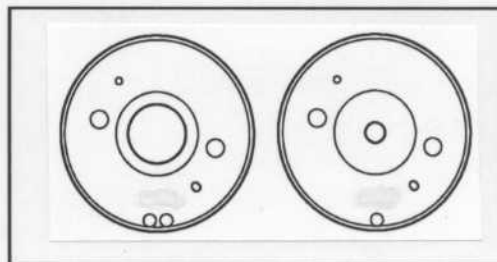
White Calibration Plate CM-A90 is the white calibration standard for reflectance measurements for the Spectrophotometer. The white calibration data is included stored on a 3.5-inch floppy disk and also listed on data sheets.



### Target Mask CM-A122 (for use with Ø8mm measurement area)

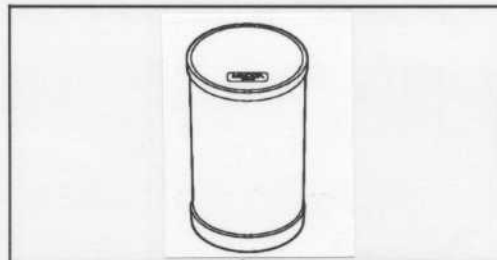
### Target Mask CM-A123 (for use with Ø30mm measurement area)

Target Masks CM-A122 and CM-A123 attach to the Spectrophotometer to limit the illumination area to the area appropriate for the measurement area. Protective cases are also included.



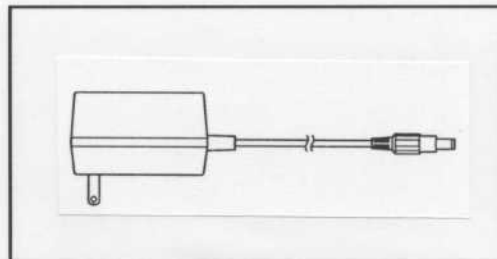
### Zero Calibration Box CM-A124

Zero Calibration Box CM-A124 is for performing zero calibration for reflectance measurements.



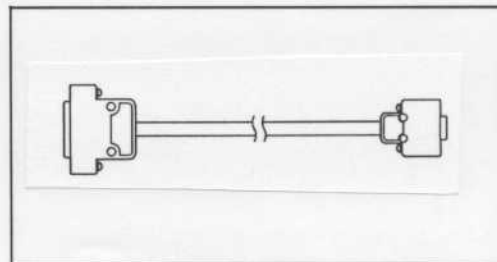
### AC Adapter AC-A12

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



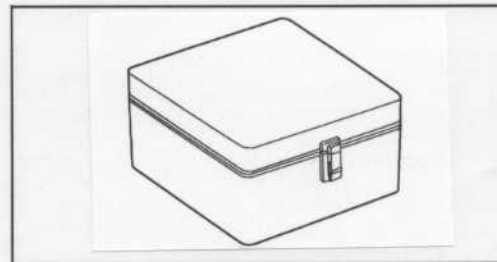
### RS-232C Cable IF-A12

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.



### Carrying Case for Accessories CM-A67

Carrying Case for Accessories CM-A67 stores and protects accessories.

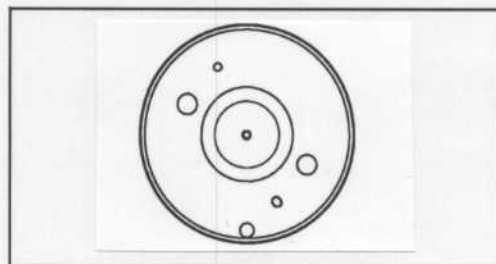




## OPTIONAL ACCESSORIES

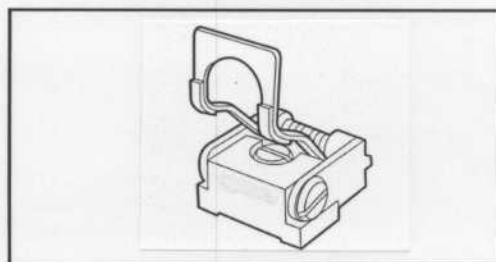
### Target Mask CM-A121(for $\varnothing 3\text{mm}$ )

Target Mask CM-A121 attaches to the Spectrophotometer to limit the illumination area to the area appropriate for the measurement area.



### 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.

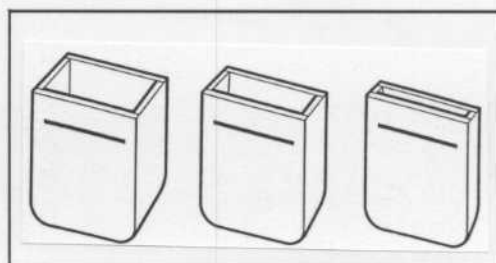


Cell CM-A97 (Optical path length: 2mm)

Cell CM-A98 (Optical path length: 10mm)

Cell CM-A99 (Optical path length: 20mm)

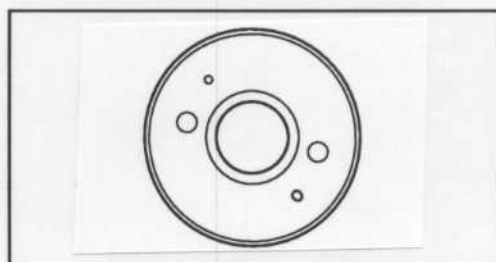
Cells CM-A97 through CM-A99 are glass cells for holding liquid specimens for transmittance measurements.



### Petri Dish Set CM-126

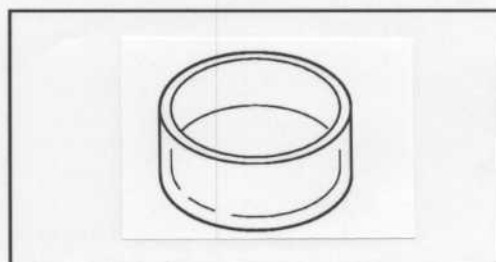
#### Target Mask (for Petri Dish) CM-127

Target Mask CM-A127 attaches to the Spectrophotometer to limit the illumination area to the area appropriate for measurements using the petri dish.



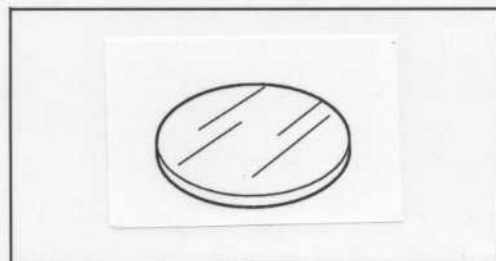
### Petri Dish CM-A128

Petri Dish CM-A128 can be used to hold powder, paste, or liquid specimens for reflectance measurements.



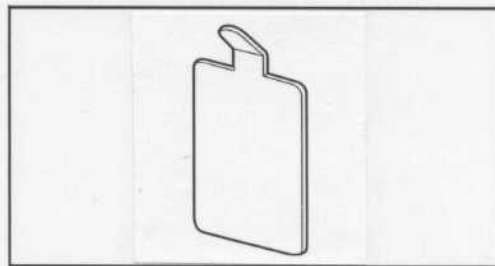
### Calibration Glass (for Petri Dish) CM-A129

Calibration Glass CM-A129 is made of the same material and is the same thickness as the bottom of the petri dish. It is used during white and zero calibration for measurements using the petri dish.



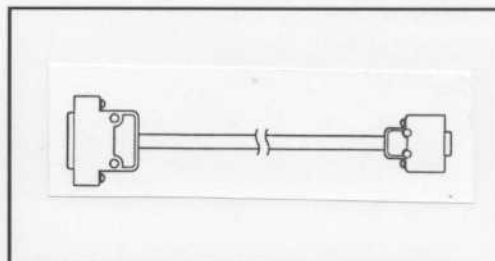
**Transmittance Zero Calibration Plate CM-A100**

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

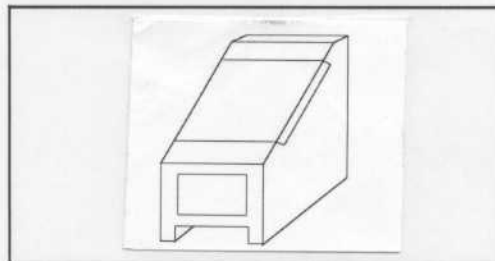
**RS-232C Cables IF-A11 through IF-A15**

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

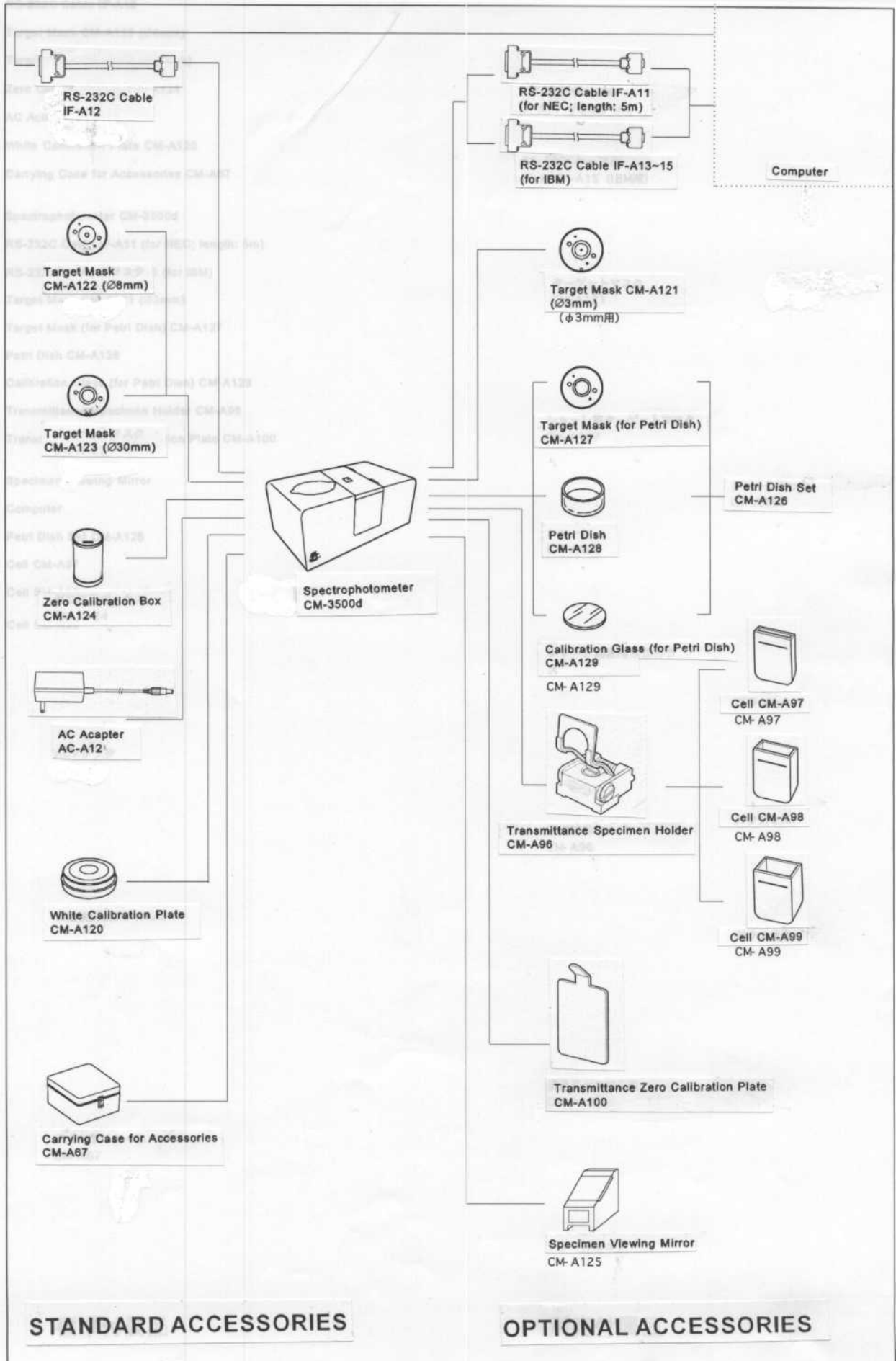
Cable	Length	Connector
RS-232C Cable IF-A11	5m/16.4 ft.	Male 25-pin D-subminiature
RS-232C Cable IF-A12	2m/6.6 ft.	Female 9-pin D-subminiature
RS-232C Cable IF-A13	5m/16.4 ft.	Female 9-pin D-subminiature
RS-232C Cable IF-A14	2m/6.6 ft.	Female 25-pin D-subminiature
RS-232C Cable IF-A15	5m/16.4 ft.	Female 25-pin D-subminiature

**Specimen Viewing Mirror CM-A125**

Specimen Viewing Mirror CM-A125 is for checking position of specimen for reflectance measurement.



# SYSTEM DIAGRAM



## COMMUNICATION PARAMETERS

The baud rate of the Spectrophotometer are set using the DIP switches on the back 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, 2 and 3:

Baud rate	1200	2400	4800	9600	19200
DIP switch 1	OFF	OFF	OFF	OFF	ON
DIP switch 2	OFF	OFF	ON	ON	OFF
DIP switch 3	OFF	ON	OFF	ON	OFF

At the time of shipment from the factory, DIP switch1 is set to OFF and DIP switch 2 and 3 are set to ON, resulting in the baud rate being set to 9600. Other Communication parameters are fixed at the following settings;

Character length: 8 bits  
Stop bits: 1  
Parity: None  
X parameter: Not used

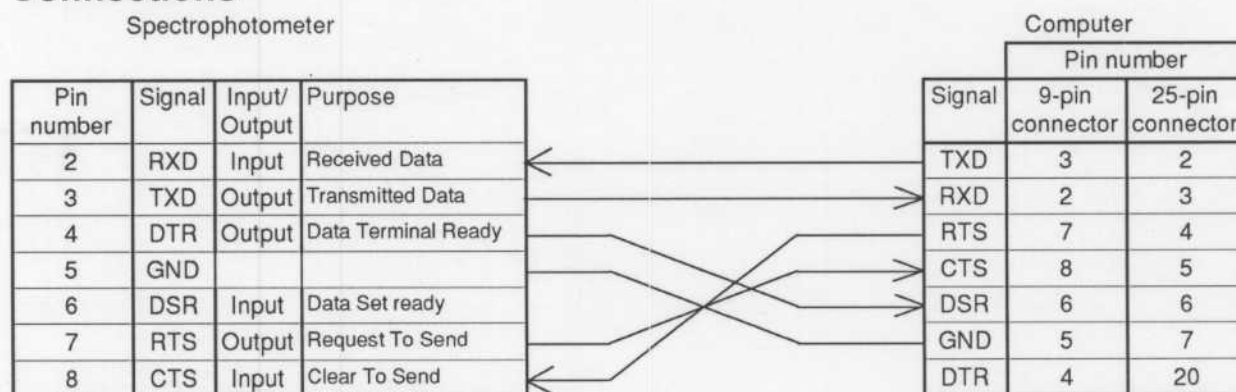
## CONNECTION WITH A COMPUTER

- 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

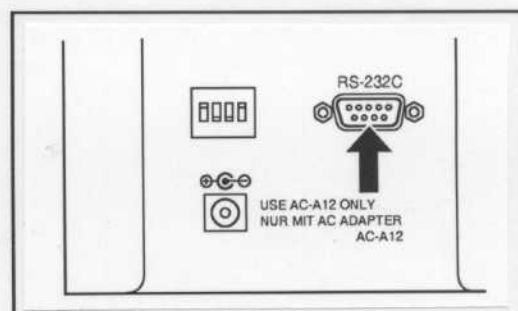


## Connections



## Connection Procedure

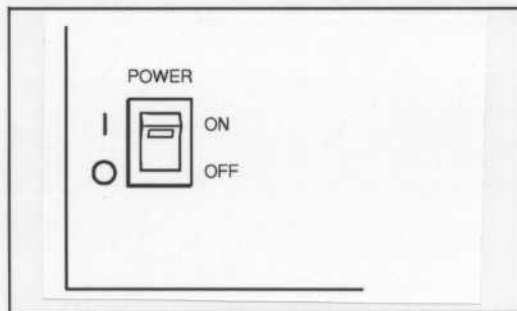
- 1 Check that the power of both the Spectrophotometer and the computer are switched off.
- 2 Connect the cable to the Spectrophotometer's RS-232C terminal and to the computer.



## CONNECTING AC ADAPTER

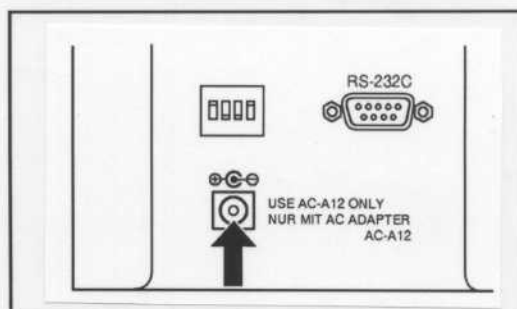
- Use only AC Adapter AC-A12 to supply power to the Spectrophotometer. Do not use other AC adapters.

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

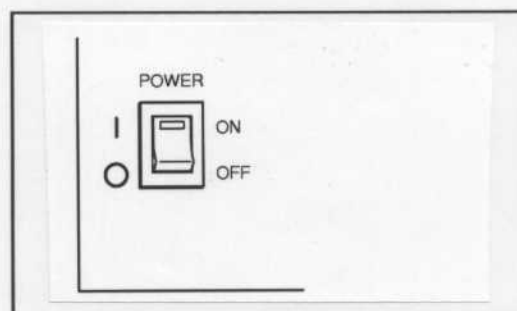


To disconnect the AC adapter, reverse the above procedure.

- 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.

## SWITCHING SPECTROPHOTOMETER ON AND OFF

Be sure to wait approx. 30sec. after switching power off before switching power back on to avoid possibly causing the CM-350Cd to malfunction.





## ATTACHING TARGET MASK

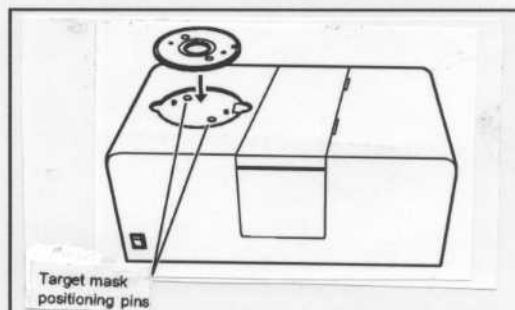
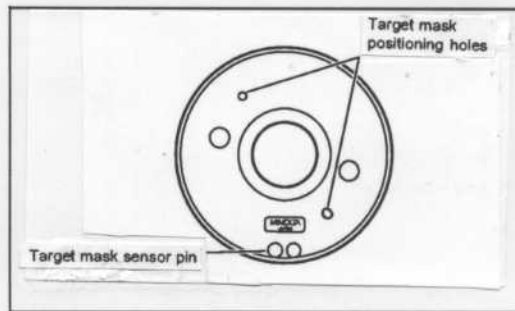
Four interchangeable target masks with different aperture sizes are included with the Spectrophotometer. The target masks limit the area of the specimen which is illuminated to the area appropriate for the corresponding measurement area. The three target masks and the measurement area that each mask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

Target Mask CM-A122 (aperture size: Ø11mm) :	For use with Ø8mm measurement area
Target Mask CM-A123 (aperture size: Ø36mm) :	For use with Ø30mm measurement area
Target Mask CM-A121 (aperture size: Ø3mm) :	For use with Ø3mm measurement area. Use Ø8mm measurement area setting.
Target Mask CM-A127 (aperture size: Ø36mm) :	For use with Petri Dish CM-A128. Use Ø30mm measurement area setting.

- 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 shutter and the integrating sphere of the Spectrophotometer, one of the target masks should be attached to the Spectrophotometer even when the Spectrophotometer is not being used.
- Keep floppy disks away from strong magnetic fields. Since software and data are stored magnetically on floppy disks, such software and /or data may be altered or damaged if the disks are placed within a strong magnetic field. (Please note that the target mask is held onto the CM-3500d by magnets. For this reason, floppy disks should be kept away from the area to which the target masks are attached.)

- 1 Align the target mask positioning holes of the target mask to be attached with the target mask positioning pins of the Spectrophotometer and slide the target mask down against the Spectrophotometer.

- The white coating surface of target mask should face down.
- Target mask sensor pins should be toward the right side of the Spectrophotometer.



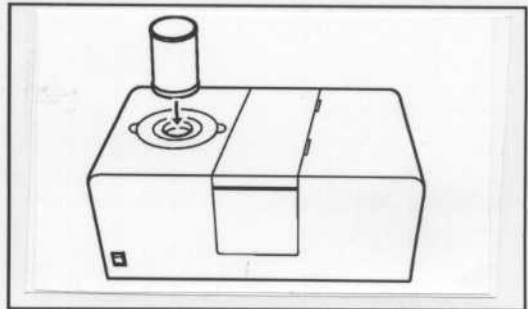
## ATTACHING ZERO CALIBRATION BOX

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

- Do not touch the black inside surface of the Zero Calibration Box. Protect the black surface from scratch and stains.
- To prevent dust from entering the Zero Calibration Box, always place the cap on the Zero Calibration Box when it is not being used. If dust enters the Zero Calibration Box, use a blower to blow away the dust.

## Reflectance Measurements

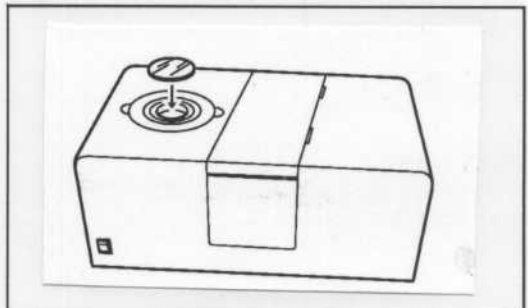
1. Set the Zero Calibration Box into the groove of the Target Mask.



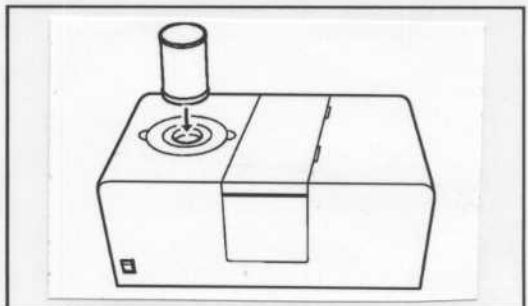
## Measurements using a Petri Dish

- If the bottom of the Petri Dish or the Calibration Glass (for Petri Dish) CM-A129 becomes stained, 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 Petri Dish or the Calibration Glass becomes scratched or permanently stained, replace the Petri Dish or Calibration Glass with a new one.

1. Set the Calibration Glass (for Petri Dish ) CM-A129 into the recessed area of the Target Mask (for Petri Dish) CM-A127.



2. Set the Zero Calibration Box into the groove of the Target Mask.



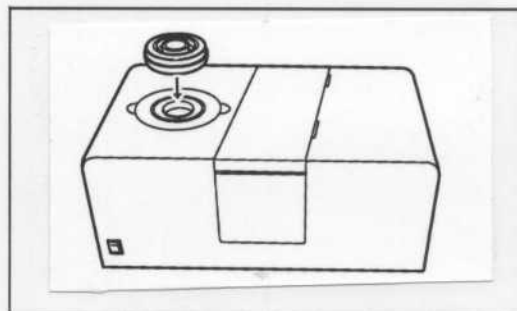
## ATTACHING WHITE CALIBRATION PLATE

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.

## Reflectance Measurements

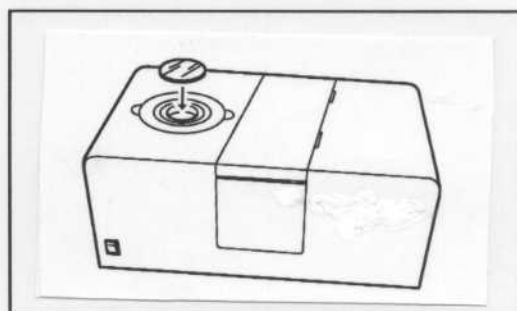
1. Set the White Calibration Plate into the groove of the Target Mask.



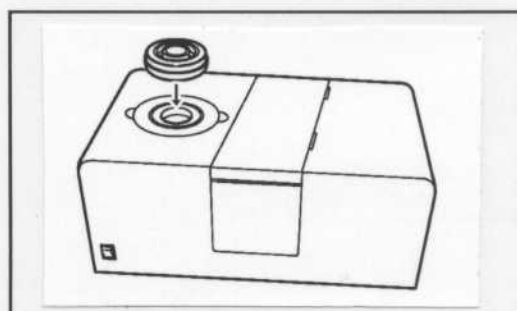
## Measurements using a Petri Dish

- If the bottom of the Petri Dish or the Calibration Glass (for Petri Dish ) CM-A129 becomes stained, 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 Petri Dish or the Calibration Glass becomes scratched or permanently stained, replace the Petri Dish or Calibration Glass with a new one.

1. Set the Calibration Glass into (for Petri Dish ) CM-A129 into the recessed area of the Target Mask (for Petri Dish) CM-A127.



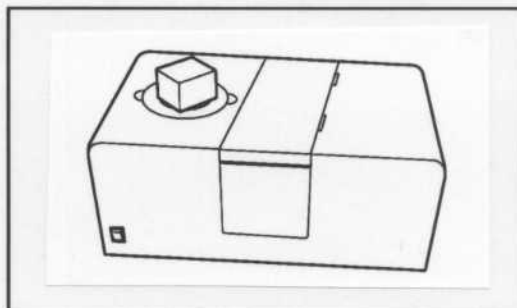
2. Set the White Calibration Plate into the groove of the Target Mask.



## POSITIONING SPECIMENS

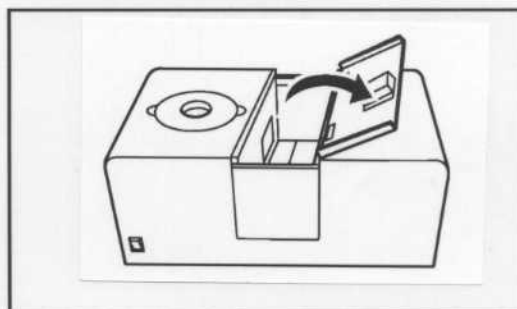
### Reflectance Measurements

- When the CM-3500d has not been used for a long time, use a blower to blow away any dust on the shutter before taking a measurement.
- 1 Place the specimen on the Target Mask so that the area to be measured covers the Target Mask aperture.

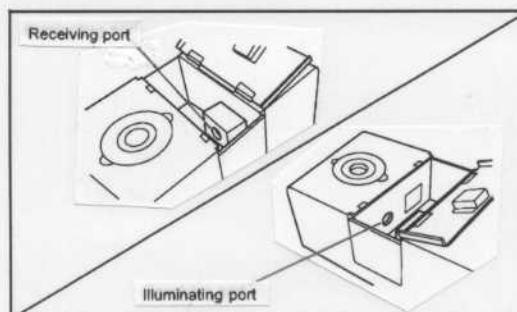


### Transmittance Measurements

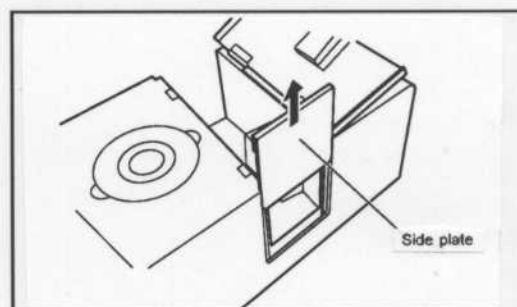
- 1 Open the cover of the transmittance specimen chamber.



- 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.
  - If the specimen cannot be positioned because the side plate is in the way, the side plate can be removed.

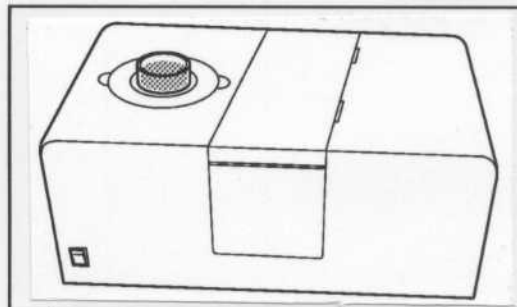


- 3 Close the cover of transmittance specimen chamber .



## Measurements using a Petri Dish

- If the bottom of the Petri Dish or the Calibration Glass (for Petri Dish) CM-A129 becomes stained, 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 Petri Dish or the Calibration Glass becomes scratched or permanently stained, replace the Petri Dish or Calibration Glass with a new one.
- 1 Pour the specimen to be measured into the Petri Dish.
  - 2 Set the Petri Dish into the recessed area of the Target Mask (for Petri Dish ) CM-A129.



## CLEANING

### 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 White Calibration Plate.

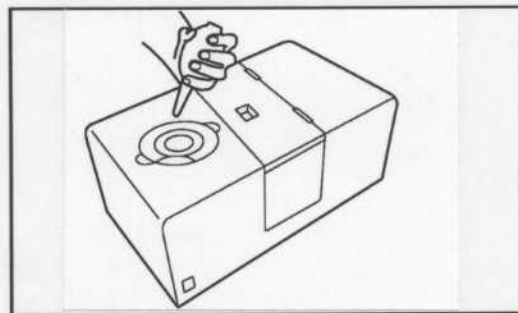
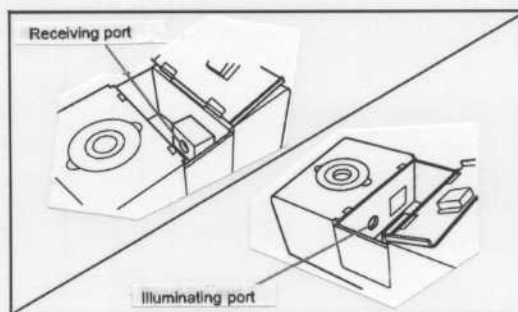
### Target Masks

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.

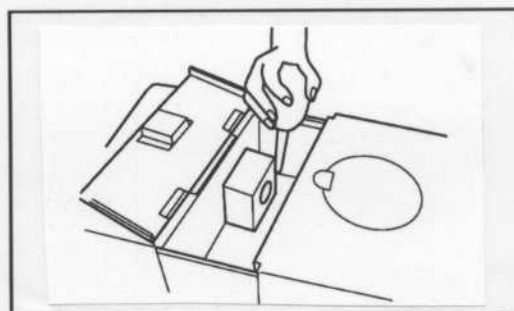
### Integrating Sphere

- 1 Set the SCI/SCE setting to SCE.
- 2 Check that there is nothing blocking the illumination port in the transmittance specimen chamber.
- 3 Cover the receiving port in the transmittance specimen chamber to prevent any dust or dirt from entering the port.
- 4 Open shutter 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

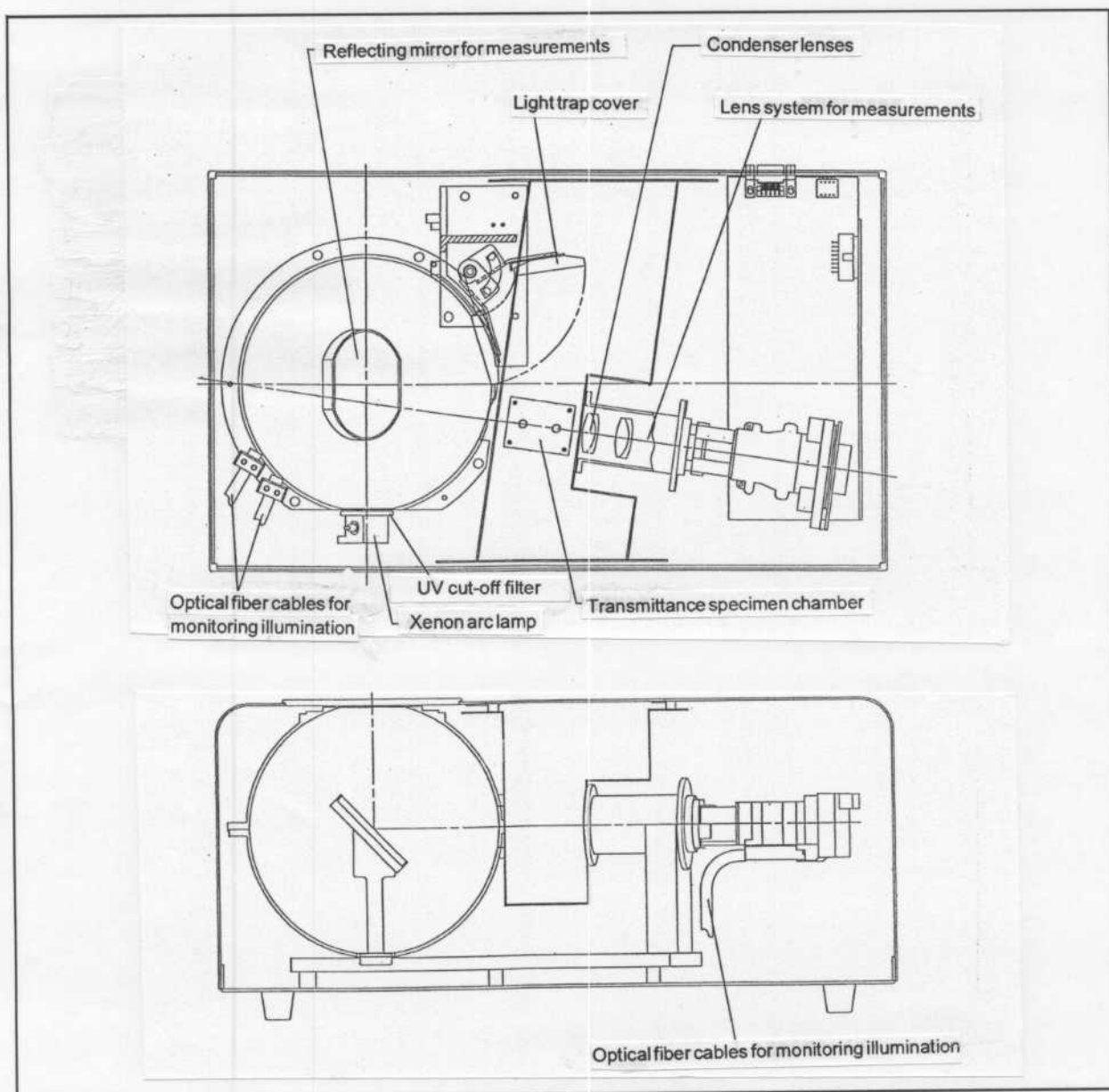
- 1 Set measurement area to  $\varnothing 8\text{mm}$ .
- 2 Use a blower to blow the dust, dirt, etc. off the receiving port and lens.





## 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  $8^\circ$  to the normal to the specimen surface; this geometry is termed d/8 (diffuse/ $8^\circ$ ). 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<sup>1</sup> and DIN 5033 Teil 7<sup>1</sup>; in addition, the system also meets the recommendations for d/0 (diffuse/normal) geometry published in CIE Publication 15.2<sup>2</sup> and the ASTM E 1164 specifications<sup>3</sup> 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  $8^\circ \pm 2^\circ$  and that the angle between the axis of the viewing beam and any ray within that beam should not exceed  $5^\circ$ . The axis of the Spectrophotometer's viewing beam is at an angle of  $8^\circ$  to the normal to the specimen with a total beam width of less than  $10^\circ$  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  $10^\circ$  and that the angle between the axis of the viewing beam and any ray within that beam should not exceed  $5^\circ$ . The axis of the Spectrophotometer's viewing beam is at an angle of  $8^\circ$  to the normal to the specimen with a total beam width of less than  $10^\circ$  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  $10^\circ$  and that the angle between the axis of the viewing beam and any ray within that beam should not exceed  $5^\circ$ . The axis of the Spectrophotometer's viewing beam is at an angle of  $8^\circ$  to the normal to the specimen with a total beam width of less than  $10^\circ$  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  $8^\circ$  to the normal is reflected by a mirror and passes out of the integrating sphere through the illumination port for transmittance measurements, is collected by the lens system for taking measurements, and enters spectral sensor (for measurement). 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 (for monitoring illumination).
- 3 The light entering each spectral sensor is divided by wavelength (from 400 to 700nm at 20nm intervals) by the wedge-shaped continuous interference filter 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<sup>1</sup>, the specifications for d/0 geometry described in DIN 5033 Teil 7<sup>2</sup>, and the ASTM E 1164 specifications<sup>3</sup> 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  $5^\circ$  and that the angle between the axis of the viewing beam and any ray within that beam should not exceed  $5^\circ$ . 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  $10^\circ$  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  $5^\circ$ . 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  $10^\circ$  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  $5^\circ$  and that the angle between the axis of the viewing beam and any ray within that beam should not exceed  $5^\circ$ . 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  $10^\circ$  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 (for measurement). 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 (for monitoring illumination).
- 3 The light entering each spectral sensor is divided by wavelength (from 400 to 700nm at 20nm intervals) by the wedge-shaped continuous interference filter 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 transmittance 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 transmitted by the specimen, 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.

## Illumination Area and Measurement Area

Two different measurement area settings can be selected on the Spectrophotometer: Ø30mm and Ø8mm. Two 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 Mask CM-A122 :            Ø8mm measurement area / Ø11mm illumination area  
Target Mask CM-A123:            Ø30mm measurement area / Ø36mm illumination area

Two additional target masks are available as optional accessories:

Target Mask CM-A121:            Ø3mm measurement area / Ø3mm illumination area (Use Ø8mm setting)  
Target Mask (for Petri Dish) CM-A127: Ø30mm measurement area / Ø36mm illumination area (Use Ø30mm setting)

### TARGET MASKS

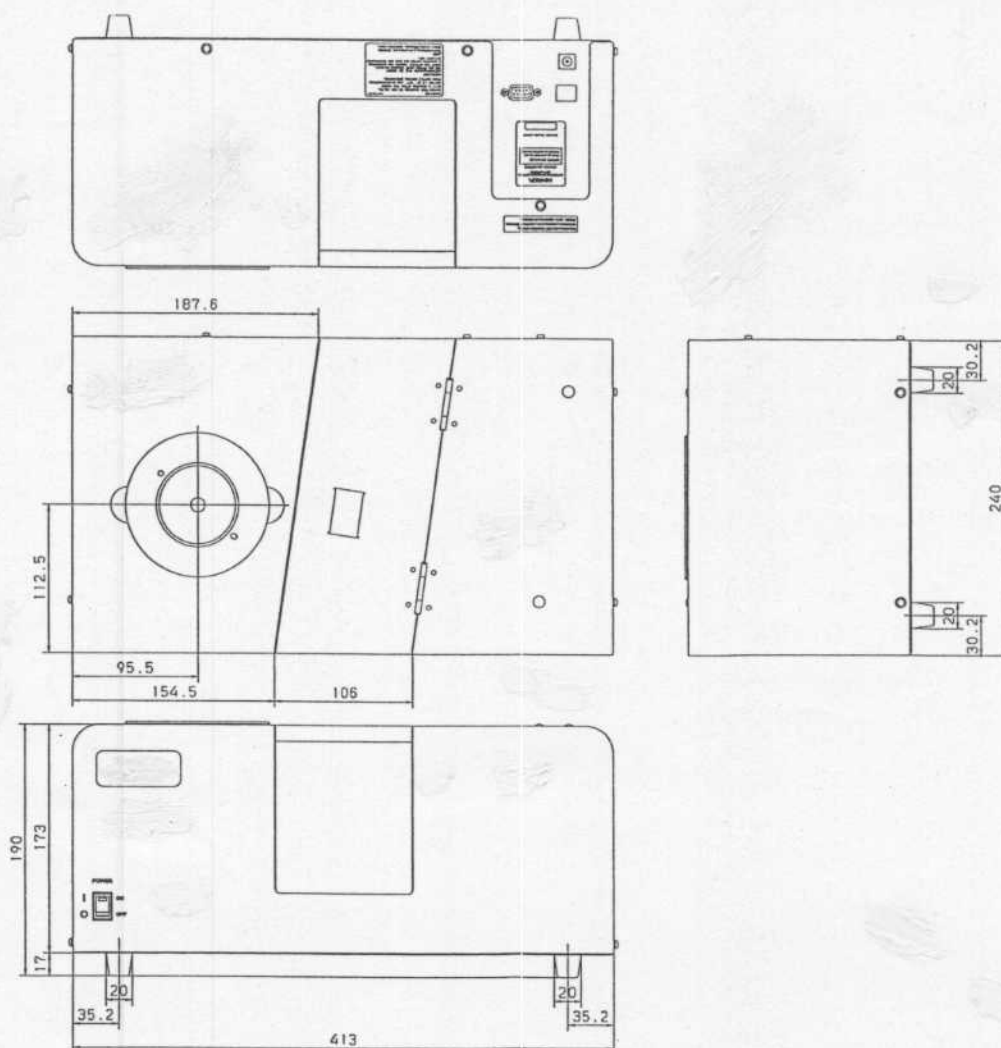
Each target mask is equipped with pins at the bottom of the target mask plate; the number and position of these pins indicate to the Spectrophotometer which target mask is attached (and thus which illumination area is being used). However, changing the target mask does not automatically change the measurement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

The target mask 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.

(Units: mm)



## Specifications

Model	CM-3500d
Illumination/viewing system	Reflectance: d/3 (diffused illumination, 8-degree viewing), SCI (specular component included)/SCE (specular component excluded) switchable. Conforms to CIE No. 15, ISO 7724/1, ASTM E1164, DIN 5033 Teil 7, and JIS Z 8722 Condition C standard. Transmittance: d/0 (diffused illumination, 0-degree viewing) Conforms to CIE No. 15, ASTM E1164, and DIN 5033 Teil 7 standards.
Light-receiving element	Silicon photodiode array
Spectral separation device	Wedge-shaped continuous interference filter
Wavelength range	400nm to 700nm
Wavelength pitch	20nm
Half bandwidth	Approx. 20nm average
Reflectance range	0 to 175%, resolution: 0.01%
Light source	Pulsed xenon arc lamps
Measurement time	Approx. 2.5 seconds (to start of data output)
Minimum interval between measurements	Approx. 3 seconds
Measurement/illumination area	Reflectance: Changeable $\phi 30\text{mm}/\phi 36\text{mm}$ $\phi 8\text{mm}/\phi 11\text{mm}$ Transmittance: Approx. $\phi 12\text{mm}$
Inter instrument agreement	Mean $\Delta E^*ab$ 0.3 (SCI) based on 12 BCRA Series II color tiles compared to values measured with master body.
Repeatability	Spectral reflectance: Standard deviation within 0.20% Colorimetric values: Standard deviation within $\Delta E^*ab$ 0.05 (when a white calibration plate is measured 30 times at 10-second intervals)
Temperature drift	Spectral reflectance: Within $\pm 0.30\%/^{\circ}\text{C}$ Color difference: Within $\Delta E^*ab$ 0.05/ $^{\circ}\text{C}$
Specimen conditions for Transmittance measurements	Sheet, Plate, or liquid form up to a maximum thickness of approximately 50mm
Control method	Directly connected to a computer
Interface	RS-232C Terminal : D-subminiature 9-pin (female) Baud rate : 1200, 2400, 4800, 9600, 19200bps Character bits : 8 bits Stop bit : 1 bit Parity check : None Xparameter : Off
Power	100-240Vac, 50-60Hz 25W AC (with a dedicated AC adapter AC-A12)
Size (W x H x D)/weight	413 x 190 x 240mm (16-1/4 x 7-1/2 x 9-7/16 inch) 10Kg (22 lb).
Operating temperature/humidity range	0 to 40°C (32 to 104° F); relative humidity 85% or less (with no condensation) (at 35°C with no condensation)
Storage temperature/humidity range	-20 to 45°C, relative humidity 85% or less (at 35°C with no condensation)
Standard accessories	White calibration plate CM-A120 Target mask ( $\phi 8\text{mm}$ ) CM-A122 Target mask ( $\phi 30\text{mm}$ ) CM-A123 Zero calibration box CM-A124 AC adapter AC-A12 RS-232C cable (for IBM PC/AT, 2m) IF-A12
	Target mask ( $\phi 3\text{mm}$ ) CM-A121 Transmittance Specimen Holder CM-A96 Cell(2mm) CM-A97 Cell(10mm) CM-A98 Cell(20mm) CM-A99 Petri Dish set CM-A126 Target Mask(for Petri Dish) CM-A127 Petri Dish set CM-A128 Calibration Glass(for Petri Dish) CM-A129 Transmittance Zero Calibration Plate CM-A100 RS-232C cable (Male 25-pin D-sub:2m/6.6ft) IF-A10 (Male 25-pin D-sub:5m/16.4ft) IF-A11 (Female 9-pin D-sub:5m/16.4ft) IF-A13 (Female 25-pin D-sub:2m/6.6ft) IF-A14 (Female 25-pin D-sub:5m/16.4ft) IF-A15 Specimen Viewing Mirror CM-A125

- Specifications subject to change without notice.



KONICA MINOLTA