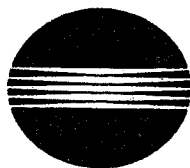


SPECTROPHOTOMETER

CM-512m3

HARDWARE MANUAL



MINOLTA

NOTES ON USING THESE MANUALS

The instructions for Spectrophotometers CM-512m3 is divided into two manuals:

- 1 **HARDWARE MANUAL** (this manual): A manual explaining the Spectrophotometer and its operation, including:
 - Names of parts and functions of controls
 - Cautions and warnings; Care and storage
 - Preparations (Power, calibration, settings)
 - Measurement operations
 - Error messages and troubleshooting
 - Measuring principle
 - Specifications
- 2 **COMMUNICATION MANUAL**: A manual describing communication between the Spectrophotometer and a separate computer, including:
 - Connections and communication settings
 - Commands and input/output formats
 - Error-check code

Measurement angles:

The CM-512m3 uses three-angle illumination/single-angle viewing geometries. The illumination angles for this model are shown in the table below:

Model	Angle A	Angle B	Angle C
CM-512m3	25°	45°	75°

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 UNIT IS DISASSEMBLED BY UNQUALIFIED PERSONNEL. Any necessary repairs should be done only by a Minolta-authorized service facility.
- USE ONLY THE AC ADAPTER INCLUDED AS A STANDARD ACCESSORY (AC ADAPTER AC-A12) TO SUPPLY POWER TO THE INSTRUMENT FROM AN AC OUTLET.

CAUTION

General

- Do not subject this instrument to strong physical shock or vibration.
- Do not press on the liquid crystal display.
- This instrument should be used at ambient temperatures of between 0 and 40°C (32 and 104°F).
- Do not use this instrument in extremely humid or dusty areas.
- When disconnecting the AC adapter, always pull on the plug. Never pull on the cord.
- Do not leave 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 ambient temperature in such cases.
- When connecting or disconnecting this instrument and a computer, be sure to turn off the power of both this instrument and the computer.
- Do not touch or press on the connector pins.

When Taking Measurements

- Be careful to prevent the components inside the measuring aperture from becoming dirty. When taking measurements with the instrument inverted, be sure to prevent anything (such as dust, etc.) from entering the measuring aperture.
- Since measurement values may drift somewhat due to repeated use, physical shock, vibration, or instrument aging, white calibration should be performed at the start of a measurement period (and periodically throughout the period if the measurement period is long) to ensure measurement accuracy.
- Since the color of specimens themselves may change due to changes in temperature (resulting in variations in measurement values even if white calibration has been performed), white calibration, target color measurement, and specimen measurement should all be performed at the same temperature.

White Calibration Cap

- To protect the white surface of the calibration cap from being scratched or stained, changing color due to ambient light, etc., be sure to close the cover of the white calibration cap after use. If the plate does become stained, refer to **CARE AND STORAGE** for the cleaning procedure.

CARE AND STORAGE

- If the instrument body becomes dirty, the body may be wiped with a soft, dry cloth. Never use benzene, thinner, or other solvents for cleaning.
- If the components inside the measuring aperture become extremely dirty, they may be wiped gently with a soft dry cloth. Be extremely careful to avoid scratching the components.
- If the white calibration becomes dirty, it may be wiped with a soft, dry cloth. If the stain remains even after wiping, a soft cloth moistened with lens-cleaning fluid may be used. After cleaning the white calibration plate with lens-cleaning fluid, wipe the plate with a cloth moistened with water and then let the surface dry before use.
- This instrument should be stored in areas with temperature between -20 and 50°C (-4 and 122°F). Do not store this instrument in areas subject to high temperatures, high humidity, or rapid temperature changes, or where there is much dust. For added safety, it is recommended that the instrument be stored with a drying agent (such as silica gel) in an area where the temperature is relatively constant.
- Do not leave this instrument in direct sunlight, inside or in the trunk of an automobile, or in any other area subject to extremely high temperatures.
- To prevent the white surface of the white calibration plate from changing color due to exposure to light (which may occur even in normal room light), always close the cover of the white calibration plate after use.
- To avoid the possibility of damage due to battery leakage or corrosion, remove the batteries from the instrument if the instrument will not be used for more than two weeks. This applies to both the Spectrophotometer itself and also to the remote control.

CAUTION

General

- Do not subject this instrument to strong physical shock or vibration.
- Do not press on the liquid crystal display.
- This instrument should be used at ambient temperatures of between 0 and 40°C (32 and 104°F).
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- Do not leave 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 ambient temperature in such cases.
- When connecting or disconnecting this instrument and a computer, be sure to turn off the power of both this instrument and the computer.
- Do not touch or press on the connector pins.

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- Since the color of specimens themselves may change due to changes in temperature (resulting in variations in measurement values even if white calibration has been performed), white calibration, target color measurement, and specimen measurement should all be performed at the same temperature.

White Calibration Cap

- To protect the white surface of the calibration cap from being scratched or stained, changing color due to ambient light, etc., be sure to close the cover of the white calibration cap after use. If the plate does become stained, refer to **CARE AND STORAGE** for the cleaning procedure.

CARE AND STORAGE

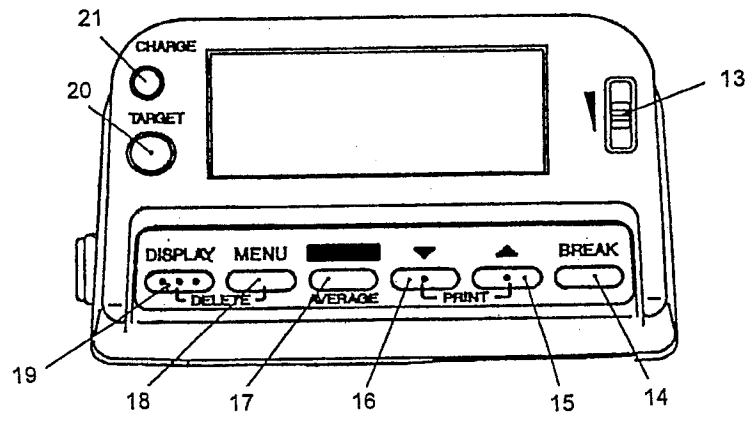
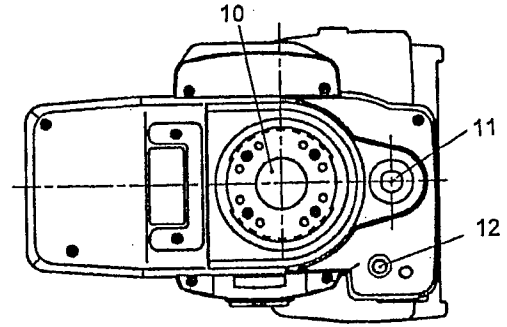
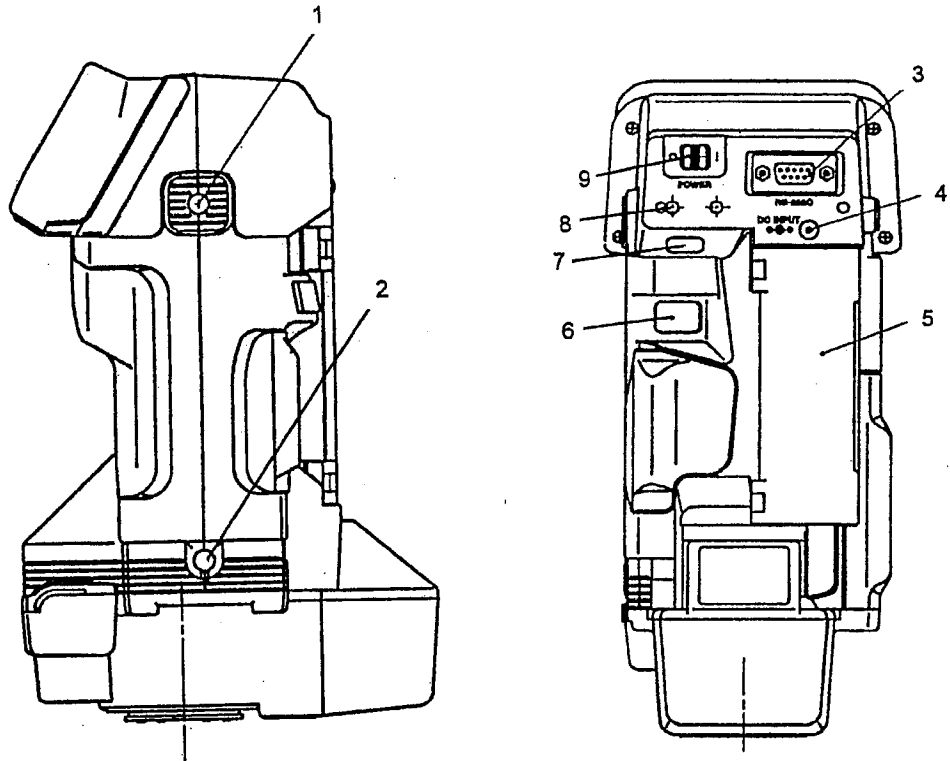
- If the instrument body becomes dirty, the body may be wiped with a soft, dry cloth. Never use benzene, thinner, or other solvents for cleaning.
- If the components inside the measuring aperture become extremely dirty, they may be wiped gently with a soft dry cloth. Be extremely careful to avoid scratching the components.
- If the white calibration becomes dirty, it may be wiped with a soft, dry cloth. If the stain remains even after wiping, a soft cloth moistened with lens-cleaning fluid may be used. After cleaning the white calibration plate with lens-cleaning fluid, wipe the plate with a cloth moistened with water and then let the surface dry before use.
- This instrument should be stored in areas with temperature between -20 and 50°C (-4 and 122°F). Do not store this instrument in areas subject to high temperatures, high humidity, or rapid temperature changes, or where there is much dust. For added safety, it is recommended that the instrument be stored with a drying agent (such as silica gel) in an area where the temperature is relatively constant.
- Do not leave this instrument in direct sunlight, inside or in the trunk of an automobile, or in any other area subject to extremely high temperatures.
- To prevent the white surface of the white calibration plate from changing color due to exposure to light (which may occur even in normal room light), always close the cover of the white calibration plate after use.
- To avoid the possibility of damage due to battery leakage or corrosion, remove the batteries from the instrument if the instrument will not be used for more than two weeks. This applies to both the Spectrophotometer itself and also to the remote control.

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NAMES OF PARTS AND FUNCTIONS OF CONTROLS



- 1 Strap guide hole
- 2 Accessory switch mounting socket
- 3 RS-232C terminal
- 4 AC adapter socket
- 5 Battery chamber cover
- 6 Measuring button
- 7 Measuring button selector
- 8 IrDA receiver
- 9 POWER switch
 - Switches power on (I) and off (O).
- 10 Measurement aperture
- 11 Temperature sensor
 - Measures the temperature of the specimen at the same time as color is measured.
- 12 Strap mounting socket A
- 13 Contrast adjustment slide
- 14 **BREAK**
 - Returns to next higher display, with measurement display being the highest level display.
 - When pressed together with **TARGET**, causes data to be displayed inverted.
- 15 ▲
 - Changes settings or changes to next higher specimen number, target number, or numerical value.
- 16 ▼
 - Changes settings or changes to next lower specimen number, target number, or numerical value.
- 17 **CURSOR/AVERAGE**
 - Moves cursor when setting data or changing MENU settings.
 - In measurement mode or **TARGET** mode, starts/stops manual averaging sequence.
- 18 **MENU**
 - Enters MENU mode for setting various conditions and functions.
- 19 **DISPLAY**
 - Changes between measurement displays for selected DISPLAY setting in measurement mode.
 - Changes between MENU displays in MENU mode.
- 20 **TARGET**
 - Enters TARGET mode for setting or selecting target color data.
 - When pressed together with **BREAK**, causes data to be displayed inverted.
- 21 **CHARGE** lamp
 - Lit when lamp circuit has completed charging and is ready to take a measurement.

PREPARATIONS

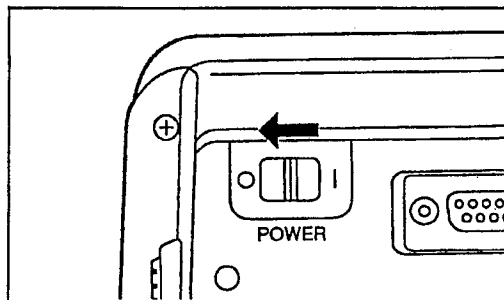
Power

The Spectrophotometer can be powered by 4 AA-size batteries or the included AC adapter AC -A12.

- When data communication via the RS-232C port or IrDA will be performed, it is recommended that the AC adapter be used to power the Spectrophotometer.

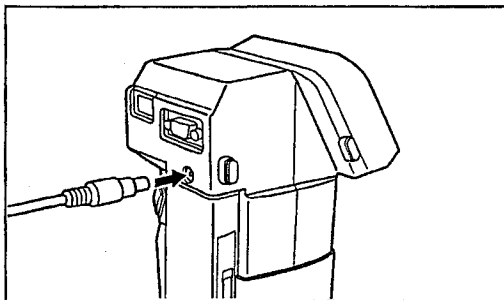
USING AC ADAPTER

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



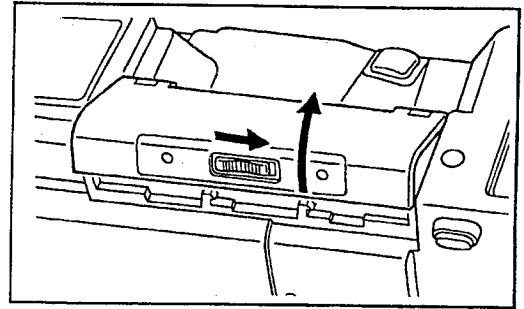
- 2 Insert the output plug of the AC adapter into the Spectrophotometer's AC adapter socket.

- 3 Insert the input plug of the AC adapter into an AC outlet.
 - Use only AC Adapter AC-A12 (output:9V 1.2A) to supply power to the Spectrophotometer from AC outlet. Do not use other AC adapters.
 - When disconnecting the AC adapter, be sure that the Spectrophotometer's POWER switch is set to ○ (off).
 - When taking measurement continuously long period of time, take a pause more than 30 minutes at every 300 measurements.



INSTALLING BATTERIES

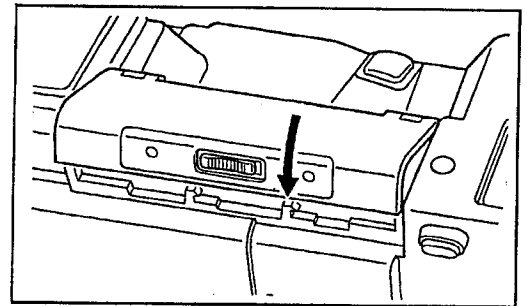
- 1 Check that the POWER switch is set to O (off).
- 2 Slide battery chamber cover lock up and open the battery chamber cover.



- 3 Install four AA-size alkaline-manganese, carbon-zinc, or nickel-cadmium batteries in the battery chamber with their polarities as indicated inside battery chamber.
 - Do not mix battery types or ages. Mixing battery types or ages may result in battery leakage or bursting, or in shorter battery life.
 - Do not touch or short out the battery contacts in the battery chamber. Doing so may cause the Spectrophotometer to malfunction.

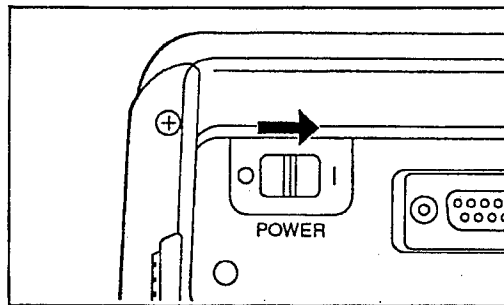
- 4 Close the battery-chamber cover.

- When the Spectrophotometer will not be used for more than two weeks, remove the batteries to avoid the possibility of damage due to battery leakage or corrosion.

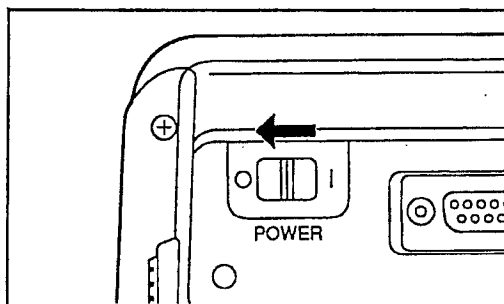


SWITCHING POWER ON AND OFF

To switch the power on, slide the POWER switch to I (on). The startup display sequence will occur and then the calibration display will appear.



To switch the power off, slide the POWER switch to O (off).



AUTO POWER SAVE FUNCTION

The Spectrophotometer is equipped with an auto power save function which switches off the charging circuits if none of the Spectrophotometer's controls are operated for more than approximately three minutes. (Except same screens) When the auto power save function has been activated, the CHARGE lamp will go out. The auto power save function is cancelled when any of the Spectrophotometer's controls are operated and lit the CHARGE lamp.

MEMORY BACKUP

Data in memory are maintained even when the POWER is switched off, the batteries are removed, or the AC adapter is disconnected. It can maintain the data in memory for one to two months (after it has been fully recharged by leaving the Spectrophotometer switched on with the AC adapter connected to the Spectrophotometer and an AC outlet.

Adjusting Display Contrast

The contrast of the display can be adjusted by moving the contrast-adjustment slide in either direction to obtain the best contrast viewing.

The appearance of the display also varies according to the angle from which it is viewed.

Inverting Displayed Data

Data can be shown upside-down in the display if desired by pressing TARGET and BREAK at the same time. (Except same screens) To return the display to normal, press TARGET and BREAK at the same time again.

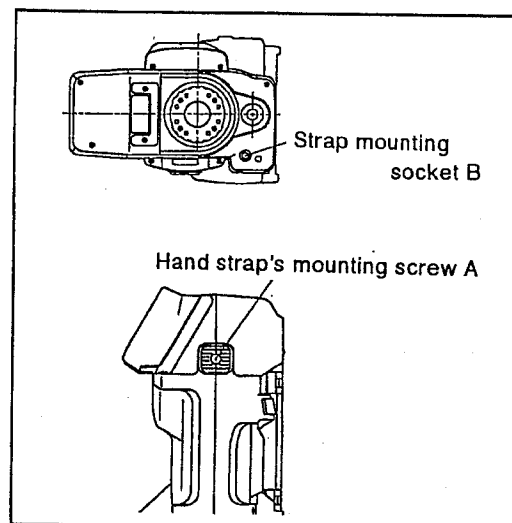
Hand Strap CM-A24

ATTACHING

- 1 Align the pin of the atrap's lower mounting plate with the Spectrophotometer's strap guide hole.
- 2 Align the hand strap's mounting screw B with the Spectrophotometer's strap mounting socket B and turn the screw clockwise unit. Do not overtighten.
- 3 Align the hand strap's mounting screw A with the Spectrophotometer's strap mounting socket A and turn the screw clockwise unit snug. Do not overtighten.

REMOVING

To remove the hand strap, revers the above procedure.



CALIBRATION

White Calibration

After the Spectrophotometer has been switched on, white calibration should be performed before starting measurements.

- When measurements will not be taken, white calibration is unnecessary. Press **BREAK** to skip calibration.
- When using the calibration plate fast time or the white calibration data in memory have been deleted or when using a calibration plate other than the white calibration plate included as a standard accessory, white calibration data should be set according to the following procedure (see p.13).
- To ensure measurement accuracy, perform white calibration fairly frequently if the ambient temperature varies or if measurements are taken repeatedly within a relatively short period of time (which may cause the internal temperature of the Spectrophotometer to increase). Any change in temperature (both ambient temperature and the internal temperature of the Spectrophotometer) may affect measurement accuracy.

PERFORMING WHITE CALIBRATION

- White calibration should be performed under the same ambient conditions (temperature, etc.) as those under which measurements will be taken.

- 1 Slide POWER switch from O (off) to | (on). The startup sequence will occur for approximately three seconds and then the Spectrophotometer will automatically change to <CALIBRATION> mode.

- After the Spectrophotometer changes to <CALIBRATION> mode, the cursor (highlighted area) should be on WHITE CALIBRATION. If the cursor is on ZERO CALIBRATION, press **CURSOR** to move cursor to WHITE CALIBRATION.

<CALIBRATION>
WHITE CALIBRATION
1. SET ON W-CAL. PLATE
ZERO CALIBRATION
1. AIM INTO AIR

2. PUSH [MEAS.]

- 2 Press the white calibration cap up against the Spectrophotometer and turn the cap in the direction of the arrow until it stops.
- 3 After the CHARGE lamp has become lit, press the measuring button. Nine measurements will be taken for calibration. After calibration has been completed, the display will automatically change to the measurement display.

- To perform white calibration again, turn off the Spectrophotometer once and then repeat the above procedure from step 1.

SETTING WHITE CALIBRATION DATA

- Slide **POWER** switch from **O** (off) to **|** (on). The startup sequence will occur for approximately three seconds and then the Spectrophotometer will automatically change to **<CALIBRATION>** mode.

```

<CALIBRATION>
WHITE CALIBRATION
1. SET ON W-CAL. PLATE
ZERO CALIBRATION
1. AIM INTO AIR
-----
2. PUSH [MEAS.]
    
```

- Press **MENU**. The display will change to **WHITE CAL. DATA**.

```

WHITE CAL. DATA
1. [▼▲] INPUT DATA
2. [CURSOR] NEXT DATA
400 90.00 90.00 90.00
420 90.00 90.00 90.00
440 90.00 90.00 90.00
460 90.00 90.00 90.00
    
```

- Press **▲** and **▼** to set the value and press **CURSOR** to move the cursor to the next value. Repeat this procedure to set all data for 400 to 460nm.

- Press **DISPLAY** to change the screen and repeat step 3 to set the data for 480 to 540nm. Repeat steps 3 and 4 to set all data for 560 to 620nm and for 640 to 700nm.

- Press **BREAK**. The confirmation display shown at right will appear. To overwrite the white calibration data in memory with the data that were just set, press **DELETE**; to cancel the changes just made to the white calibration data and keep the white calibration data presently in memory, press **BREAK**. After either key is pressed, the display will change to **<CALIBRATION>**. If measurements will be taken or target color data will be measured, perform white calibration (see p. 12).

```

OLD DATA DELETE OK?

YES : PUSH [DELETE]
NO  : PUSH [BREAK ]
    
```

Zero Calibration

Zero calibration is performed to compensate for the effects of stray light due to the flare characteristics of the optical system. At the time of shipment, zero calibration data measured by Minolta are stored in an EEPROM in the Spectrophotometer. However, since the flare characteristics will change over time due to dust, stains, etc. in the optical system, zero calibration should be performed periodically to enable the effects of stray light to be eliminated more accurately.

- Zero calibration should also be performed periodically to eliminate variations in measured values due to changes in ambient temperature or in the internal temperature of the Spectrophotometer or due to repeated measurements, vibration, shock, etc. In addition, if the Spectrophotometer has not been used for a long time, it is recommended that zero calibration be performed to ensure the best possible accuracy.
- Measured zero calibration data will remain in the Spectrophotometer's memory even if the POWER switch is set to O (off).
- If the Spectrophotometer is not used for a long period of time, all data in memory (including zero calibration data measured by the user) may be lost. If this occurs, the zero calibration data measured by Minolta at the time of shipment will be used.

- 1 Slide POWER switch from O (off) to I (on). The startup sequence will occur for approximately three seconds and then the Spectrophotometer will automatically change to <CALIBRATION> mode.

```
<CALIBRATION>
WHITE CALIBRATION
1. SET ON W-CAL. PLATE
ZERO CALIBRATION
1. AIM INTO AIR
-----
2. PUSH [MEAS.]
```

- 2 Press **CURSOR** to move cursor to "ZERO CALIBRATION".
- 3 Aim the Spectrophotometer's measurement aperture into the air.
 - Do not aim it toward a light source.
 - There should be no object within 1m (39 inches) of the measurement aperture.
- 4 After the CHARGE lamp has become lit, press the measuring button. Nine measurements will be taken for calibration. After calibration has been completed, the display will automatically return to <CALIBRATION> mode. Continue by performing white calibration (see p. 12).

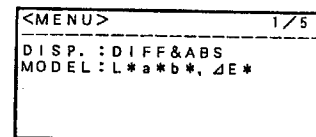
```
<CALIBRATION>
WHITE CALIBRATION
1. SET ON W-CAL. PLATE
ZERO CALIBRATION
1. AIM INTO AIR
-----
2. PUSH [MEAS.]
```

MENU SETTINGS

The Spectrophotometer's functions can be set in the following six menus:

- <MENU> 1/5: Display type; color modes
- <MENU> 2/5: Observer; illuminants
- <MENU> 3/5: Automatic measurement averaging; abnormal data delete; buzzer
- <MENU> 4/5: Data communications settings
- <MENU> 5/5: Date and time

<MENU> 1/5 (Display Settings)



DISP.:

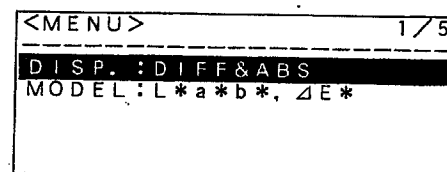
- DIFF & ABS: Displays color difference and absolute color data measured under the illuminant selected for ILLUMINANT 1 in <MENU> 2/5.
- METAMERISM: Displays metamerism index.
- ABS 1 & 2: Displays absolute color data measured under the illuminants selected for ILLUMINANT 1 and ILLUMINANT 2.
- DIFF 1 & 2: Displays color difference data measured under the illuminants selected for ILLUMINANT 1 and ILLUMINANT 2.
- PASS/FAIL: Displays the results of tolerance checking. See p. 30.

MODE:

- L*a*b*, ΔE*: CIE 1976 L*a*b* color system; color difference data shown as ΔL^* , Δa^* , and Δb^* plus ΔE^*_{ab} .
- L*C*h, ΔE*: CIE 1976 L*C*h color system; color difference data shown as ΔL^* , ΔC^* , and ΔH^* plus ΔE^*_{ab} .
- L*C*h, CMC: CIE 1976 L*C*h color system; color difference data shown in terms of CMC color difference.
 - Values for l and c of CMC can be set by using **CURSOR** to move the cursor to the value to be changed and using **▲** or **▼** to change the value.

SETTING PROCEDURE

- 1 In measuring mode, press **MENU**. The display will change to one of the menus (the last menu which was exited from).
 - 2 Press **DISPLAY** repeatedly to select <MENU> 1/5.
 - The menu displayed will change to the next higher numbered menu each time **DISPLAY** is pressed and will return to <MENU> 1/5 if **DISPLAY** is pressed while <MENU> 5/5 is shown.
 - 3 Press **CURSOR** repeatedly to move the cursor to the item to be set.
 - 4 Use **▲** or **▼** to select the desired setting. The setting is selected when it is displayed.
- To select settings in other menus, press **DISPLAY** to change to that menu.
 - To return to measurement display, press **BREAK**.



<MENU> 2/5 (Observer/Illuminant)

<MENU>		2/5
OBSEVER	:	2°
ILLUMINANT 1	:	D65
ILLUMINANT 2	:	---

- OBSERVER:** Determines observer functions to be used for calculating colorimetric measurement data.
2° CIE 2° Standard Observer functions.
10° CIE 10° Standard Observer functions.
- ILLUMINANT 1:** Can be set to D65, D50, C, A, F2, F6, F7, F8, F10, F11, or F12. When DISP. is set to METAMERISM, ILLUMINANT 1 serves as the reference illuminant for determining the metamerism index.
- ILLUMINANT 2:** Can be set to D65, D50, C, A, F2, F6, F7, F8, F10, F11, F12 or ---. When DISP. is set to METAMERISM, ILLUMINANT 2 serves as the test illuminant for determining the metamerism index.
- Illuminant settings:**
- D65 CIE Standard Illuminant D65 representing average daylight including ultraviolet radiation. Correlated color temperature: 6504K
 - D50 CIE Standard Illuminant D50 representing daylight including ultraviolet radiation. Correlated color temperature: 5003K
 - C CIE Standard Illuminant C representing average daylight excluding ultraviolet radiation. Correlated color temperature: 6774K
 - A CIE Standard Illuminant A representing an incandescent lamp. Correlated color temperature: 2856K
 - F2 CIE Fluorescent Illuminant F2 representing a cool white fluorescent lamp. Correlated color temperature: 4230K
 - F6 CIE Fluorescent Illuminant F6 representing a cool white fluorescent lamp. Correlated color temperature: 4150K
 - F7 CIE Fluorescent Illuminant F7 representing a daylight fluorescent lamp. Correlated color temperature: 6500K
 - F8 CIE Fluorescent Illuminant F8 representing a daylight white fluorescent lamp. Correlated color temperature: 5000K
 - F10 CIE Fluorescent Illuminant F10 representing a three band daylight white fluorescent lamp. Correlated color temperature: 5000K
 - F11 CIE Fluorescent Illuminant F11 (DIN TL84) representing a three band white fluorescent lamp. Correlated color temperature: 4000K
 - F12 CIE Fluorescent Illuminant F12 representing a three band warm white fluorescent lamp (Ultralume 3000). Correlated color temperature: 3000K

SETTING PROCEDURE

- If the display presently shows a menu, skip step 1.
- 1 In measuring mode, press **MENU**. The display will change to one of the menus (the last menu which was exited from).
 - 2 Press **DISPLAY** repeatedly to select <MENU> 2/5.
 - The menu displayed will change to the next higher numbered menu each time **DISPLAY** is pressed and will return to <MENU> 1/5 if **DISPLAY** is pressed while <MENU> 5/5 is shown.
 - 3 Press **CURSOR** repeatedly to move the cursor to the item to be set.
 - 4 Use **▲** or **▼** to select the desired setting. The setting is selected when it is displayed.
- To select settings in other menus, press **DISPLAY** to change to that menu.
 - To return to measurement display, press **BREAK**.

<MENU>		2/5
OBSEVER	:	2°
ILLUMINANT 1	:	D65
ILLUMINANT 2	:	---

<MENU> 3/5 (Data Processing Functions)

<MENU>	3/5
AUTO AVERAGE	: 1
DELETE OUTLIER	: OFF
BUZZER	: ON

- AUTO AVERAGE:** Number of measurements to be taken and averaged (if 3, 5, or 8 is set) when measuring button is pressed. The average of the measurements will then be treated as one measurement by the Spectrophotometer. See p. 27.
1, 3, 5, or 8
- DELETE OUTLIER:** **ON** Deletes the two measurements most different from the average and recalculates the average to improve accuracy.
OFF Automatic averaging is performed without deleting outlier data.
See p. 29.
- BUZZER:** **ON** Buzzer will sound each time a key is pressed or when the color of the measured specimen is beyond the set tolerance values.
OFF Buzzer will not sound.

SETTING PROCEDURE

- If the display presently shows a menu, skip step 1.
- 1 In measuring mode, press **MENU**. The display will change to one of the menus (the last menu which was exited from).
 - 2 Press **DISPLAY** repeatedly to select <MENU> 3/5.
 - The menu displayed will change to the next higher numbered menu each time **DISPLAY** is pressed and will return to <MENU> 1/5 if **DISPLAY** is pressed while <MENU> 5/5 is shown.
 - 3 Press **CURSOR** repeatedly to move the cursor to the item to be set.
 - 4 Use **▲** or **▼** to select the desired setting. The setting is selected when it is displayed.
- To select settings in other menus, press **DISPLAY** to change to that menu.
 - To return to measurement display, press **BREAK**.

<MENU>	3/5
AUTO AVERAGE	: 1
DELETE OUTLIER	: OFF
BUZZER	: ON

<MENU> 4/5 (Data Communication Functions)

<MENU>		4/5
REMOTE	:	NO
DATA DUMP	:	NO
AUTO PRINT	:	OFF
BAUD RATE	:	9600
COMMUNICATION	:	232C

REMOTE:	NO	(Normally selected) Normal handheld operating mode, with operation controlled by keys and measurement results shown in display.
	YES	REMOTE mode for when Spectrophotometer is controlled by a separate computer connected to the RS-232C terminal. This mode is entered immediately after ▲ or ▼ is pressed to change setting to YES. See <i>COMMUNICATION MANUAL</i> for further information on remote operation.
DATA DUMP:	NO	(Normally selected)
	YES	Immediately enters <MENU> DATA DOWNLOAD mode (see p. 34) for selecting measurement data to be dumped to a printer.
AUTO PRINT:	ON	Data will be automatically printed out immediately after each measurement (see p. 33).
	OFF	Data will not be printed out automatically.
BAUD RATE:		Baud rate for data communication. 1200, 2400, 4800, 9600, or 19200
COMMUNICATION:	232C,IRDA	Selects RS-232c or IrDA for data communication.(when using IrDA,baud rate should be set at 9600)

SETTING PROCEDURE

- If the display presently shows a menu, skip step 1.
- 1 In measuring mode, press **MENU**. The display will change to one of the menus (the last menu which was exited from).
 - 2 Press **DISPLAY** repeatedly to select <MENU> 4/5.
 - The menu displayed will change to the next higher numbered menu each time **DISPLAY** is pressed and will return to <MENU> 1/5 if **DISPLAY** is pressed while <MENU> 5/5 is shown.
 - 3 Press **CURSOR** repeatedly to move the cursor to the item to be set.
 - 4 Use ▲ or ▼ to select the desired setting. The setting is selected when it is displayed.
- To select settings in other menus, press **DISPLAY** to change to that menu.
 - To return to measurement display, press **BREAK**.

<MENU>		4/5
REMOTE	:	NO
DATA DUMP	:	NO
AUTO PRINT	:	OFF
BAUD RATE	:	9600
COMMUNICATION	:	232C

Deleting Target Color Data

All target color data stored in the Spectrophotometer can be deleted according to the procedure below.

- Deleted target color data cannot be recovered.
- 1 In measurement mode, press **TARGET**. Display will change to <TARGET> mode.

<TARGET>	T1	2° / D65	
L	27.43	7.10	3.31
a	-9.43	-3.53	-0.22
b	-6.82	-5.82	-3.17
[1997.02.28 15:30]			

- 2 Press **DELETE**. The display will change to TARGET DELETE.
- 3 Press **DELETE** again to complete deletion of target color data. All target color data stored in the Spectrophotometer will be deleted and the display will return to <TARGET> mode.
- 4 Press **BREAK** to return to measurement mode.

TARGET DELETE	
EXE	: PUSH [DELETE]
ESC	: PUSH [BREAK]

ALL DATA DELETE	

TAKING MEASUREMENTS

- White calibration should be performed before taking measurements.
- Measurements should be performed under the same ambient conditions (temperature, etc.) as white calibration and setting of target color data.
- Fluorescent colors cannot be measured accurately since the range of wavelengths used by the Spectrophotometer for illumination and measurement does not extend below 400nm.

Data memory:

The Spectrophotometer has memory space for up to 650 sets of data. This space is shared by target color data and measurement data; how the memory space is divided between the two types of data is not fixed. For example, if 50 sets of target color data have been stored, then up to 600 sets of measurement data can be stored in the remaining space; likewise, if 200 sets of target color data have been stored, then 450 sets of measurement data can be stored in the remaining space. If measurements are taken after the memory has become full, the measurement data will overwrite the data for the highest specimen number.

Measurement Procedure

- If color difference measurements will be taken, target color data must be set before taking measurements (see p. 20). If target color data have already been stored in the Spectrophotometer's memory, the desired target color to be used by pressing **TARGET** to change to <TARGET> and selecting the desired target color using **▲** or **▼**.

```
<TARGET> T1
                2° / D 6 5
L  27. 43      7. 10      3. 31
a  -9. 43     -3. 53     -0. 22
b  -6. 82     -5. 82     -3. 17
[1997. 02. 28 15:30]
```

- 1 Press **BREAK** repeatedly until Spectrophotometer is in measurement mode.

```
<MEASURE. ABS>
NO.                2° / D 6 5
L
a
b
```

- 2 Place the Spectrophotometer perpendicular to the surface of the specimen and hold it steady against the specimen surface with both hands.
 - 3 After the CHARGE lamp has become lit, press the measuring button to take a measurement. The xenon lamps will flash six times in succession and the measured data will be stored.
 - Do not move Spectrophotometer until the measurement has been completed and the measurement data appear in the display.
 - The date and time of measurement will be stored as the comment.
- Measurement display examples are shown on p. 24.
 - Previously measured specimen data can be recalled to the display using **▲** and **▼**. Pressing **▲** causes the data for the next higher specimen number to be shown in the display; pressing **▼** causes the data for the next lower specimen number to be shown in the display. Holding **▲** or **▼** pressed causes the specimen numbers to change more rapidly.

Measurement Displays

Some settings of DISPLAY in <MENU> 1/5 have two different measurement displays; the displays available and the contents of each display are described in the table below. The desired display can be selected by pressing DISPLAY.

DISPLAY setting \ Measurement display	Measurement display 1	Measurement display 2
DIFF & ABS	Color difference under ILLUMINANT 1	Absolute color under ILLUMINANT 1
METAMERISM	Metamerism index	(None)
DIFF 1 & 2	Color difference under ILLUMINANT 1	Color difference under ILLUMINANT 2
ABS 1 & 2	Absolute color under ILLUMINANT 1	Absolute color under ILLUMINANT 2
PASS/FAIL	Judgement under ILLUMINANT 1	(None)
With ILLUMINANT 2 set	Judgement under ILLUMINANT 1	Judgement under ILLUMINANT 2

- Absolute color and color difference will be displayed according to the setting of MODE in <MENU> 1/5.

DISPLAY EXAMPLES

Absolute Color Data

		Observer/illuminant	
Specimen number	<MEASURE. ABS>		20.0°C
	NO. 10	2° / D65	Measured surface temperature
L	25.94	7.87	3.28
a	-10.02	-3.48	+0.47
b	-6.65	-5.56	-3.37
[1997.02.28 16:00]			
	Data for angle 1(25°)	Data for angle 2(45°)	Data for angle 3(75°)
	Date		

Color Difference Data

		Target number	
		20.0°C	
		T15	
		2° / D65	
L	-0.70	-0.44	-0.13
a	-0.16	-0.59	-0.03
b	+0.18	+0.16	-0.09
E	0.74	0.75	0.16

Metamerism Index

		Observer/illuminant 1 (reference illuminant)	
		20.0°C	
		2° / D65	
		2° / C	
		Observer/illuminant 2 (test illuminant)	
M	0.02	0.04	0.01
[1997.02.28 16:00]			

PASS/FAIL

		Target number	
		20.0°C	
		T15	
		2° / D65	
E	0.74	0.75	0.16
	PASS	PASS	PASS
PASS (within tolerance values) or FAIL (exceeding tolerance values)			

- If tolerance values have been set, measured values which exceed the tolerance values will be highlighted.
- If a measured value for color difference has more than two integer places, the value will be displayed as xx.xx.

Deleting Measurement Data

Data for a single specimen measurement or all measurement data in memory can be deleted if desired.

- Measurement data which have been deleted cannot be recovered.

DELETING DATA FOR A SINGLE SPECIMEN MEASUREMENT

- 1 Press **BREAK** repeatedly until Spectrophotometer is in measurement mode.

```
<MEASURE. ABS>      20.0°C
NO. 10      2° / D65

L  25.94      7.87      3.28
a-10.02      -3.48      +0.47
b  -6.65      -5.56      -3.37
[1997.02.28 16:00]
```

- 2 Press **▲** or **▼** to recall the specimen data to be deleted to the display. Pressing **▲** causes the data for the next higher specimen number to be displayed; pressing **▼** causes the data for the next lower specimen number to be displayed. Holding **▲** or **▼** pressed causes the specimen numbers to change more rapidly.

- 3 Press **DELETE**. The display will change to DATA DELETE.

- Be sure that the cursor (highlighted area) is on No.xx DELETE [*comment*]. If it is on ALL DATA DELETE, press **CURSOR** to move the cursor to No.xx DELETE [*comment*].

```
DATA DELETE
EXE : PUSH [DELETE]
ESC : PUSH [BREAK]
-----
No. 10 DELETE
[1997.02.28 16:00]
ALL DATA DELETE
```

- 4 Press **DELETE** again. The data for the selected specimen number will be deleted and the remaining specimen measurement data will be renumbered to fill the space left by the deletion. For example, if data for Specimen 9 is deleted, data for Specimen 10 will become data for Specimen 9, data for Specimen 11 will become data for Specimen 10, etc. The Spectrophotometer will return to measurement mode.

- To return to measurement mode without deleting the data for the selected specimen number, press **BREAK** instead of **DELETE** in step 4.

DELETING ALL MEASUREMENT DATA

- 1 Press **BREAK** repeatedly until Spectrophotometer is in measurement mode.

```
<MEASURE. ABS>      20.0°C
NO. 10      2° / D65

L  25.94      7.87      3.28
a-10.02      -3.48      +0.47
b  -6.65      -5.56      -3.37
[1997.02.28 16:00]
```

- 2 Press **DELETE**. The display will change to DATA DELETE.

- 3 Press **CURSOR** to move the cursor to ALL DATA DELETE.

- 4 Press **DELETE** again. All specimen measurement data will be deleted and the Spectrophotometer will return to measurement mode.

- To return to measurement mode without deleting all specimen measurement data, press **BREAK** instead of **DELETE** in step 4.

```
DATA DELETE
EXE : PUSH [DELETE]
ESC : PUSH [BREAK]
-----
No. 10 DELETE
[1997.02.28 16:00]
ALL DATA DELETE
```

ADDITIONAL FUNCTIONS

In addition to the basic functions described so far, the Spectrophotometer has the following functions:

- Measurement averaging: Averages a series of measurements and uses the average as a single set of measurement or target color data. Either automatic averaging, in which a series of 3, 5, or 8 measurements are automatically taken and averaged when the measuring button is pressed once, or manual averaging, in which each measurement in the series is taken by pressing the measuring button, can be performed. See p. 27.
- Deletion of outlying data during averaging: Deletes the two data sets furthest from the average and recalculates the average to improve accuracy when automatic averaging of 3, 5, or 8 measurements is performed. See p. 29.
- Tolerance checking: Automatically determines whether or not a measurement is within previously set tolerance limits from the target color when color difference measurements are performed. See p. 30.
- Target color comment: Allows a comment to be stored along with the target color data so that target color data can be easily identified. See p. 31.
- Temperature sensor: Measures the temperature of the surface being measured to enable users to determine whether or not a color difference may be due to thermochromism. See p. 35.

Measurement Averaging

Averaging a series of measurements when measuring a specimen or target color provides higher accuracy. The Spectrophotometer offers two different ways of taking a series of measurements for averaging: a series of measurements of a single area can be taken automatically with one press of the measuring button according to the setting of AUTO AVERAGE in <MENU> 3/5, or the user can take the series of measurements manually, repositioning the Spectrophotometer and pressing the measuring button each time.

The automatic series of measurements of a single spot is used mainly to improve accuracy. In addition, to further improve accuracy, the two measurements furthest from the average can be automatically deleted and the average recalculated by using the DELETE OUTLIER function (see p. 29).

The manual series of measurements is used mainly for taking a series of measurements of randomly selected areas of a specimen or target color to reduce the effect of slight variations of color within the specimen or target color and thus provide more accurate measurement data for the overall specimen or target color.

Automatic and manual series of measurements can also be used together to further improve accuracy.

AUTOMATIC SERIES OF MEASUREMENTS (AUTO AVERAGE)

1 In measuring mode, press **MENU**. The display will change to one of the menus (the last menu which was exited from).

2 Press **DISPLAY** repeatedly to select <MENU> 3/5.

3 Press **CURSOR** repeatedly to move the cursor to AUTO AVERAGE.

4 Use **▲** or **▼** to set the desired number of measurements (1, 3, 5, or 8).

- If 1 is set, only a single measurement will be taken when the measuring button is pressed.

5 Press **BREAK** to return to measurement mode.

<MENU>	3/5
AUTO AVERAGE	: 5
DELETE OUTLIER	: OFF
BUZZER	: ON

6 If color difference measurements will be taken, press **TARGET** to change to <TARGET> and select the desired target color using **▲** or **▼**.

7 Take measurements according to the procedure on p. 22.

- The xenon lamp will fire six times for each measurement. Do not move the Spectrophotometer until the measurement results appear in the display.
- While measurements are being performed, AUTO AVERAGE: (number set in step 4) AVERAGING (number of present measurement) will be shown in the display.

<MEASURE. ABS>	20.0°C
NO. 10	2° / D 65
L	25.94 7.87 3.28
a	-10.02 -3.48 +0.47
b	-6.65 -5.56 -3.37
[1997.02.28 15:30]	

<TARGET> T1	2° / D 65
L	27.43 7.10 3.31
a	-9.43 -3.53 -0.22
b	-6.82 -5.82 -3.17
[1997.02.28 15:30]	

MANUAL SERIES OF MEASUREMENTS

- If AUTO AVERAGE will be used together with manually taking a series of measurements, select the desired number for AUTO AVERAGE before performing the following procedure.

1 Press **BREAK** repeatedly to return to measurement mode.

```

<MEASURE. ABS>      20.0°C
NO. 10      2° / D65

L  25.94      7.87      3.28
a -10.02     -3.48      +0.47
b  -6.65     -5.56     -3.37
[1997.02.28 15:30]
    
```

2 If color difference measurements will be taken, press **TARGET** to change to <TARGET> and select the desired target color using ▲ or ▼.

```

<TARGET> T1
                2° / D65

L  27.43      7.10      3.31
a  -9.43     -3.53     -0.22
b  -6.82     -5.82     -3.17
[1997.02.28 15:30]
    
```

3 Press **AVG. (CURSOR)**. The Spectrophotometer will change to manual averaging mode.

AVERAGING: Number of measurements already taken.
 DEVIATION: Standard deviation (in terms of ΔE^*_{ab}) for measurements already taken.

```

NO. 10      2° / D65
-----
AVERAGING :
D
-----
<CONT. > : [MEAS.] BUTTON
<END>   : [AVERAGE] KEY
    
```

- 4 Take measurements according to the procedure on p. 22.
- The xenon lamp will fire six times for each measurement. Do not move the Spectrophotometer until the measurement results appear in the display.
 - If AUTO AVERAGE in <MENU> 3/5 is set to 3, 5, or 8, the Spectrophotometer will take the corresponding number of measurements when the measuring button is pressed.
- 5 Continue taking measurements until the desired number of measurements have been taken.
- 6 After the desired number of measurements have been taken, press **AVG (CURSOR)** again. The average of the measurements will be calculated and the results displayed and stored in memory as the measurement data.
- If **BREAK** is pressed while manually taking a series of measurements for averaging, the previous measurements in the series will be deleted and manual averaging mode will be canceled.

Deletion of Outlying Data (DELETE OUTLIER)

To further improve measurement accuracy when using the Spectrophotometer with AUTO AVERAGE in <MENU> 3/5 (see p. 17) set to 3, 5, or 8, the Spectrophotometer can be set to automatically delete the two measurements furthest from the calculated average and then recalculate the average without these data.

- If this function is selected when AUTO AVERAGE in <MENU> 3/5 is set to 3, data for only one measurement will remain after the two outlying measurements have been deleted. Thus, the results will not be an average.

1 In measuring mode, press **MENU**. The display will change to one of the menus (the last menu which was exited from).

2 Press **DISPLAY** repeatedly to select <MENU> 3/5.

3 Press **CURSOR** repeatedly to move the cursor to AUTO AVERAGE and use **▲** or **▼** to set the desired number of measurements (3, 5, or 8).

4 Press **CURSOR** to move the cursor to DELETE OUTLIER.

<MENU>	3/5
AUTO AVERAGE	: 5
DELETE OUTLIER	: OFF
BUZZER	: ON

5 Use **▲** or **▼** to set DELETE OUTLIER to ON.

<MENU>	3/5
AUTO AVERAGE	: 5
DELETE OUTLIER	: ON
BUZZER	: ON

6 Press **BREAK** to return to measurement mode.

<MEASURE. ABS>	20.0°C
NO. 10	2° / D65
L	25.94 7.87 3.28
a	-10.02 -3.48 +0.47
b	-6.65 -5.56 -3.37
[1997.02.28 16:00]	

7 If color difference measurements will be taken, press **TARGET** to change to <TARGET> and select the desired target color using **▲** or **▼**.

<TARGET>	T1
	2° / D65
L	27.43 7.10 3.31
a	-9.43 -3.53 -0.22
b	-6.82 -5.82 -3.17
[1997.02.28 15:30]	

8 Take measurements according to the procedure on p. 22.

- The xenon lamp will fire six times for each measurement. Do not move the Spectrophotometer until the measurement results appear in the display.
- While measurements are being performed, AUTO AVERAGE: (number set in step 4) AVERAGING (number of present measurement) will be shown in the display.

Tolerance Checking

When taking color-difference measurements, the Spectrophotometer can automatically check whether or not the measured color is within previously set tolerance limits from the target color.

Different positive and negative tolerance limits can be set for each target color. If target number T3 is selected, the tolerance limits for target number T2 will be ignored.

1 In measuring mode, press **TARGET**. The Spectrophotometer will change to <TARGET> mode.

<TARGET>		T1		2° / D65	
L	27.43	7.10	3.31		
a	-9.43	-3.53	-0.22		
b	-6.82	-5.82	-3.17		
[1997.02.28 15:30]					

2 Press **▲** or **▼** to select the desired target number.

- Holding **▲** or **▼** pressed will cause the target number to change more rapidly.

3 Press **DISPLAY** to change to <TARGET> +TOLERANCE (the display for inputting positive tolerance values). The display will change in the following order:

<TARGET>		T10		2° / D65	
+TOLERANCE					
L	+ 0.0	+ 0.0	+ 0.0		
a	+ 0.0	+ 0.0	+ 0.0		
b	+ 0.0	+ 0.0	+ 0.0		
E	0.0	0.0	0.0		

... → <TARGET> +TOLERANCE → <TARGET> -TOLERANCE
 → <TARGET> INPUT COMMENT → <TARGET> INPUT
 TARGET → <TARGET> → <TARGET> +TOLERANCE → ...

- If ILLUMINANT 2 in <MENU> 2/5 has also been set, the order of the display change will be as follows:

... → <TARGET> +TOLERANCE (for ILLUMINANT 1) →
 <TARGET> -TOLERANCE (for ILLUMINANT 1) →
 <TARGET> +TOLERANCE (for ILLUMINANT 2) →
 <TARGET> -TOLERANCE (for ILLUMINANT 2) →
 <TARGET> INPUT COMMENT → <TARGET> INPUT
 TARGET → <TARGET> → <TARGET> +TOLERANCE
 (for ILLUMINANT 1) → ...

4 Press **CURSOR** to move the cursor to the value to be set, and use **▲** and **▼** to set the desired value.

- Tolerance values can be set from 0.0 to 20.0; ---- (no tolerance limits) appears between 0.0 and 20.0. Pressing **▲** causes the values to increase; pressing **▼** causes the values to decrease.
- Holding **▲** or **▼** pressed will cause the value to change more rapidly.

5 Repeat step 4 to set other positive tolerance values.

6 Repeat steps 3 through 5 to set negative tolerance values.

- If ILLUMINANT 2 in <MENU> 2/5 has also been set, repeat steps 3 through 6 to set tolerance values under ILLUMINANT 2.

7 After all tolerance values have been set for the selected target number, press **DISPLAY** repeatedly to return to <TARGET> mode, or press **BREAK** to return to measurement mode.

Once tolerance limits have been set, tolerance checking will be performed when measurements are taken using the target color for which the tolerance limits were set. If the measured color is outside of any of the tolerance limits, the value which is outside the limits will be highlighted in the display (and a buzzer will sound if BUZZER in <MENU> 3/5 is set to ON. Also, if DISP. in <MENU> 1/5 is set to PASS/FAIL, the results of tolerance checking will be displayed as PASS (if measured color is within tolerance limits) or FAIL (if measured color is outside tolerance limits).

Target Color Comment

A comment of up to 16 characters can be set for each target color after the target color data have been measured or set. This enables users to clearly identify target colors and makes it easier to find the desired target color from among all of those stored in the Spectrophotometer's memory.

- 1 In measuring mode, press **TARGET**. The Spectrophotometer will change to <TARGET> mode.

```
<TARGET> T1
                2° / D65
L  27.43    7.10    3.31
a  -9.43   -3.53   -0.22
b  -6.82   -5.82   -3.17
[1997.02.28 15:30]
```

- 2 Press **▲** or **▼** to select the desired target number.
 - Holding **▲** or **▼** pressed will cause the target number to change more rapidly.

- 3 Press **DISPLAY** three times (six times if ILLUMINANT 2 has also been set) to change to the INPUT COMMENT display. The display will change in the following order:

```
... → <TARGET>+TOLERANCE → <TARGET> -TOLERANCE
     → <TARGET> INPUT COMMENT → <TARGET> INPUT
     TARGET → <TARGET> → <TARGET> +TOLERANCE → ...
```

- If ILLUMINANT 2 in <MENU> 2/5 has also been set, the order of the display change will be as follows:

```
... → <TARGET> +TOLERANCE (for ILLUMINANT 1) →
     <TARGET> -TOLERANCE (for ILLUMINANT 1) →
     <TARGET> +TOLERANCE (for ILLUMINANT 2) →
     <TARGET> -TOLERANCE (for ILLUMINANT 2) →
     <TARGET> INPUT COMMENT → <TARGET> INPUT
     TARGET → <TARGET> → <TARGET> +TOLERANCE
     (for ILLUMINANT 1) → ...
```

```
<TARGET> T10
INPUT COMMENT
-----
[1997.02.28 15:30]
```

- 4 Press **CURSOR** to move the cursor to the character location to be set, and use **▲** and **▼** to set the desired character.

- Holding **▲** or **▼** pressed will cause the value to change more rapidly.
- Characters will change in alphabetical and numerical order as follows when **▲** is pressed:

```
... → (letters A through Z) → (numbers 0 through 9) →
     : → . → (space) → (letters A through Z) → ...
```

When **▼** is pressed, characters will change in reverse order.

- 5 After the desired comment has been set, press **DISPLAY** repeatedly to return to <TARGET> mode, or press **BREAK** to return to measurement mode.

Printing Data Using a Printer

By connecting a printer directly to the Spectrophotometer via the Spectrophotometer's RS-232C terminal, measurement data can be printed at the time of measurement, a selected series of measurement data in memory can be printed out, or the Spectrophotometer's display can be printed out (except same screens).

SUITABLE PRINTERS

Printers which can be used with the Spectrophotometer must meet the following specifications:

Number of printed columns:	At least 27
Data input:	RS-232C standard
Data control:	BUSY
Baud rate:	1200, 2400, 4800, 9600, or 19200bps
Character length:	8 bits
Parity	None
Number of stop bits:	1
Basic operating codes:	Carriage return CR (0D hexadecimal)

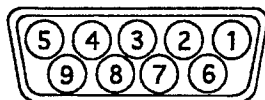
Examples of printers which meet these specifications include Seiko Instruments Inc. Standalone Thermal Printer Unit models DPU-201GS or DPU-411

COMMUNICATION PARAMETERS OF SPECTROPHOTOMETER

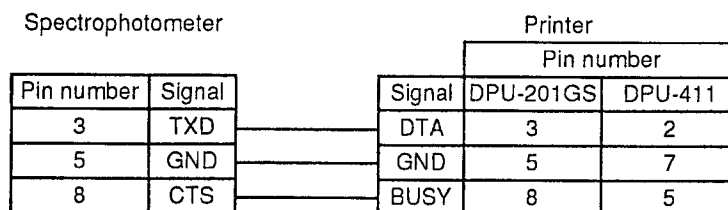
Baud rate:	1200, 2400, 4800, 9600, or 19200bps (set in <MENU> 4/5)
Character length:	8 bits
Parity	None
Number of stop bits:	1

RS-232C TERMINAL PIN DIAGRAM AND CONNECTIONS

The pin diagram of the Spectrophotometer's RS-232C terminal is shown below. A D-subminiature 9-pin male connector (such as Hirose Connector GHDEB-9P) should be used for connection to this terminal.



Connection with a DPU-201GS or DPU-411 printer would be as follows:



- When connecting the Spectrophotometer to a printer, be sure that the power of both the Spectrophotometer and the printer are switched off.
- Check that the connector and the terminal are correctly positioned in relation to each other before connecting. They can be connected in only one position.
- Do not touch the pins or sockets of the connecting cable or the terminal of the Spectrophotometer or printer, get them dirty, or apply excessive force to them.
- Be sure that the length of the connecting cable is sufficient. If the cord is slightly short or if there is strain on the cable, the connection may not be good or an internal wire may break.
- When disconnecting the cable, be sure that the power of both the Spectrophotometer and printer are switched off. Pull on the plug, not on the cable, when disconnecting.
- Never pull on the cable itself, apply excessive force to the cable, or bend it sharply.

AUTOMATIC PRINTOUT AFTER EACH MEASUREMENT (AUTO PRINT)

- 1 Switch off power of both Spectrophotometer and printer, and connect Spectrophotometer to printer.
 - Internal connections of the connecting cable should be as shown on p. 32.
- 2 Switch on power of both Spectrophotometer and printer, and perform white calibration (see p. 12).
- 3 In measuring mode, press **MENU**. The display will change to one of the menus (the last menu which was exited from).
- 4 Press **DISPLAY** repeatedly to select <MENU> 4/5.
 - The menu displayed will change to the next higher numbered menu each time **DISPLAY** is pressed and will return to <MENU> 1/5 if **DISPLAY** is pressed while <MENU> 5/5 is shown.
- 5 Use **CURSOR**, **▲**, and **▼** to set the following settings:
 - DATA DUMP: NO
 - AUTO PRINT: ON
 - BAUD RATE: (same as baud rate set on printer)
 - COMMUNICATION: 232C
- 6 Press **BREAK** to return to measurement display.

<MENU>	4/5
REMOTE	: NO
DATA DUMP	: NO
AUTO PRINT	: ON
BAUD RATE	: 9600
COMMUNICATION	: 232C

After the settings above have been set, measurement data will be automatically output to the printer after each measurement.

PRINTING DATA FROM MEMORY (DATA DUMP)

- 1 Switch off power of both Spectrophotometer and printer, and connect Spectrophotometer to printer.
 - Internal connections of the connecting cable should be as shown on p. 32.
- 2 Switch on power of both Spectrophotometer and printer.
 - If measurements have not yet been performed, perform white calibration (see p. 12) and then perform measurements (p. 22).
- 3 In measuring mode, press **MENU**. The display will change to one of the menus (the last menu which was exited from).
- 4 Press **DISPLAY** repeatedly to select <MENU> 4/5 and check that the baud rate is set to the same baud rate as the printer.
 - The menu displayed will change to the next higher numbered menu each time **DISPLAY** is pressed and will return to <MENU> 1/5 if **DISPLAY** is pressed while <MENU> 5/5 is shown.

<MENU>	4 / 5

REMOTE	: NO
DATA DUMP	: NO
AUTO PRINT	: ON
BAUD RATE	: 9600
COMMUNICATION	: 232C

- 5 Press **CURSOR** to move cursor to DATA DUMP and use ▲ or ▼ to change setting to YES. The display will change to DATA DOWNLOAD mode.
- 6 Press **CURSOR** to move cursor to START No. and use ▲ or ▼ to set the specimen number of the first measurement data to be output.
- 7 Press **CURSOR** to move cursor to END No. and use ▲ or ▼ to set the specimen number of the last measurement data to be output.
- 8 Press **PRINT** (▲ and ▼ together). Data will be printed out from the specimen number set for START No. to the specimen number set for END No.

<MENU>	
DATA DOWNLOAD	

START No.	: 1
END No.	: 100
[PRINT] EXECUTE	

<MENU>	
DATA DOWNLOAD	

START No.	: 1
END No.	: 100
[PRINT] EXECUTE	

PRINTING DISPLAY

- The display of the Spectrophotometer can be printed out exactly as it appears by pressing **PRINT** (▲ and ▼ together).
- <MENU> 5/5 (calendar/clock) cannot be printed out.
 - BAUD RATE must be set to the same baud rate as the printer and CONNECTED TO must be set to PRINT in <MENU> 4/5.

Temperature Sensor

Paints and some other materials have the property of thermochromism, in which the color of the surface depends on the temperature of the surface. For this reason, it is important to know the temperature of the surface at the time of measurement to ensure that measurement values do not include the influence of differences in temperature when measuring different objects.

The Spectrophotometer is equipped with a temperature sensor (thermopile) which is mounted next to the Spectrophotometer's measurement aperture. The sensor measures the temperature of the specimen surface at the same time as the color measurement is being taken.

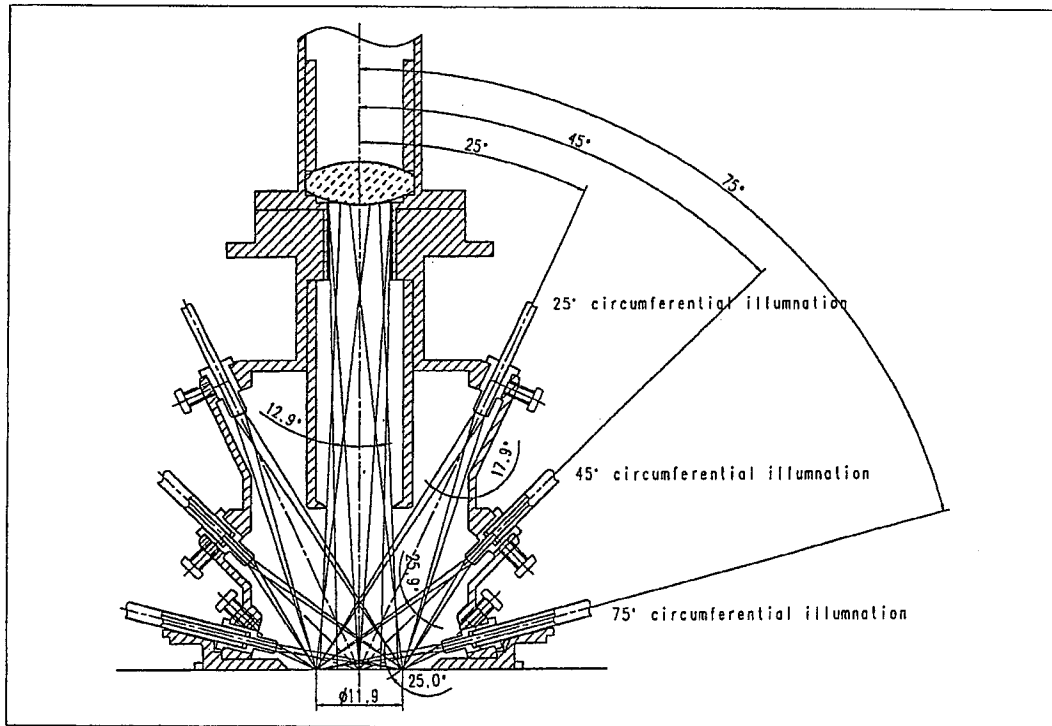
IMPORTANT: The Spectrophotometer is equipped to only measure the temperature; it does not perform any compensation of measurement values for differences in temperature. How to compensate for differences in temperature must be determined by the user based on experimentation or past experience.

MEASURING PRINCIPLE

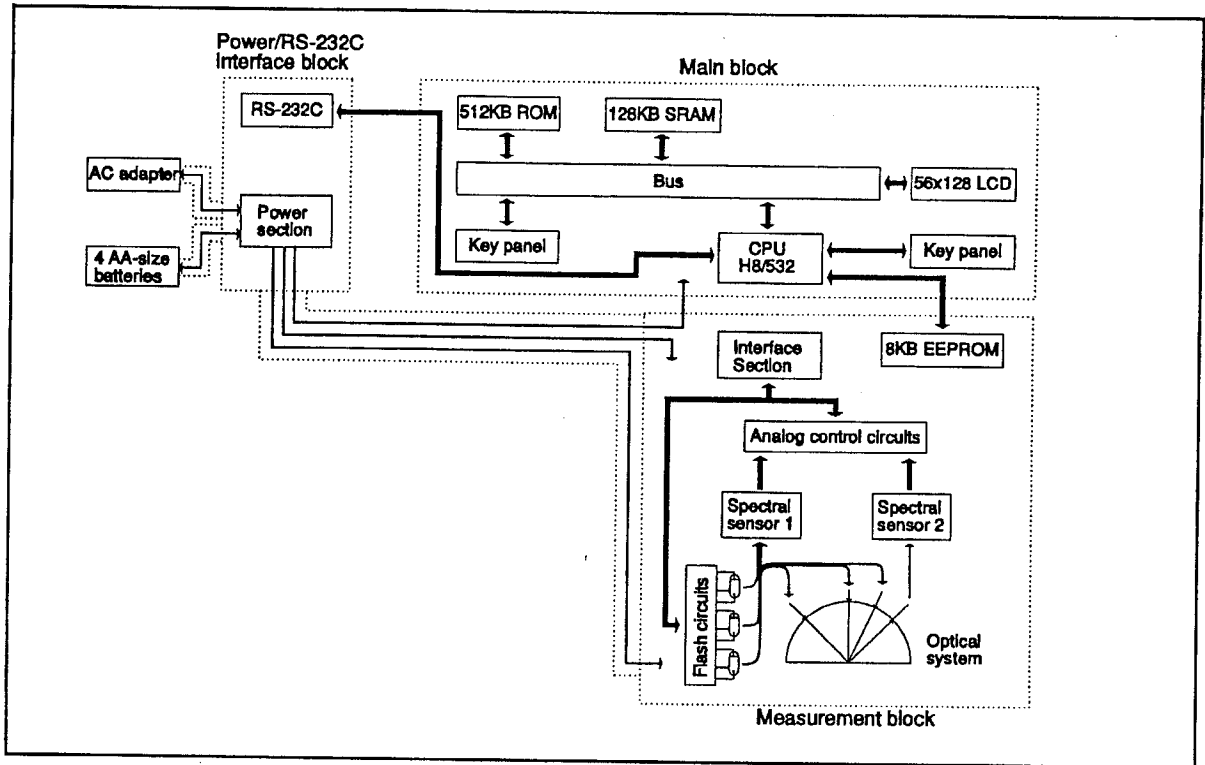
Illuminating/Viewing System

For measurement of metallic paints, a single measurement angle was found to be inadequate for specifying the color due to the fact that the color of a metallic paint varies according to the angle from which it is viewed. A variety of multi-angle geometries have therefore been proposed; Spectrophotometers CM-512m3 uses three-angle illumination/single-angle viewing geometries.

The CM-512m3 utilizes the geometry with illumination angles of 25°, 45°, and 75° from the angle which would produce specular reflection at the viewing angle; the viewing angle is the normal to the specimen surface.



Component Block Diagram



Measurement Process

- 1 Pre-flash (see below) is performed for light source 1 to determine the suitable intensity of light for measurement at that angle.
- 2 Light of this intensity is then produced by the pulsed xenon arc lamp and illuminates the specimen surface.
- 3 Light reflected from the specimen at 45° to the normal enters the optical fiber cable for taking measurements and is transmitted to spectral sensor 1. At the same time, light direct from the lamp (the light which illuminates the specimen surface) enters the optical fiber cable for monitoring illumination and is transmitted to spectral sensor 2.
- 4 The light from each optical fiber cable is divided by wavelength (from 400nm to 700nm at 20nm intervals) by the corresponding spectral sensor. The segments of the sensors convert the received light into electrical currents proportional to the intensity of the light; these electrical currents are then passed to the analog control circuits.
- 5 The analog control circuits convert the currents into proportional electrical voltages, and then into digital signals.
- 6 The digital signals are input to the CPU, which performs various calculations to determine the spectral reflectance values. These values are stored in the Spectrophotometer's memory, and the process is repeated from step 1 for the remaining two light sources.
- 7 After all spectral values have been determined, the CPU performs further calculations according to the menu settings of the Spectrophotometer and the results are displayed.

PRE-FLASH FUNCTION

The Spectrophotometer is equipped with a pre-flash function which determines the light intensity suitable for measurement according to the reflectance of the specimen surface. During a measurement cycle, before the actual measurement for the illumination angle is taken, the pulsed xenon lamp is fired at low intensity (2% of maximum intensity). The light reflected from the specimen surface as a result of this low-intensity pre-flash is used by the Spectrophotometer to determine the maximum spectral reflectance and the wavelength at which this occurs. The xenon lamp is then fired again to take the actual measurement, with the intensity of the light from the xenon lamp adjusted based

on the pre-flash results so that a specific amount of light will be reflected from the specimen surface at the wavelength determined by the pre-flash process. In this way, only the necessary amount of light is used for measurements: High-reflectance specimens are measured using a small amount of light, and low-reflectance specimens are measured using a large amount of light. As a result, repeatability for low-reflectance specimens is improved and power consumption is reduced.

The pre-flash process is performed for each illumination angle, resulting in the xenon lamp being fired a total of six times [(1 pre-flash + 1 measurement) × 3 angles] for each measurement cycle.

ERROR MESSAGES

If any of the following messages continue to appear and normal operation cannot be resumed, contact the nearest Minolta authorized service facility.

Error message	Meaning	Solution
ADDRESS ERROR	Internal program is running wild due to electrical noise or component malfunction.	Set POWER switch to O (off) for a moment, then set it back to I (on). If this message reappears, contact the nearest Minolta authorized service facility.
A/D ERROR	Error in Spectrophotometer's A/D converters.	Set POWER switch to O (off) for a moment, then set it back to I (on). If this message reappears, contact the nearest Minolta authorized service facility.
CHARGE ERROR	Illumination circuit has not finished charging.	Wait until the Spectrophotometer's CHARGE lamp is lit before performing measurement or calibration. (If this message appears with LOW BATTERY, replace batteries first.)
EEPROM ERROR	Data in Spectrophotometer's EEPROM were destroyed.	Contact the nearest Minolta authorized facility.
FLASH ERROR	The Spectrophotometer's pulsed xenon arc lamp did not flash.	Perform measurement or calibration again. If this message reappears, contact the nearest Minolta authorized service facility. (If this message appears with LOW BATTERY, replace batteries first.)
ILLEGAL ERROR	Internal program is running wild due to electrical noise or component malfunction.	Set POWER switch to O (off) for a moment, then set it back to I (on). If this message reappears, contact the nearest Minolta authorized service facility.
LOW BATTERY	Battery power is low.	Replace batteries with new ones or use AC adapter.
LOW ILLUMINANT	Monitored illumination inside integrating sphere is low.	Contact the nearest Minolta authorized service facility. (If this message appears with LOW BATTERY, replace batteries first.)
SRAM ERROR	Error in Spectrophotometer's SRAM.	Contact the nearest Minolta authorized service facility.
TIME OUT	Data could not be output because the CTS input of the Spectrophotometer is OFF.	Connect RS-232C cable correctly. Check CTS input and status of receiving device.
ZDIV ERROR	Internal program is running wild due to electrical noise or component malfunction.	Set POWER switch to O (off) for a moment, then set it back to I (on). If this message reappears, contact the nearest Minolta authorized service facility.

TROUBLESHOOTING GUIDE

If a problem occurs with the Spectrophotometer, please check the following points before requesting service. If the problem continues to occur even after the suggested corrective actions have been taken, contact the nearest Minolta authorized service facility.

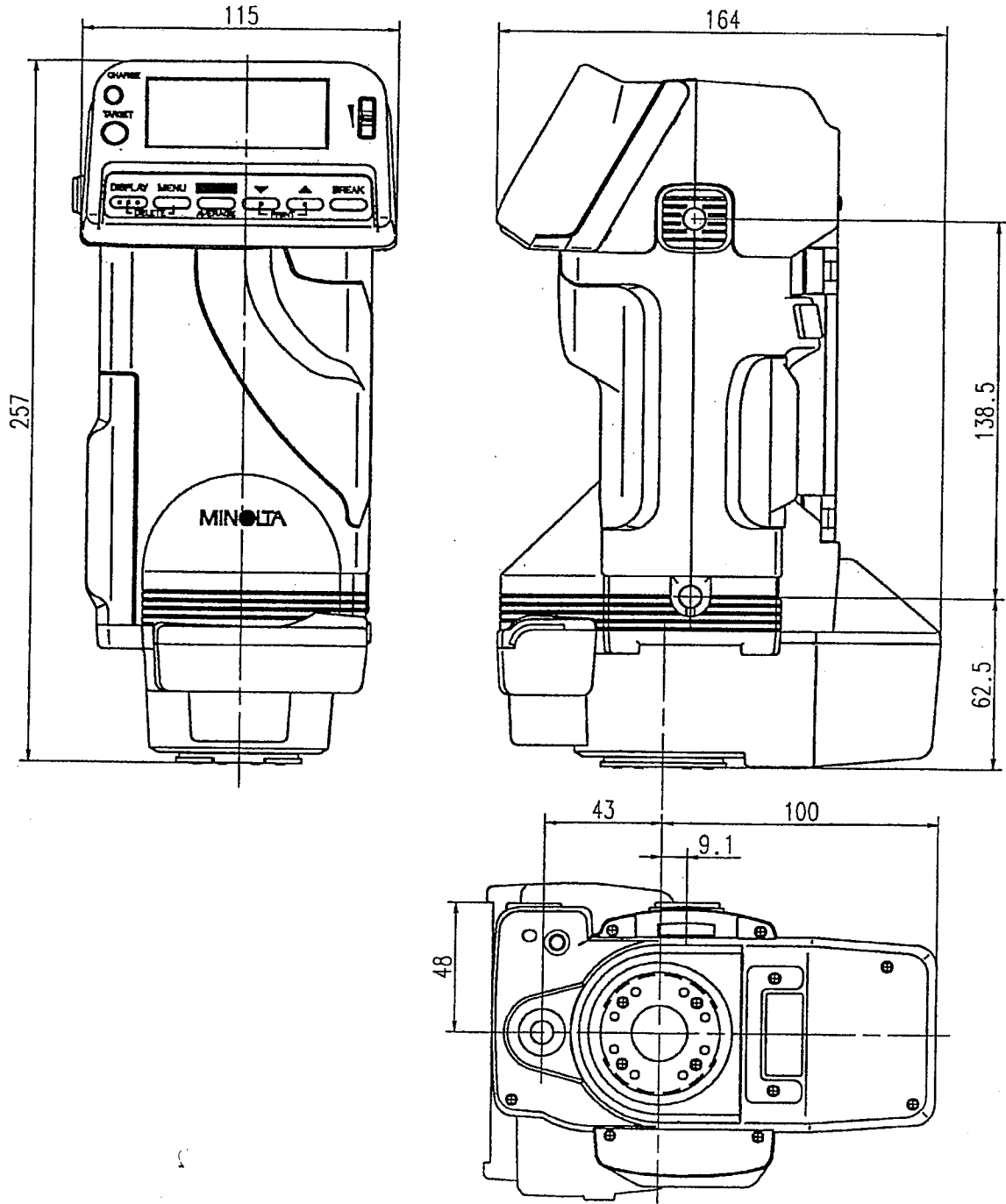
- Reference page numbers: H-xx Page in *HARDWARE MANUAL* (this manual)
C-xx Page in *COMMUNICATION MANUAL*

Condition	Checkpoint	Corrective action	Refer to page
Nothing is shown in the display.	Are batteries installed correctly or is AC adapter connected correctly to both Spectrophotometer and AC wall outlet?	Install batteries correctly or connect AC adapter correctly.	H-8 H-9
	Is battery power exhausted?	Replace batteries with new ones.	H-9
	Is display contrast adjusted correctly?	Move contrast adjustment slide for easiest viewing.	H-10
Charge lamp does not light.	Are batteries installed correctly or is AC adapter connected correctly to both Spectrophotometer and AC wall outlet?	Install batteries correctly or connect AC adapter correctly.	H-8 H-9
	Is battery power exhausted?	Replace batteries with new ones.	H-9
Nothing happens when a key is pressed.	Does the key have a function in the present mode?	Press a key which has a function in the present mode.	
	Was the command KEN input and is the program set up to handle the key codes?	Input the command KEN and set the program so that it handles the key codes.	C-8
Nothing happens when the measuring button is pressed.	Is the Spectrophotometer in the middle of processing the previous measurement?	After a measurement has been taken, wait until the CHARGE lamp is lit before pressing the measuring button to take the next measurement.	
	Is the Spectrophotometer in measuring mode?	Set Spectrophotometer to measuring mode before pressing measuring button.	
	Was the command KEN input and is the program set up to handle the measuring button's key code? Was the measuring switch selector set correctly?	Input the command KEN and set the program so that it handles the key code BTN08.	C-8
Buzzer does not sound when a key is pressed.	Is BUZZER in <MENU> 3/5 set to ON?	Set BUZZER in <MENU> 3/5 to ON.	H-17
Measurement results seem strange.	Was the Spectrophotometer held correctly against the specimen surface, with the measurement aperture flat against the surface and the Spectrophotometer perpendicular to the surface?	Hold the Spectrophotometer correctly against the specimen surface.	H-22
	Is white calibration data correct?	Set correct white calibration data for white calibration cap used for white calibration.	H-13
	Was white calibration performed correctly?	Perform white calibration correctly.	H-12
	Was zero calibration performed correctly?	Perform zero calibration correctly.	H-14
Measurement values vary widely, even when measuring the same specimen.	Was the Spectrophotometer moved during measurement?	Do not move the Spectrophotometer until the measurement has been completed.	H-22
FAIL appears in the display and data are highlighted even though tolerance values for the selected target color are not set.	Are tolerance values set to 0.0?	If tolerance checking is not desired, set tolerance values to ----.	H-30

Condition	Checkpoint	Corrective action	Refer to page
Data input/output between the Spectrophotometer and a computer cannot be performed. Commands cannot be input to the Spectrophotometer from a computer.	Is the RS-232C cable connected correctly to both the Spectrophotometer and the computer?	Connect the RS-232C cable correctly to both the Spectrophotometer and the computer.	C-4
	Are the internal connections of the RS-232C cable correct?	The internal connections should be the same as those in the <i>COMMUNICATION MANUAL</i> .	C-4
	Are the communication parameters set on the computer the same as those of the Spectrophotometer?	Set the communication parameters of the computer to those of the Spectrophotometer.	C-4
	Is the program correct?	Check operation using the program in the <i>COMMUNICATION MANUAL</i> .	
	Is the command being input when the RTS output of the Spectrophotometer is OFF?	Input a command only when the Spectrophotometer's RTS output (the computer's CTS input) is ON.	
The input command was not received correctly.	Are lower-case characters being input for the command?	Commands must be input using only upper-case letters.	C-6
BREAK does not function in <REMOTE> mode.		Set POWER switch of Spectrophotometer to O (off) and then set it back to (on).	

DIMENSIONS

(Units: mm)



SPECIFICATIONS

Model	CM-512m3
Illuminating/viewing system	Three-angle illumination (25°, 45°, and 75° from viewing angle)/0° viewing angle
Receptors	Silicon photodiode array with spectral filter array
Wavelength range	400 to 700nm
Wavelength pitch	20nm
Half bandwidth	Approx. 20nm
Photometric range	25°: 0 to 300% reflectance 45°, 72.5°: 0 to 200% reflectance (Resolution: 0.01%)
Light source	Pulsed arc xenon lamp
Minimum interval between measurements	5 seconds
Battery life	Alkaline manganese batteries: Approx. 400 measurements at 10-sec. intervals (when dense color is measured)
Illumination/measurement area	Ø20mm/Ø12mm (Measurement aperture: Ø20mm)
Repeatability	Spectral reflectance: Standard deviation within 0.30% Colorimetric values: Standard deviation ΔE^*_{ab} within 0.08 (Measurement conditions: White calibration plate measured 30 times at 10s intervals)
Display	21-character x 7-line (128 x 56-dot) dot-matrix LCD with adjustable contrast
Measuring modes	Single measurement/automatic averaging of multiple measurements/REMOTE mode for control by computer via RS-232C terminal
Interface	RS-232C standard Terminal: 9-pin D-subminiature connector Communication parameters: Baud rate: 1200, 2400, 4800, 9600, 19200bps Character length: 8 bits Stop bits: 1 bit Parity: None IrDA Transmission distance: 1m Emission angle: $\pm 15^\circ$ to $\pm 30^\circ$ Wave length: 850nm to 900nm Pulse width: 3/16 bit Baud rate: 9600bps
Display data	Colorimetric values: $L^*a^*b^*$, L^*C^*h Color difference: $\Delta(L^*a^*b^*)$, $\Delta(L^*C^*H^*)$, ΔE^*_{ab} , CMC($l:c$) Data or messages transmitted from a computer connected to the RS-232C terminal can also be displayed in REMOTE mode
Measurement conditions	Illuminant: A, C, D50, D65, F2, F6, F7, F8, F10, F11, F12 Observer: CIE 2° and 10° Standard Observers
Data memory	Space for a total of 650 sets of data (combination of measurement and target color data)
Temperature sensor	Detector: Thermopile Measurement wavelength: 1 to 17 μ m Measurement/display range: 0 to 70°C in 0.1°C increments Measurement area: Ø21mm Accuracy: (Conditions: emissivity: 0.93; ambient temperature: 18 to 28°C) 0 to 10°C: $\pm 2.5^\circ\text{C} \pm 1$ digit 10 to 30°C: $\pm 1.5^\circ\text{C} \pm 1$ digit 30 to 50°C: $\pm 2.5^\circ\text{C} \pm 1$ digit
Repeat measurement rate	Operating: Continuous 300 measurements Lesting: 30 min. (When using AC adaptor AC-A12)

Other	Measurements for averaging can be taken manually or automatically; tolerance checking; built-in calendar/clock; built-in buzzer; automatic selection of delimiter code for data output
Power source	Dedicated AC adapter (9V, 1.2A) or 4 AA-size batteries for main unit; 2 AA-size batteries for auto positioner
Dimensions	W x H x D: 115 x 257 x 163mm (4-1/2 x 10-1/8 x 6-3/8 in.)
Weight	1.4kg (3.1 lb.) without batteries
Operating temperature/humidity range	0 to 40°C (32 to 104°F); less than 85% relative humidity at 35°C (95°F) with no condensation
Storage temperature range	-20 to 50°C (-4 to 122°F) with no condensation
Standard accessories	White calibration plate, AC adapter, AC power cord, Shoulder strap, Hard case, 4 AA-size batteries
Optional accessories	Accessory Switch CM-A23, Measuring Stand CM-A40, RS-232C cable IF-A10~15

- Specifications are subject to change without notice.

