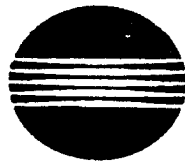# SPECTRORADIOMETER
CS-1000

INSTRUCTION MANUAL

MINOLTA

SAFETY PRECAUTIONS

• To ensure correct use of this CS-1000, 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 anytime a question arises.

WARNING (Failure to adhere to the following points may result in death or serious injury.)	
Do not use the CS-1000 in places where flammable or combustible gases (gasoline etc.) are present. Doing so may cause a fire.	The CS-1000 should not be operated if it is damaged, or smoke or odd smells occur. Doing so may result in a fire. In such situations, turn the power OFF immediately, disconnect the AC adapter, and contact a service center listed on the back cover of this manual.
Always use the AC adapter supplied as a standard accessory with the CS-1000, and connect it to an AC outlet (100 VAC, 50/60 Hz). Damage to the AC adapter may cause a fire or electric shock.	Do not disassemble or modify the CS-1000. Doing so may cause a fire or electric shock.
If the CS-1000 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 adapter may cause a fire and should be removed.	Take special care not to allow liquid or metal objects to enter the CS-1000. Doing so may cause a fire or electric shock. Should liquid or metal objects enter the CS-1000, turn the power OFF immediately, disconnect the AC adapter, and contact a service center listed on the back cover of this manual.
Do not insert or disconnect the AC adapter with wet hands.	
	Never aim the CS-1000 directly at the sun and look through the viewfinder. Doing so can damage your eyes.
Do not disassemble or modify the AC adapter. Doing so may cause a fire or electric shock.	

CAUTION (Failing to adhere to the following points may result in injury or damage to the CS-1000 or other property.)	
Do not walk while looking through the view finder. Doing so may cause you to trip or bump something.	Do not place the CS-1000 on an unstable or sloping surface. Doing so may result in its dropping or overturning, causing injury. Take a care not to drop the CS-1000 when carrying it.

Introduction

CS-1000 is an integrated type spectroradiometer, designed for high-speed and high-accuracy measurement of light source color of display devices such as CRT and LCD, and lighting devices such as lamps.

Notes on Packing Materials

Keep the packing materials (corrugated boards, cushions, polyvinyl bags etc.) in a safe place. This CS-1000 is an accurate measuring instrument. Thus to minimize shock and vibration during transport, for instance when returning the CS-1000 to Minolta for maintenance, always use these packing materials.
Should the packing materials be lost or damaged, consult the nearest Minolta-authorized service facility.

CONTENTS

HANDLING PRECAUTIONS

Notes on Use

- This CS-1000 should be used in ambient temperatures of between 5 and 35°C at a relative humidity of 80% or less. No condensation is allowed.
- Do not use or leave this CS-1000 near sources of heat such as stoves. When using this CS-1000 outside, take care not to expose it to direct sunlight. Doing so will cause the temperature of the CS-1000 to rise considerably and may result in malfunctions.
- When using this CS-1000 in a cold environment, do not allow it to be exposed to rapid temperature changes. Doing so may cause condensation, resulting in improper measurements or malfunctions, which will require repair.
- Do not use this CS-1000 in extremely dusty or humid areas.
- Do not subject this CS-1000 to strong vibration or shocks. Doing so may result in malfunctions.
- Do not pull or bend the cords forcibly. Doing so may result in wire breakage.

Objective Lens

- The objective lenses supplied with this CS-1000 are designed for use with this CS-1000. Using an objective lens designed for other cameras will hinder proper measurements. Always use one of the objective lenses supplied with this CS-1000.
- Check that the lens no. of each objective lens supplied with this CS-1000 matches the body no. of this CS-1000. Using an objective lens supplied with another CS-1000 unit will hinder proper measurements. Always use one of the objective lenses supplied with this CS-1000.
- If purchase of a new objective lens is required due to damage of the current one(s), re-calibration is required. Thus, return this CS-1000 to the nearest Minolta-authorized service facility.
- Before performing measurements, make sure that the surface of the objective lenses are clean. If dust, dirt or finger prints are present, correct measurements may be hindered.
- Do not touch the surface of the objective lenses and dust-proof glass with fingers. If dirt or dust is present, wipe it off with a soft cloth. It the surface is extremely dirty, wipe it with a soft cloth moistened with lens-cleaning fluid may be used. Never use acetone or organic solvent.
- Rapid changes in the ambient temperature high humid environment will cause the objective lenses to cloud over, hindering correct measurements.

Notes on Storage

- This CS-1000 should be stored in areas with temperatures of between 0 and 45°C at a relative humidity of 80% or less. No condensation is allowed. Do not store this CS-1000 in areas subject to high temperature or high humidity. We recommend storing this CS-1000 at a relatively constant temperature with a desiccant (silica gel etc.).
- Make sure that no condensation develops during storage. During transport to the storage area, take care not to allow rapid temperature changes which may cause condensation.
- Use the packing materials (supplied with this CS-1000) or hard case and store the CS-1000 in a safe area.

Objective Lens

- When storing this CS-1000 with an objective lens installed, make sure that a protective cap is attached to the objective lens. Also attach a protective cap to the objective lens when the lens is removed from the CS-1000 and left to stand. In addition, make sure that a protective cap is also attached to the dust-proof glass.

Notes on Transport

- To minimize shock and vibration during transport of this CS-1000, use the packing materials supplied when this CS-1000 was purchased.
- When returning this CS-1000 to Minolta for service maintenance, make sure that the objective lenses, AC adapter and RS-232C cables are packed with the CS-1000.

NAME OF PARTS AND FUNCTIONS OF CONTROLS

<NAME OF PARTS>

Lens unlock button

Objective lens

Finder

↑
Focaplane

LCD display

SELECT
/CANCEL key
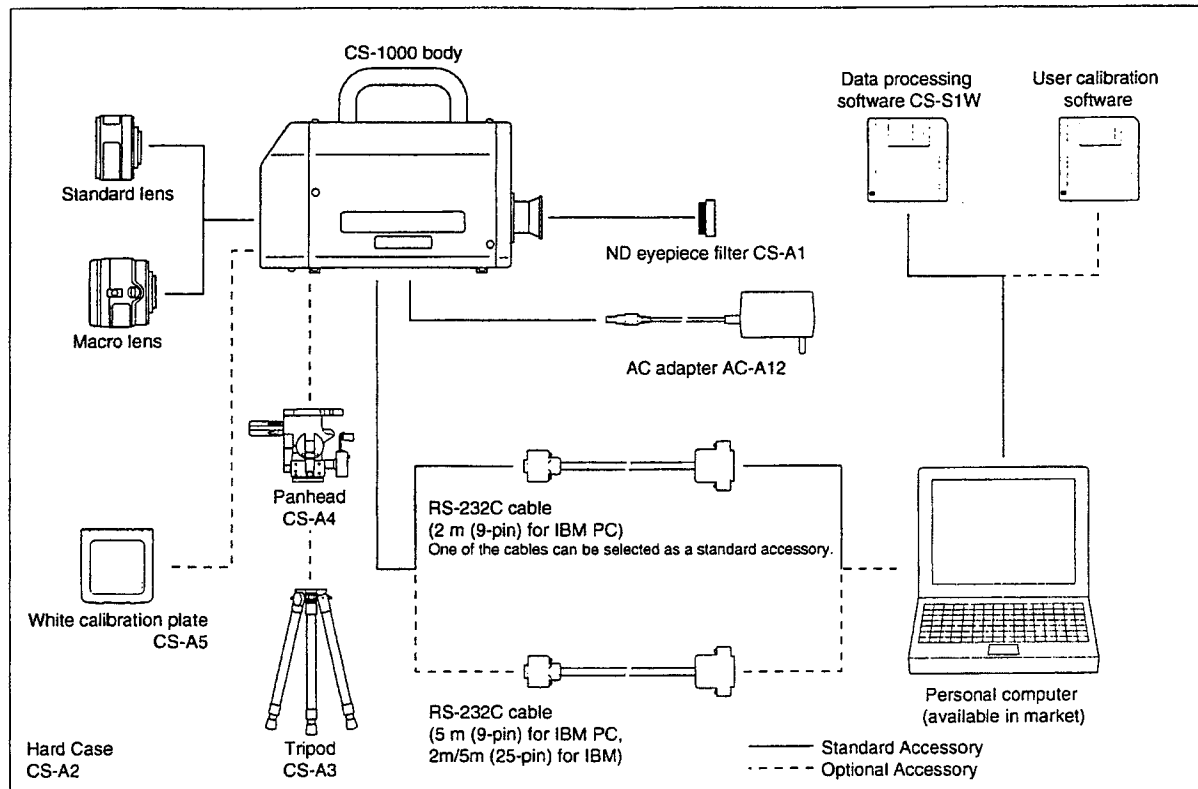
MENU key

▶ key

MEMORY key

▲ key

MEASURE
/STOP key

ENTER key

Vertical sync. terminal

RS-232C terminal

AC adapter socket
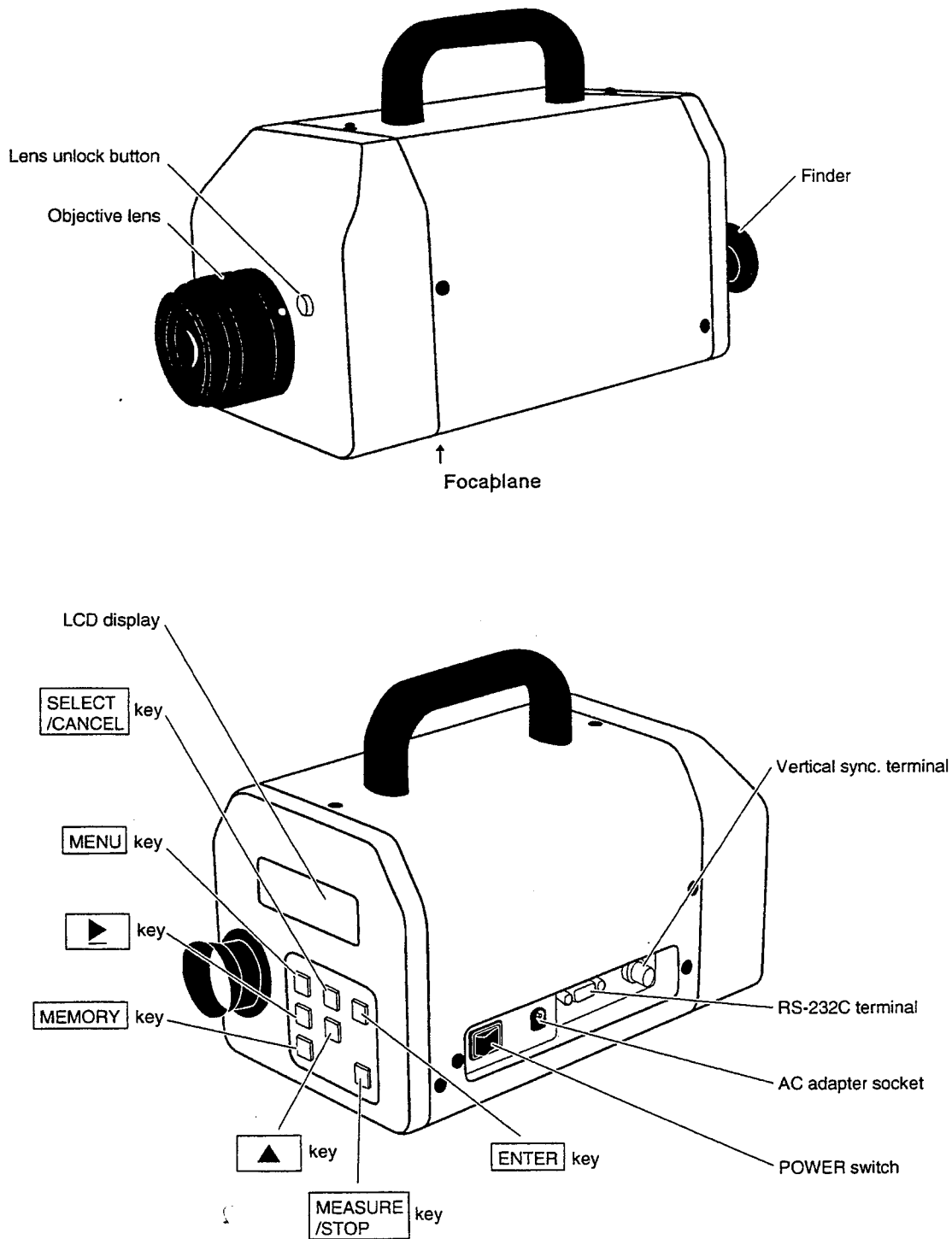
POWER switch

FUNCTIONS OF CONTROLS

POWER switch .... Used to turn the power On/Off.

AC adapter socket .... Connect to the AC adapter (supplied with this CS-1000).

RS-232C terminal .... Used when connecting this CS-1000 with a personal computer via the RS-232C interface.

Vertical sync. input terminal ... Connect to the vertical synch. output terminal of the display device.

Lens unlock button .... Used to unlock the objective lens.

MEASURE/STOP key .... Used to start measurement. Pressing this key while measurement is in progress will stop measurement. Pressing this key during remote control mode (i.e. the CS-1000 is controlled by a personal computer) will cancel remote control mode and switch to local mode.

MENU key .... Used to switch the screen between measurement and setting screens.

SELECT/CANCEL key .... Pressing this key during mode selection in the setting screen will move the "▶" mark, enabling the user to select the desired mode. If this key is pressed after a numeric value is entered, the value will be canceled. Pressing this key at the end of measurement will enable the user to check the integration time.

▶ key .... Used to move the cursor to set a numeric value.

▲ key .... Used to change a numeric value.

MEMORY key .... Used to switch the screen between measurement and memory screens.

ENTER key .... Used to save data in the memory after the data has been selected. Pressing this key while a numeric value is being entered or saved in the memory will set the value.

SYSTEM CONFIGURATION DIAGRAM

CS-1000 body

Standard lens

Macro lens

ND eyepiece filter CS-A1

AC adapter AC-A12

Data processing
software CS-S1W

User calibration
software

Panhead
CS-A4

RS-232C cable
(2 m (9-pin) for IBM PC)
One of the cables can be selected as a standard accessory.

White calibration plate
CS-A5

Hard Case
CS-A2

Tripod
CS-A3

RS-232C cable
(5 m (9-pin) for IBM PC,
2m/5m (25-pin) for IBM)

Personal computer
(available in market)

———— Standard Accessory
- - - - Optional Accessory

LCD DISPLAY

The following three screens are displayed on the LCD provided on the CS-1000.

- Measurement screen
  Displayed at the end of measurement.

```
AUTO
    Lv =     103.4cd/m²
    x  =     0.1546
    y  =     0.2475
```

- Menu screen
  Used to set the menu. This screen is displayed when the MENU key is pressed.

```
       *** MENU ***
▶ DISP.MODE:    Lvxy
   ABS./DIFF:    ABS.
```

- Memory screen
  Used to save measured data and target data. This screen is displayed when the MEMORY key is pressed.

```
▶ SAVE  TARGET  :     T1
    Lv =     103.4cd/m²
    x  =     0.1546
    Y  =     0.2475
```

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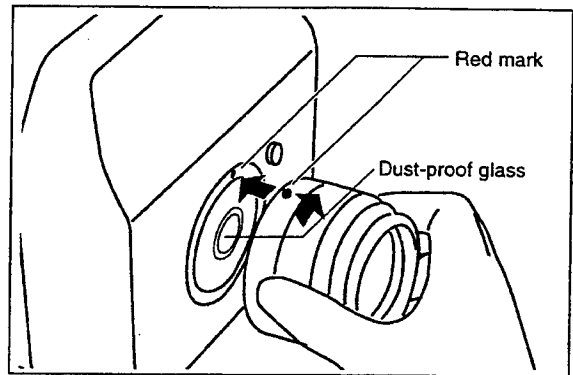# ATTACHING AN OBJECTIVE LENS

After the power is turned on, the CS-1000 detects the type of currently attached objective lens just before it starts measurement. If no objective lens is attached to the CS-1000, measurement cannot be started.
Two types of objective lens are available with this CS-1000: standard objective lens (40 cm to ∞) and macro objective lens (20 cm to ∞).

- Do not touch the surface of the objective lenses and dust-proof glass with fingers. If dirt or dust is present, wipe it off with a soft cloth. If the surface is extremely dirty, wipe it with a small amount of alcohol (high-grade alcohol). Never use acetone or organic solvent.
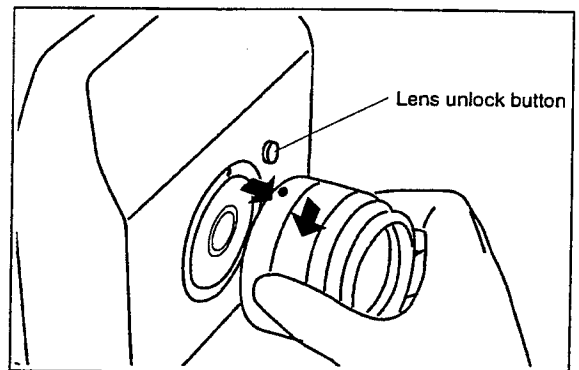
Attaching an objective lens
1. Align the red mark provided on the objective lens with that provided on this CS-1000.
2. Turn the objective lens counter-clockwise until a clicking sound is heard.

Removing an objective lens
- While holding down the lens unlock button, turn the objective lens clockwise to remove it from the CS-1000.
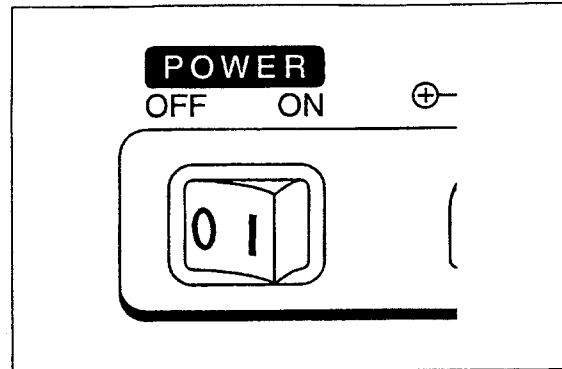
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CONNECTING THE AC ADAPTER

Connect the AC adapter to this CS-1000 and an AC outlet as described below.
* Use the AC adapter AC-A12 supplied with this CS-1000.
* Before disconnecting the AC adapter from an AC outlet, always set the POWER switch to OFF ("O").

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

2. Plug the AC adapter into the AC adapter socket provided on this CS-1000.

3. Plug the AC adapter into an AC outlet

10
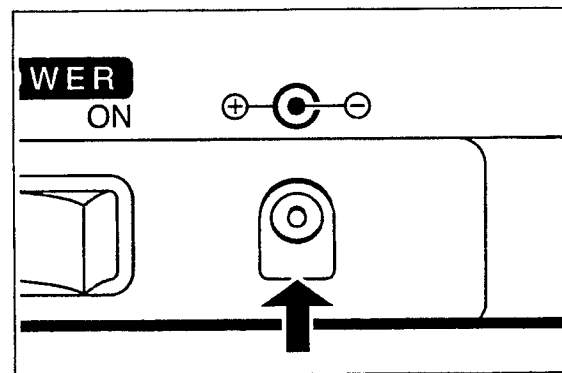
TURNING POWER ON AND OFF

It takes at least 15 minutes for the CS-1000 to stabilize. Thus, make sure that the POWER switch is set to ON ("I") to warm up the CS-1000 at least 15 minutes before start of measurement.
However, to ensure accurate measurements under the following conditions, warm-up time of 30 minutes or more is recommended.

1. When the object to be measured is a low-luminance light source: 5 cd/m² or below with 2856K (standard light source A)
2. When the operating temperature and humidity are outside the normal range

• If the power is turned off even for a short time, the CS-1000 should be warmed up again for at least 15 minutes.
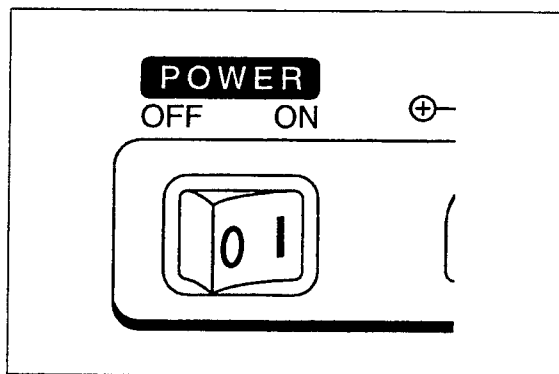
1. Set the POWER switch to ON ("I").

    ◆ The CS-1000 will start up.
    ◆ The LCD displays the settings which were in effect just before the POWER switch was set to OFF last time.
    ◆ The factory settings are shown below.

```
AUTO.
   Lv =
    x =
    y =
```
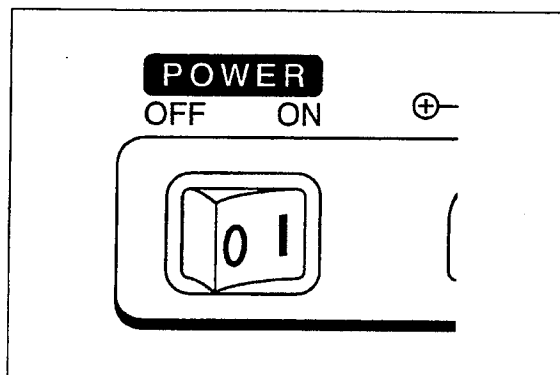
2. To turn the power off after measurement is complete, set the POWER switch to OFF ("O").

EYEPIECE ADJUSTMENT

This section describes how to adjust the eyepiece.

1. Place this CS-1000 on a stable surface or secure it to a tripod.

2. If the object is extremely bright, attach the ND eyepiece filter (supplied with this CS-1000) to the CS-1000.
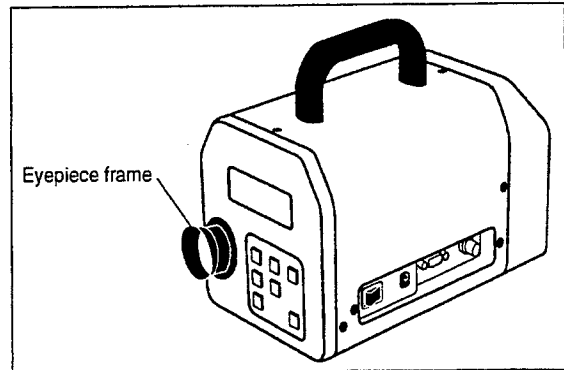
3. Turn the eyepiece frame to adjust the finder visibility.

   - Turn the eyepiece frame so that sections A and B of the aperture (i.e. black circle indicating measurement area) viewed when you look into the finder are clear.
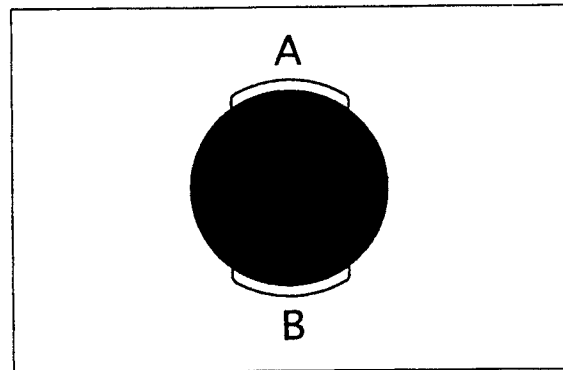
SETTING THE MENU

Selecting Measurement Mode (MEAS. MODE)

This section describes how to select measurement mode and set integration time.
Integration time: Refers to "exposure time", i.e. the period during which the sensor is measuring the light.
Measurement time: Refers to the time required for actual measurement, and is expressed as "Integration time x 2 + Chopper open/close time + Computation time". If this CS-1000 is used with a personal computer, "data transfer time" will also be taken into account.

The following four measurement modes are available.

AUTO : Used to measure a stationary light. Stationary light refers to stable light radiated from an electric bulb or an LED lit by constant-voltage power supply. The most suitable integration time is set automatically according to the brightness of the light source.

- If a light source whose luminance fluctuates considerably is measured in AUTO mode, an OVER/UNDER error sometimes occurs. In this case, switch the mode to MAN and set the longest integration time within the range in which no OVER/UNDER error occurs.

INT.SYNC : Used to measure a display device without the vertical sync. signal connected to this CS-1000 or to measure a flicker light source such as a fluorescent lamp. Enter the same frequency as the vertical sync. signal when you want to measure a display device or enter the commercial frequency (50 or 60 Hz) when you want to measure a flicker light source. The most suitable integration time is set automatically according to the entered value and brightness of the object.
The signal that is input should be the CMOS logic level (5V) signal.

EXT.SYNC : Used to measure a display device with the vertical sync. signal connected to this CS-1000. The most suitable integration time is set automatically according to the frequency of the vertical sync. signal and brightness of the object.
The signal that is input should be the CMOS logic level (5V) signal.

MAN : This mode allows the user to specify the desired integration time. A value of between 0.04 to 60 seconds can be entered.

- If the integration time specified in MAN mode is far below the one in AUTO mode, measurement accuracy may drop. To ensure accurate measurement, it is recommended to specify integration time which is at least half the integration time set in AUTO mode.

1. Press the MENU key.

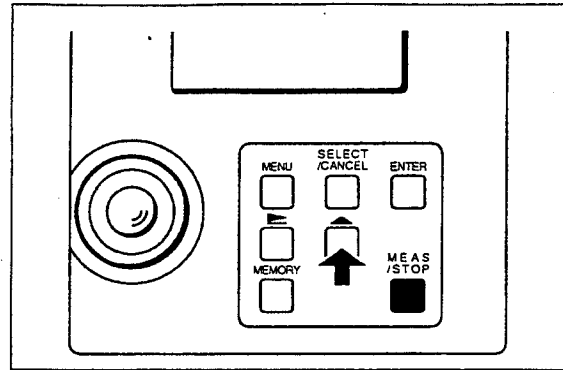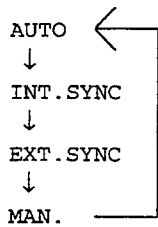- The following **MENU** screen will appear on the LCD.

```
*** MENU ***
▶ MEAS.MODE:   AUTO
```

- The "▶" mark will be positioned at MEAS.MODE.
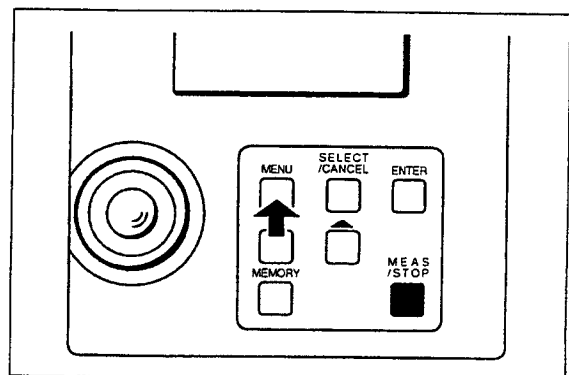
2. Press the [▲] key repeatedly until the desired measurement mode is displayed.

◆ Each time the [▲] key is pressed, measurement mode switches in the following order.

```
AUTO    <───┐
  ↓         │
INT.SYNC    │
  ↓         │
EXT.SYNC    │
  ↓         │
MAN.    ────┘
```

When INT.SYNC or MAN. is Selected

If INT.SYNC is selected, set the vertical sync. signal's frequency and commercial frequency. If MAN. is selected, set the integration time as described below.

3. Press the [▶] cursor key.
   ● The cursor will be positioned below the currently set value.
   ◆ Each time the [▶] cursor key is pressed, the cursor moves one digit.

```
    *** MENU ***
▶ MEAS.MODE    :     MAN.
   00.    040   sec.
```
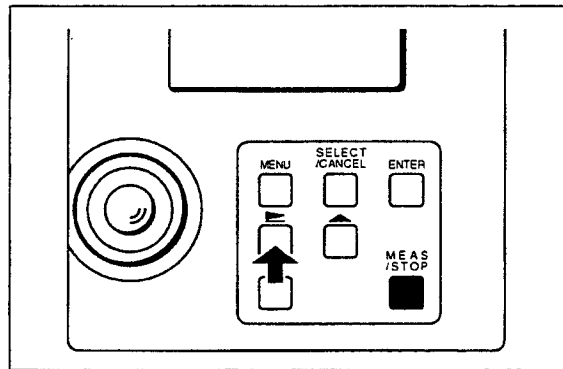
4. Press the [▲] key to set the desired value.
   ◆ Each time the [▲] key is pressed, the value increases. Holding down the [▲] key will cause the value to increase continuously.
   ● For INT.SYNC mode, a value of between 20 and 250 Hz can be set.
   ● For MAN. mode, a value of between 0.040 and 60.000 can be set.
   ● "DATA SET ERROR" message will appear if the value is outside the above range.
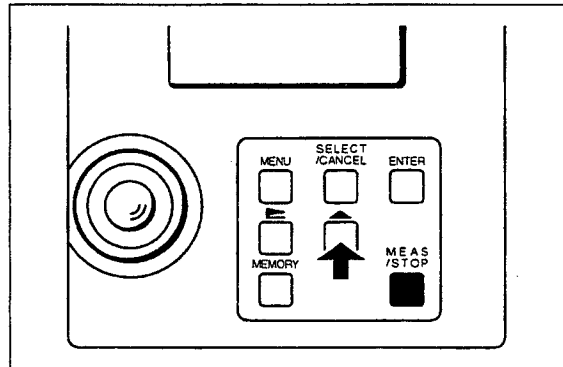
5. Press the **ENTER** key.

   ◆ The cursor below the value will disappear, indicating that the entered value has been set.
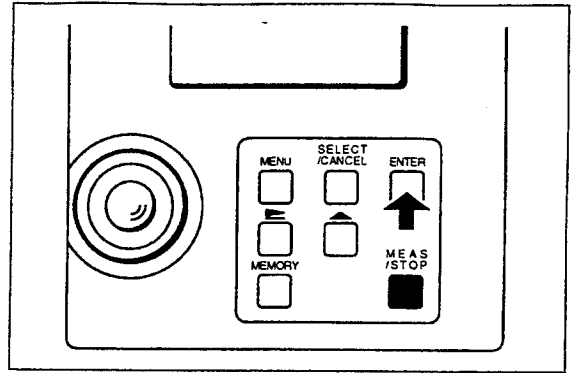
6. Press the **MENU** key.

   ◆ Measurement mode is now set.
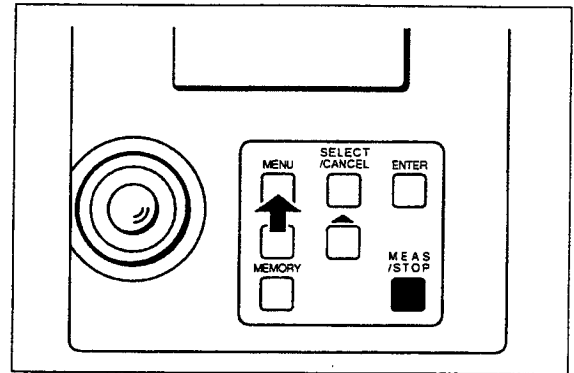
Selecting Display Mode

This section describes how to select colorimetric data type (Lvxy, Lvu'v', LvT⊿uv and Le).

① Lv : Indicates luminance.
② Le : Indicates radiance.
③ T   : Indicates correlated color temperature.
④ △uv : Indicates the color difference from the blackbody locus.
        ● The chromaticity range for which the relative color temperature can be applied is not specified. In general, the correlated color temperature is used within ± 0.02 ⊿uv.

1. Press the **MENU** key.

   ◆ The MENU screen will appear on the LCD.
   ◆ The "▶" mark will be positioned at MEAS.MODE.
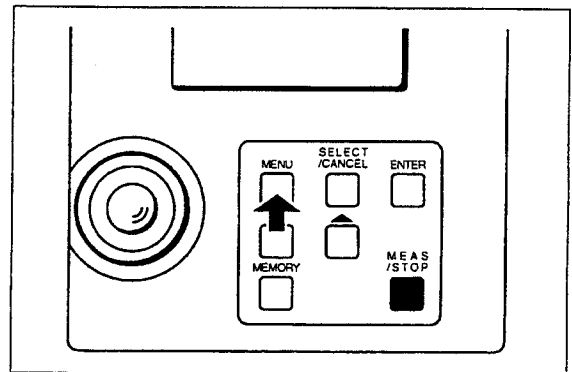
2. Press the **SELECT/CANCEL** key.

 ◆ The " ▶ " mark will be positioned at DISP.MODE.

```
    *** MENU ***
 ▶ DISP.MODE:   Lvxy
   ABS./DIFF:   ABS.
```

3. Keep pressing the [▲] key until the desired display mode is displayed.

 ◆ Each time the [▲] key is pressed, display mode switches in the following order.

```
Lvxy   ⟵┐
 ↓      │
Lvu'v'  │
 ↓      │
LvT△uv  │
 ↓      │
Le    ──┘
```
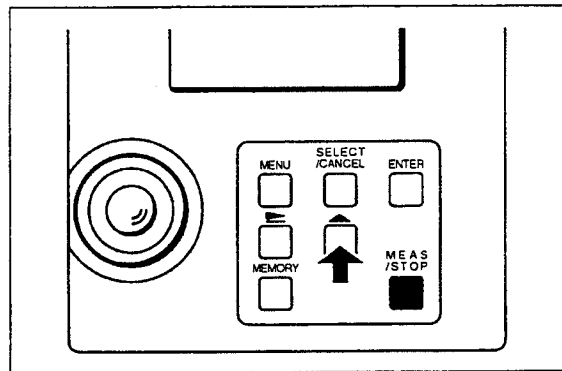
4. Press the **MENU** key.

 ◆ Display mode is now set.

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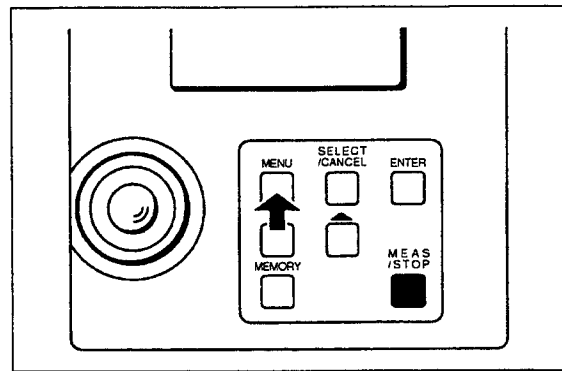
Setting Absolute Value (ABS.) or Color Difference (DIFF) Display Mode

This section describes how to select whether chromaticity in absolute value (ABS.) or in color difference (DIFF) is displayed. If selection is made so that chromaticity is displayed in color difference, luminance will be displayed in relative values (%).

- Color difference can be displayed only when Lvxy or Lvu'v' display mode is selected.

1. In the initial screen, press the **MENU** key.

   ◆ The MENU screen will appear on the LCD.
   ◆ The "▶" mark will be positioned at MEAS.MODE.
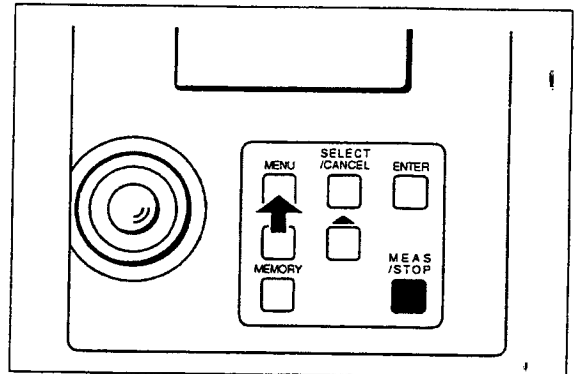
2. Press the **SELECT/CANCEL** key twice.

   ◆ The "▶" mark will be positioned at ABS./DIFF.

   ```
   *** MENU ***
     DISP.MODE:    Lvxy
   ▶ ABS./DIFF:    ABS.
   ```
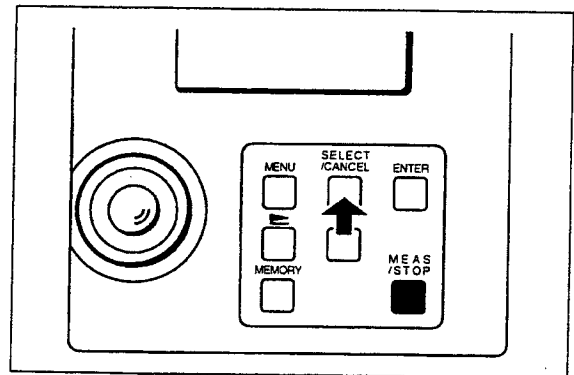
3. Press the [▲] key to select ABS. to display the chromaticity in absolute value or DIFF to display it in color difference.

   ◆ Each time the [▲] key is pressed, ABS or DIFF is selected alternately.

   ```
   ABS.
    ↓
   DIFF
   ```
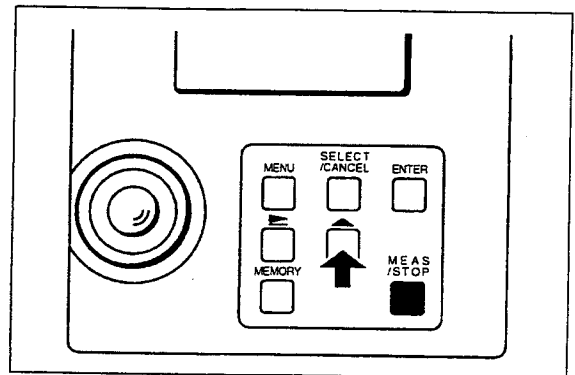
4. Press the **MENU** key.

   ◆ ABS. or DIFF display mode is now set.
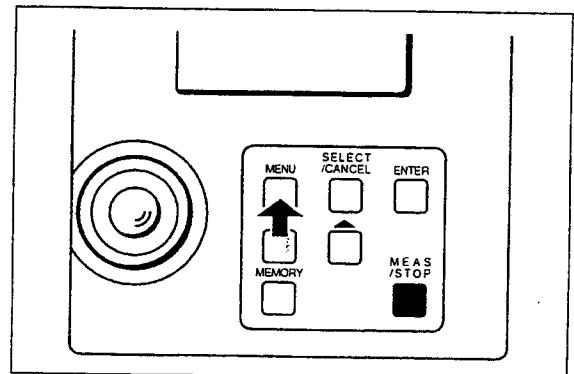
Setting the Observer

This section describes how to select the observer (2 degrees or 10 degrees) for the color matching function to be used for calculation of chromaticity.
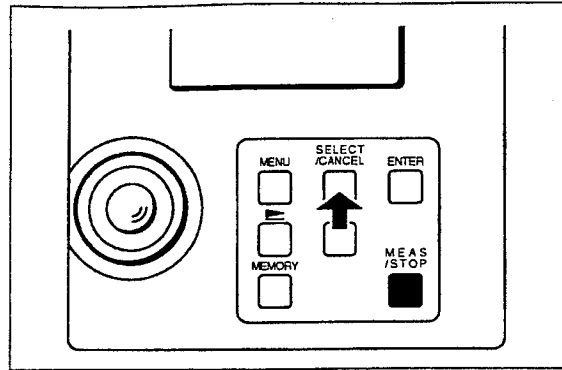
1. Press the **MENU** key.

   ◆ The following MENU screen will appear on the LCD.
   ◆ The "▶" mark will be positioned at MEAS.MODE.
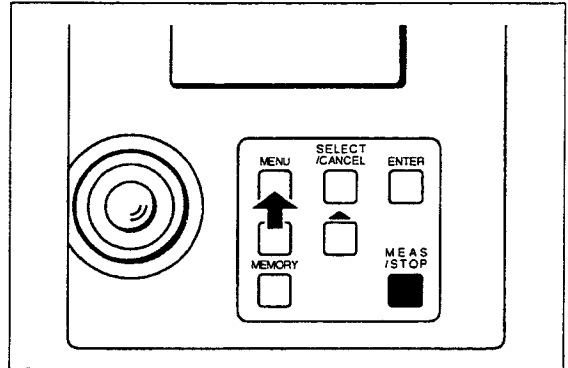
2. Press the **SELECT/CANCEL** key three times.

   ◆ The "▶" mark will be positioned at OBSERVER.

   ```
        *** MENU ***
   ▶ OBSERVER     :    2°
     BAUD RATE    :    19200
   ```
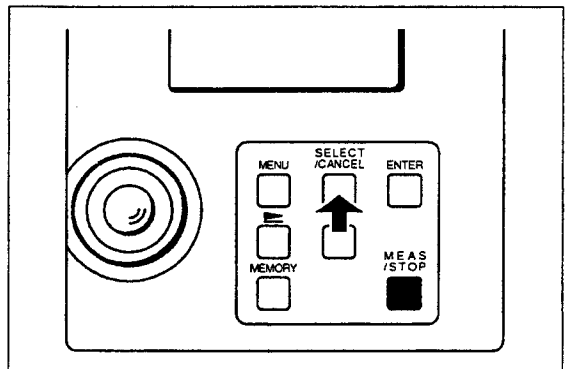
3. Press the [▲] key to select 2° or 10°.

   ◆ Each time the [▲] key is pressed, 2° or 10° is selected alternately.

   2°
   ↓
   10°
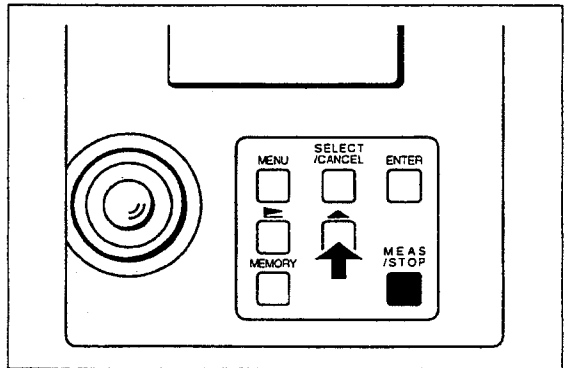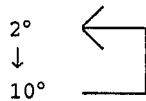
4. Press the **MENU** key.

   ◆ Observer is now set.
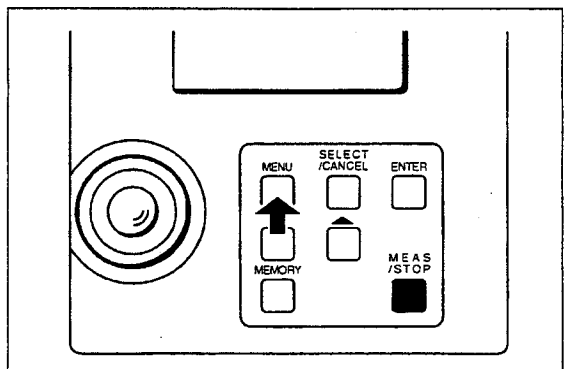
Setting the Baud Rate

This section describes how to set the baud rate for communications between this CS-1000 and a personal computer.

1. In the initial screen, press the **MENU** key.

   - ◆ The following MENU screen will appear on the LCD.
   - ◆ The "▶" mark will be positioned at MEAS.MODE.
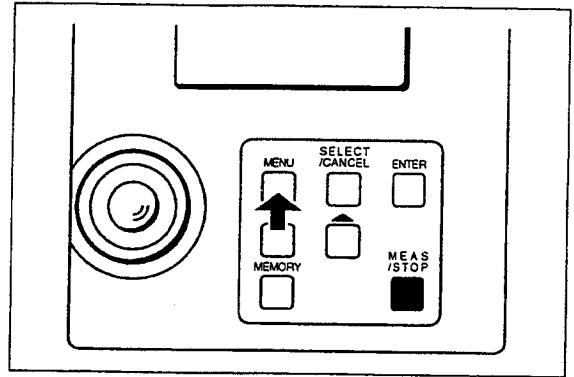
2. Press the **SELECT/CANCEL** key four times.

   - ◆ The "▶" mark will be positioned at BAUD RATE.

   ```
   ***  MENU  ***
   OBSERVER     :2°
   ▶ BAUD RATE   :      19200
   ```
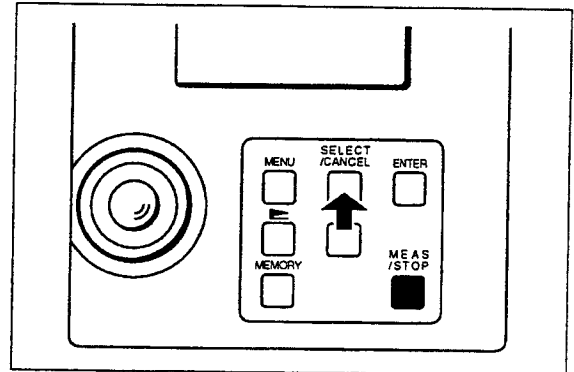
3. Keep pressing the [▲] key until the desired baud rate is selected.

   - ◆ Each time the [▲] key is pressed, baud rate switches in the following order.

   ```
   4800   ⟵
    ↓        │
   9600      │
    ↓        │
   19200 ────┘
   ```
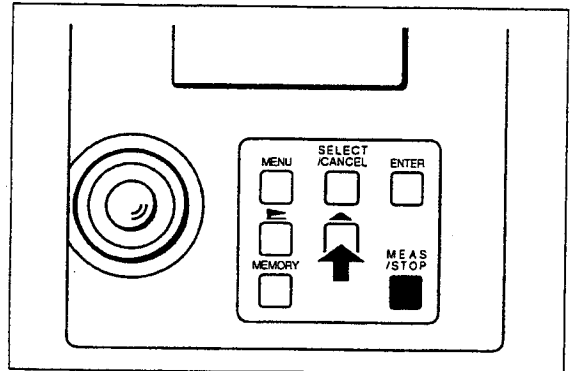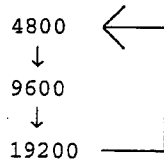
4. Press the **MENU** key.

   - ◆ The baud rate is now set.
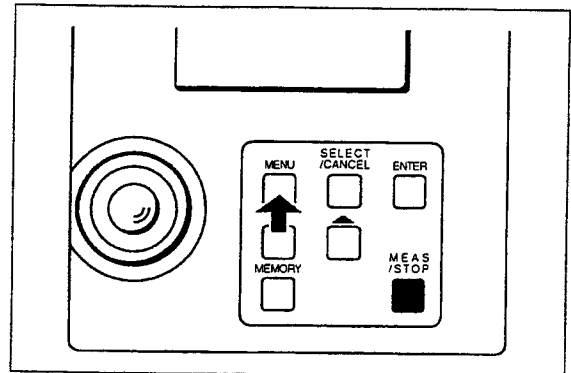
MEASURING A CONTINUOUS LIGHT

This section describes how to measure a continuous light radiated from an electric bulb or LED lit by constant-voltage power supply.

- When performing measurements in MAN mode, if the integration time specified in MAN mode is far below the one in AUTO mode, measurement accuracy may decrease. To ensure accurate measurement, it is recommended to set the integration time which is at least half the integration time set in AUTO mode.
- It takes at least 15 minutes for the CS-1000 to stabilize. Thus, make sure that the POWER switch is set to ON ("I") to warm up the CS-1000 at least 15 minutes before start of measurement.
  However, to ensure accurate measurements under the following conditions, warm-up time of 30 minutes or more is recommended.
  1. When the object to be measured is a low-luminance light source: 5 cd/m² or below with 2856K (standard light source A)
  2. When the operating temperature and humidity are outside the normal range
- If the power is turned off even for a short time, the CS-1000 should be warmed up again for at least 15 minutes.

1. Set the POWER switch to ON ("I") to warm up the CS-1000 at least 15 minutes before start of measurement.

2. Set the menu.
   (See pages 13 to 18.)

   ◆ To measure continuous light, AUTO is recommended to be selected for measurement mode.

3. Adjust the focus ring of the objective lens.

   ◆ Adjust the focus ring so that the peripheral area of the aperture (i.e. black circle indicating measurement area) viewed when you look into the finder is clear.
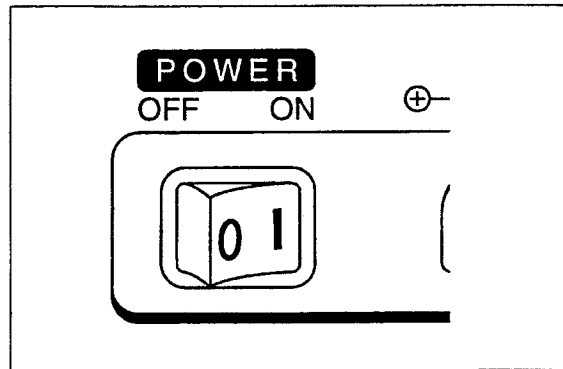
4. In the measurement screen, press the **MEASURE/STOP** key.

◆ Measurement will start.

```
*** Measuring ***
  MEASURING TIME
       3s
```

◆ Measuring time will be displayed on the LCD during measurement.
● To stop measurement, press the **MEASURE/STOP** key again. If measurement is stopped, the previously measured data will also be lost.
◆ When measurement is complete, the measurement results will be displayed as shown below.

```
AUTO
  Lv =     103.4cd/m²
  x  =     0.1567
  y  =     0.2573
```

No integration time will be displayed if **AUTO**, **INT.SYNC** or **EXT.SYNC** measurement mode has been selected. To display the integration time, press the [SELECT/CANCEL] key at the end of measurement.

```
INTEGRATION TIME
    0.500s
  [Push any key]
```

To return to the previous screen, press any key.
Integration time can be checked for the latest measurement only.
Integration time will be displayed in the measurement screen if **MAN** measurement mode has been selected.

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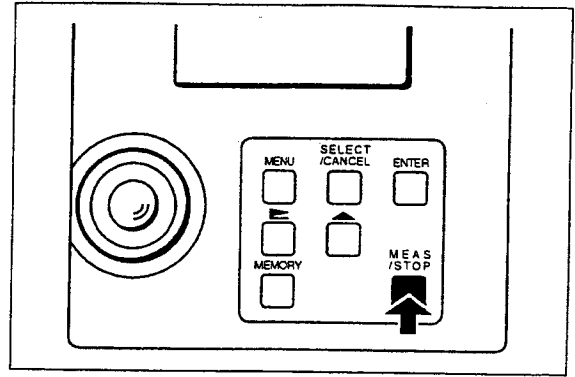
MEASURING A FLICKER LIGHT

   This section describes how to measure a light source, such as a display device and fluorescent lamp, whose brightness fluctuates periodically.
If EXT.SYNC measurement mode is selected for measurement of a display device, make sure to connect the vertical sync. input terminal (BNC) of this CS-1000 to the corresponding output terminal of the display device using an appropriate BNC cable.

- It takes at least 15 minutes for the CS-1000 to stabilize. Thus, make sure that the POWER switch is set to ON ("I") to warm up the CS-1000 at least 15 minutes before start of measurement.
  However, to ensure accurate measurements under the following conditions, warm-up time of 30 minutes or more is recommended.
    1. When the object to be measured is a low-luminance light source: 5 cd/m^2 or below with 2856K (standard light source A)
    2. When the operating temperature and humidity are outside the normal range
- If the power is turned off even for a short time, the CS-1000 should be warmed up again for at least 15 minutes.
- If EXT.SYNC measurement mode is selected, make sure that the POWER switch of this CS-1000 is set to ON ("I") before inpatting the vertical sync. signal to the CS-1000. In addition, make sure that the vertical sync. signal is not inputting from the CS-1000 before setting the POWER switch to OFF ("○").

1. Set the POWER switch to ON ("I") to warm up the CS-1000 at least 15 minutes before start of measurement.

2. Set the menu.
   (See pages 13 to 18.)

   - For measurement of a display device:
     Select INT.SYNC or EXT.SYNC measurement mode.
     For measurement of a flicker light source such as a fluorescent lamp:
     Select INT.SYNC measurement mode.

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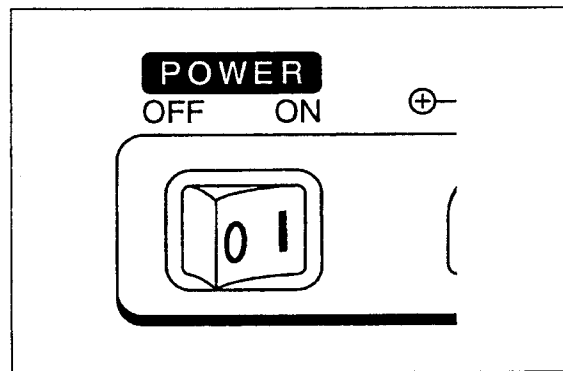
3. Press the **MEASURE/STOP** key.

◆ Measurement will start.

```
*** Measuring ***
   MEASURING TIME
        3s
```

◆ Measuring time will be displayed on the LCD during measurement.
◆ When measurement is complete, the measurement results will be displayed as shown below.

```
INT. 60.00Hz
   Lv =      103.4cd/m²
   x  =       0.1567
   y  =       0.2573
```

● To stop measurement, press the **MEASURE/STOP** key again. If measurement is stopped, the previously measured data will also be lost.

No integration time will be displayed if **AUTO**, **INT.SYNC** or **EXT.SYNC** measurement mode has been selected. To display the integration time, press the **SELECT/CANCEL** key at the end of measurement.

```
INTEGRATION TIME
0.500s
[Push any key]
```

To return to the previous screen, press any key.
Integration time can be checked for the latest measurement only.
Integration time will be displayed in the measurement screen if **MAN** measurement mode has been selected.
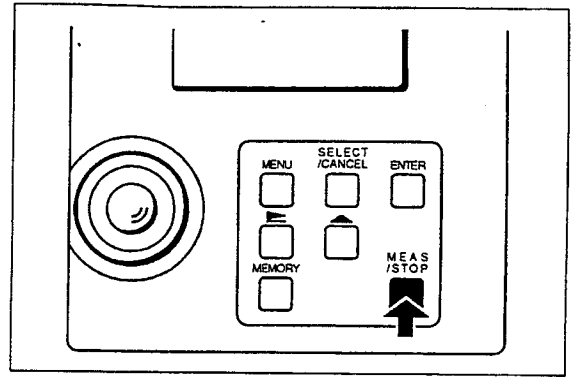
Saving the Measured Data

This section describes how to save measured data. Up to 30 measured data points can be saved.

Once measured data has been saved, it will be retained even if the AC adapter is disconnected or the power is turned off, unless it is replaced with new data.

1. Press the **MEASURE/STOP** key to start measurement.

   ◆ Measured data will be displayed as shown below when measurement is complete.

   ```
   AUTO
      Lv =        103.4cd/m²
      x  =        0.1567
      y  =        0.2546
   ```
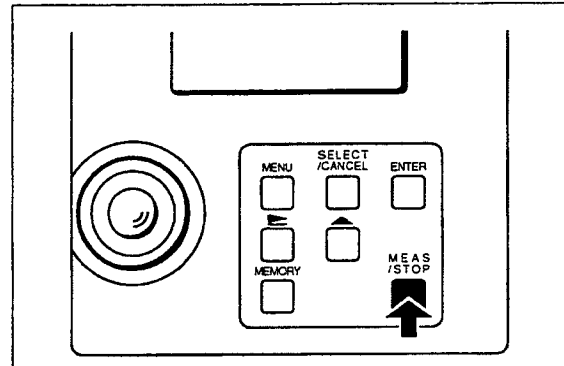
2. Press the **MEMORY** key.

   ◆ The memory screen will appear.
   ◆ "SAVE MEAS" message will appear.

   ```
   ▶ SAVE MEAS    :      M1
     Lv =
     x  =
     y  =
   ```
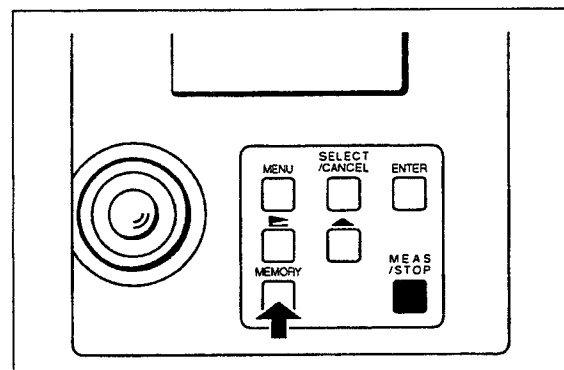
3. Keep pressing the [▲] key until the memory no. to which the measured data is to be saved is displayed.
   ✳ Each time the [▲] key is pressed, memory no. switches in the order M1, M2, M3 up to M30 and back to M1. Holding down the [▲] key will cause the memory no. to change continuously.
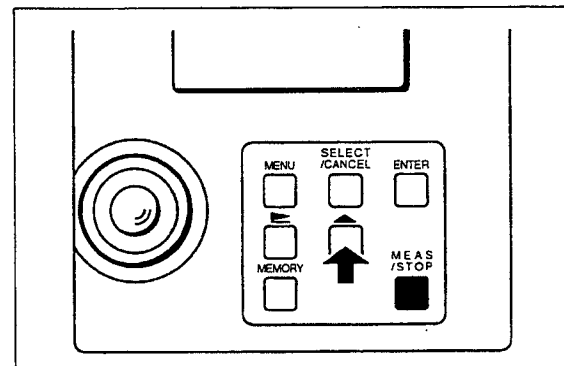
4. Press the **ENTER** key.

   ◆ "SAVE OK?" message will appear as shown below.

   ```
   SAVE OK?   M1
      Yes    :      ENTER
      No     :      CANCEL
   ```

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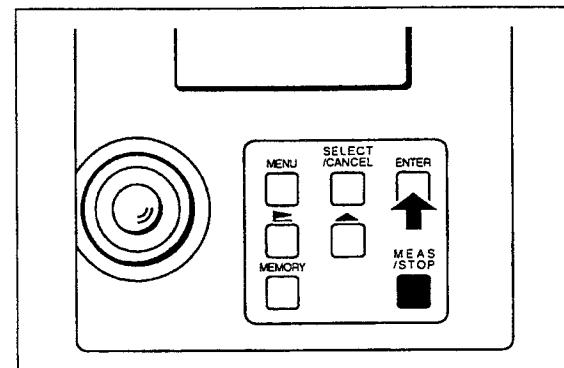
5. To save the measured data, press the **ENTER** key.

◆ The measured data will be saved.
● If measured data already exists in the selected memory No., it will be replaced with the new measured data.

```
▶ SAVE MEAS    :    M1
   Lv =      103.4cd/m²
   x  =      0.1572
   y  =      0.3467
```

● If you do not want to save the data, press the **SE-LECT/CANCEL** key.

6. Press the **MEMORY** key.
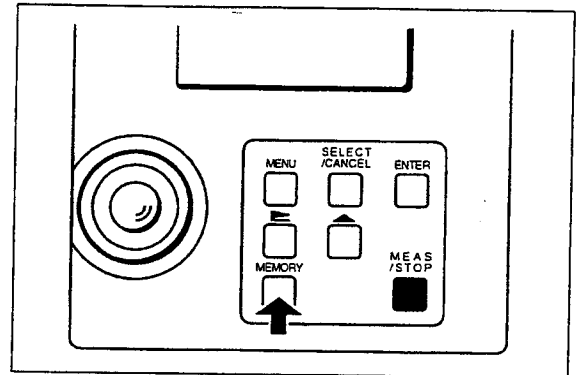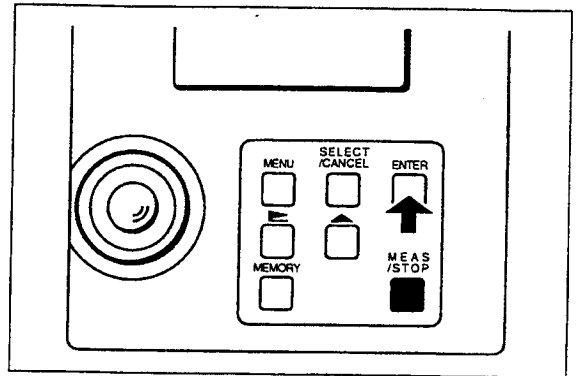
Saving the Target Data and Setting It

This section describes how to save the measured data or manually entered data as target data. The following two methods are available for saving target data.

① Saving the measured data as target data
② Entering data and saving it as target data

Up to 20 target data (TARGET) points can be saved.

Once target data has been saved, it will be retained even if the AC adapter is disconnected or the power is turned off, unless it is replaced with new data.

Saving the Measured Data as Target Data

1. Press the **MEASURE/STOP** key to start measurement.

   ◆ Measured data will be displayed as shown below when measurement is complete.

   ```
   AUTO
     Lv =      103.4cd/m²
     x  =       0.1560
     y  =       0.1579
   ```
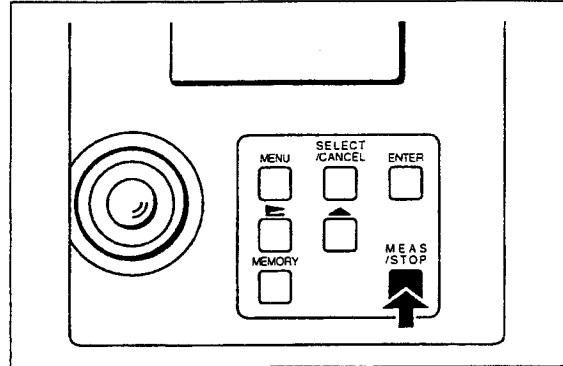
2. Press the **MEMORY** key.

   ◆ The memory screen will appear.
   ◆ "SAVE MEAS" message will appear.

   ```
   ▶ SEVE MEAS    :     M1
     Lv =      103.4cd/m²
     x  =       0.1560
     y  =       0.1579
   ```
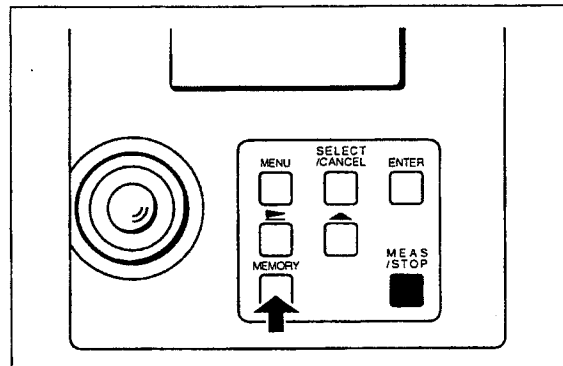
3. Press the **SELECT/CANCEL** key.

   ◆ "SAVE TARGET" message will appear.

   ```
   ▶ SEVE TARGET  :     T1
     Lv =
     x  =
     y  =
   ```

   ◆ Each time the **SELECT/CANCEL** key is pressed, the message switches in the following order.

   ```
   SAVE MEAS
       ↓
   SAVE TARGET
       ↓
   INPUT TARGET
   ```
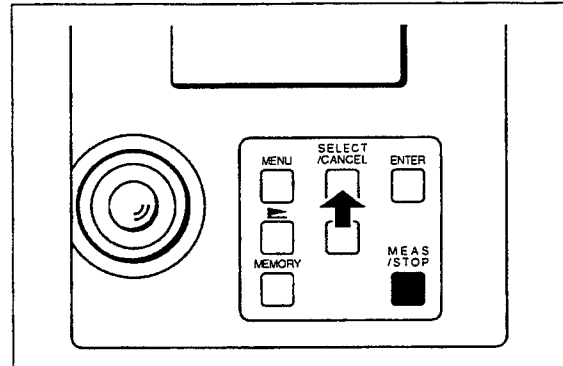
4. Keep pressing the [▲] key until the memory no. to which the target data is to be saved is displayed.

   ◆ Each time the [▲] key is pressed, memory no. switches in the order T1, T2, T3 up to T20 and back to T1. Holding down the [▲] key will cause the memory no. to change continuously.
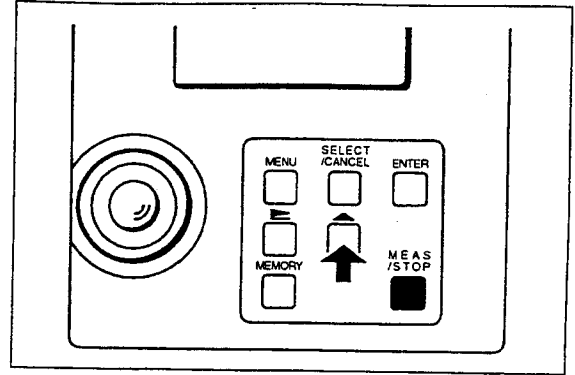
5. Press the **ENTER** key.

   ◆ "SAVE OK?" message will appear as shown below.

   ```
   SAVE OK?   T1
      Yes     :     ENTER
      No      :     CANCEL
   ```
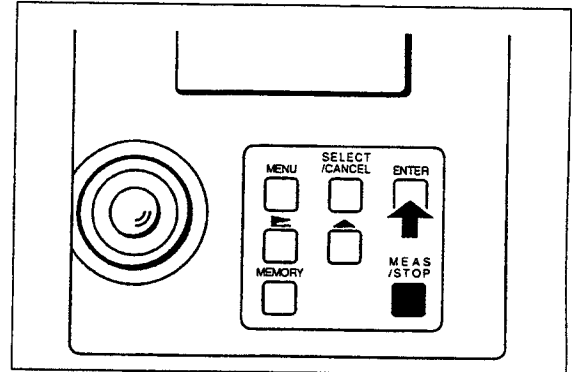
6. To save the target data, press the **ENTER** key.

   ◆ The target data will be saved.
   ● If target data already exists in the selected memory No., it will be replaced with the new target data.

   ```
   ▶  SEVE  TARGET  :        T1
      Lv =        103.4cd/m²
      x  =        0.1572
      y  =        0.3467
   ```

   ● If you do not want to save the data, press the **SE-LECT/CANCEL** key.
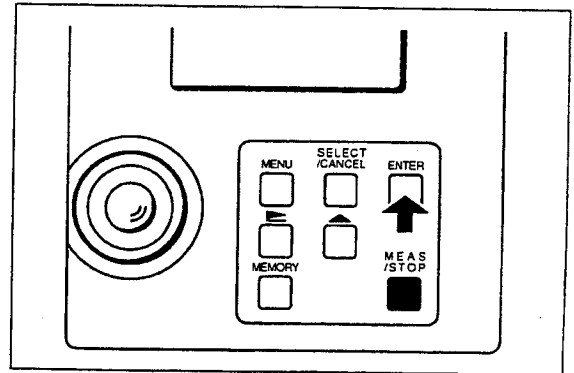
7. Press the **MEMORY** key.

   ◆ The target data will be set.
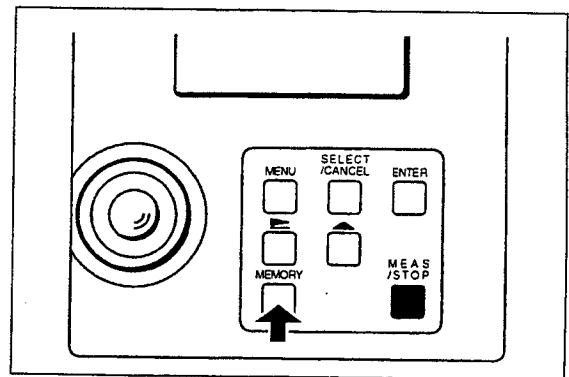
Entering Data and Saving It as Target Data

- Lvxy or Lvu'v' display mode must be selected (see pages 15 and 16).
- Target data can be entered for each observer (2° and 10°). If the both observer will be selected, the target data must be entered for both observer.

1. Select the desired observer, then press the **MEMORY** key.

   ◆ The memory screen will appear.
   ◆ "SAVE MEAS" message will appear.
   ● For setting the desired observer, refer to page 18.
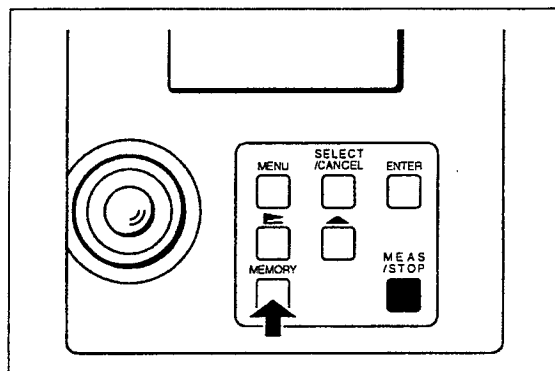
2. Press the **SELECT/CANCEL** key twice.

   ◆ "INPUT TARGET" message will appear.
   ◆ Each time the **SELECT/CANCEL** key is pressed, the message switches in the following order.

   ```
   SAVE MEAS     ⟵┐
       ↓           │
   SAVE TARGET     │
       ↓           │
   INPUT TARGET ───┘
   ```
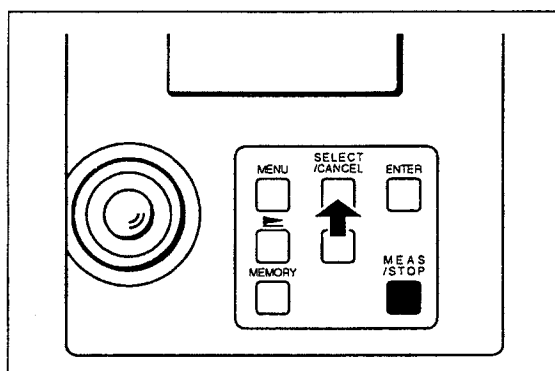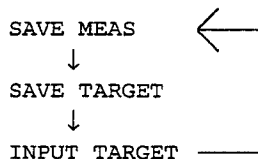
3. Keep pressing the [▲] key until the memory no. to which the manually entered data is to be saved as the target data is displayed.

   ◆ Each time the [▲] key is pressed, memory no. switches in the order T1, T2, T3 up to T20 and back to T1. Holding down the [▲] key will cause the memory no. to change continuously.
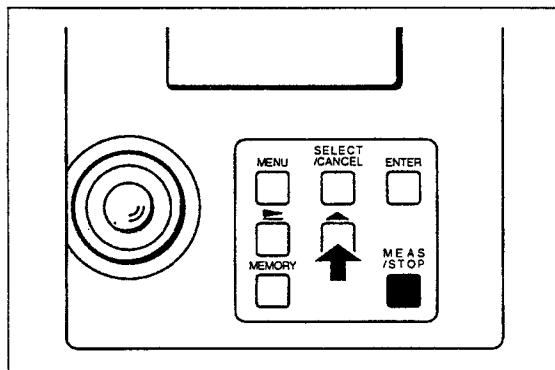
4. Press the [▶] key.

   ◆ A screen for entering the desired target data will appear.
   ◆ Each time the [▶] key is pressed, the cursor moves from a digit to another digit. Holding down the [▶] key will cause the cursor to move through digits continuously.

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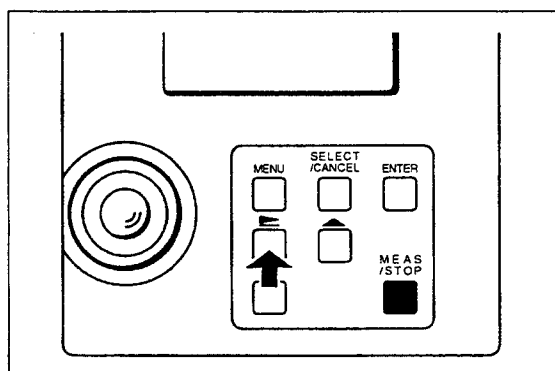
5. Keep pressing the [▲] key until the desired value is displayed at the cursor position.

- ● Lv must consist of 4 or less digits, so extra digits will be discarded.
- ◆ To cancel entry of the target data, press the **SELECT/CANCEL** key.
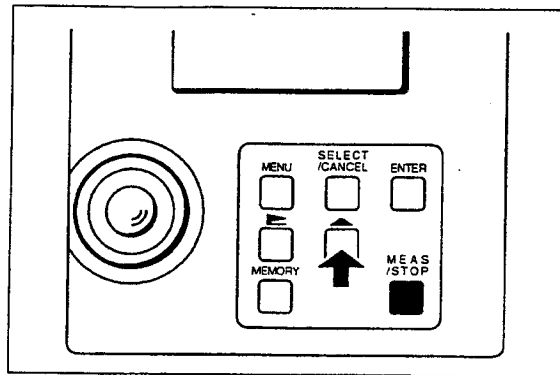
6. Press the **ENTER** key.

- ◆ "SAVE OK?" message will appear as shown below.
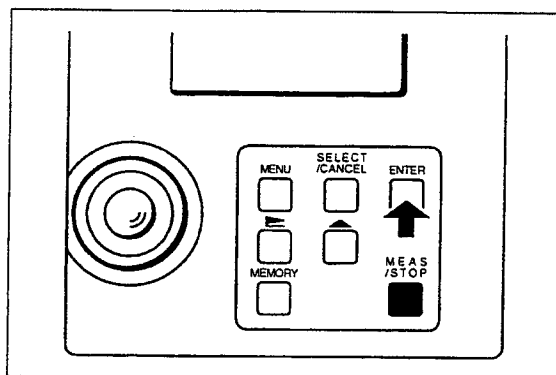
7. To save the target data, press the **ENTER** key.

- ◆ The target data will be saved.
- ● If target data already exists in the selected memory No., it will be replaced with the new target data. If the data existing in the memory is measured data, the selected observer's data will be overwritten and the other data will be deleted.
- ● If you do not want to save the data, press the **SELECT/CANCEL** key.
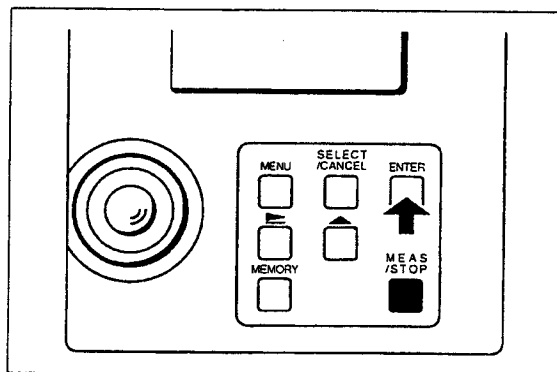
8. Press the **MEMORY** key.

- ◆ The target data will be set.
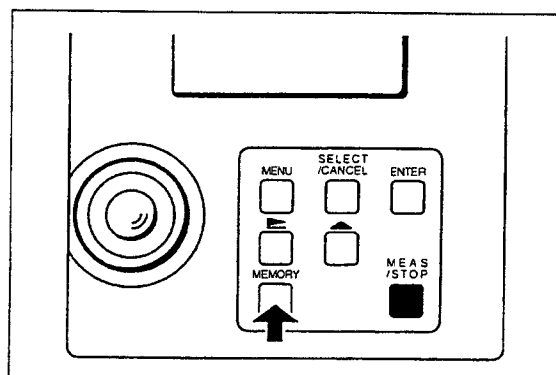
Each target data (Lvxy and Lvu'v') must be set so that the following conditions are met. If not, "DATA SET ERROR" message will appear.

① $Lv \geqq 0.01$
② $x \geqq 0.001, y \geqq 0.0001$
③ $x + y \leqq 0.9999$
④ $u' \geqq 0.0001, v' \geqq 0.0001$

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Deleting Measured Data

This section describes how to delete saved measured data.

1. Press the **MEMORY** key.

 ◆ The memory screen will appear.
 ◆ "SAVE MEAS" message will appear.

```
▶  SAVE MEAS    :      M1
   Lv =      123.4cd/m²
   x  =        0.1567
   y  =        0.2356
```
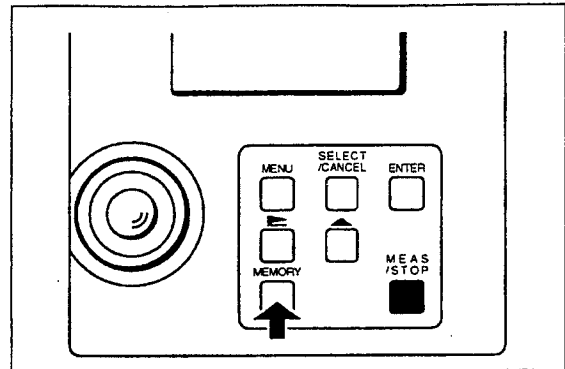
2. Keep pressing the [▲] key until the memory no. from which the measured data is to be deleted is displayed.

 ◆ Each time the [▲] key is pressed, memory no. switches in the order M1, M2, M3 up to M30 and back to M1. Holding down the [▲] key will cause the memory no. to change continuously.
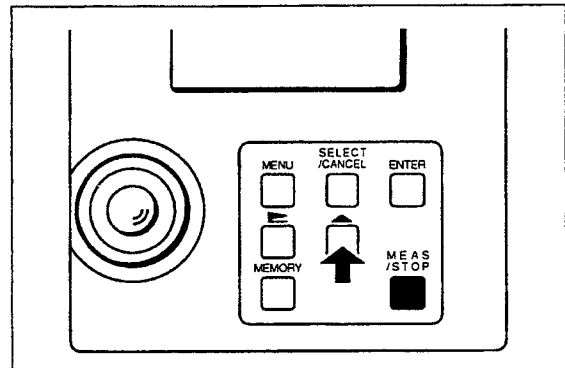
3. While holding down the [▶] key, press the **ENTER** key.

 ◆ "DELETE OK?" message will appear.

```
DELETE OK?       M1
   Yes     :    ENTER
   No      :    CANCEL
```

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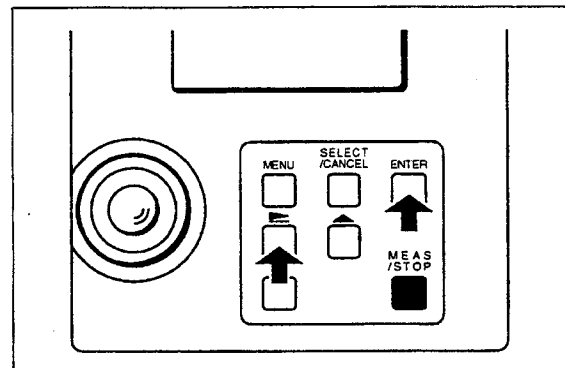
4. To delete the measured data, press the **ENTER** key.

```
▶  SAVE  MEAS    :    M1
   Lv =
   x  =
   y  =
```

◆ The measured data will be deleted.
◆ If you do not want to save the data, press the **SE-LECT/CANCEL** key.
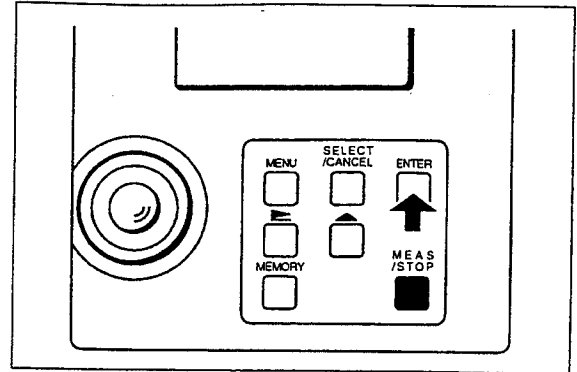
5. Press the **MEMORY** key.
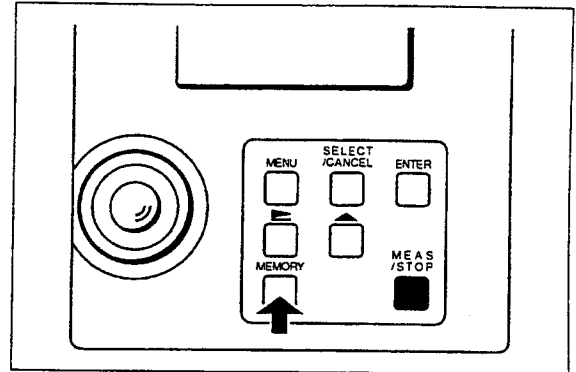
Deleting Target Data

This section describes how to delete saved target data.

1. Press the **MEMORY** key.

◆ The memory screen will appear.
◆ "SAVE MEAS" message will appear.

```
▶ SAVE  MEAS   :      M1
  Lv =      103.4cd/m²
  x  =        0.1567
  y  =        0.2756
```
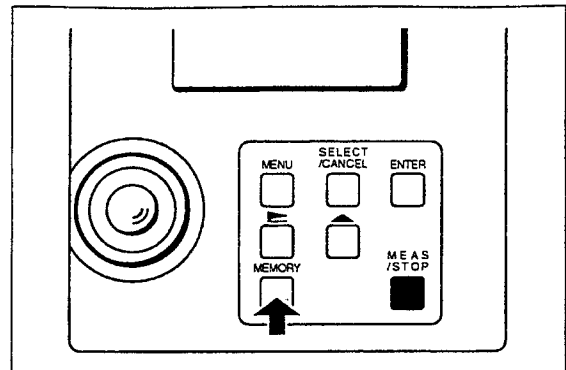
2. Press the **SELECT/CANCEL** key.

◆ "SAVE TARGET" message will appear.

```
▶ SAVE  MEAS   :      T1
  Lv =      167.4cd/m²
  x  =        0.1546
  y  =        0.1658
```

◆ Each time the **SELECT/CANCEL** key is pressed, the message switches in the following order.

```
SAVE  MEAS   ◄─┐
   ↓           │
SAVE  TARGET   │
   ↓           │
INPUT  TARGET ─┘
```
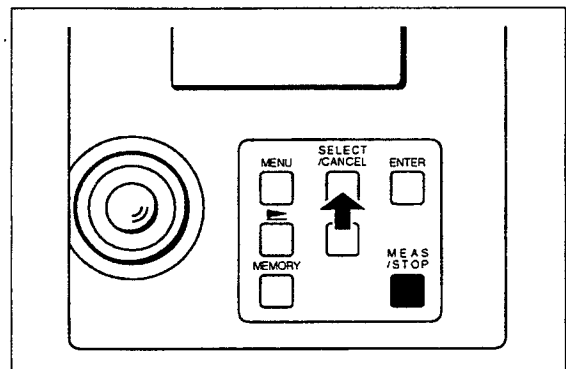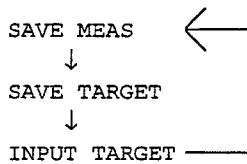
3. Keep pressing the [▲] key until the memory no. from which the target data is to be deleted is displayed.

◆ Each time the [▲] key is pressed, memory no. switches in the order T1, T2, T3 up to T20 and back to T1. Holding down the [▲] key will cause the memory no. to change continuously.
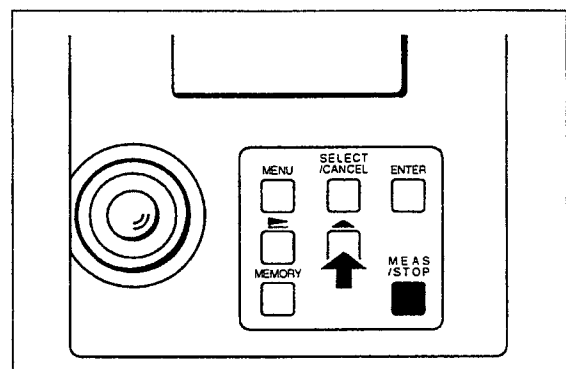
4. While holding down the [▶] key, press the **ENTER** key.

   ◆ "DELETE OK?" message will appear.

```
DELETE OK?      T1
   Yes     :    ENTER
   No      :    CANCEL
```
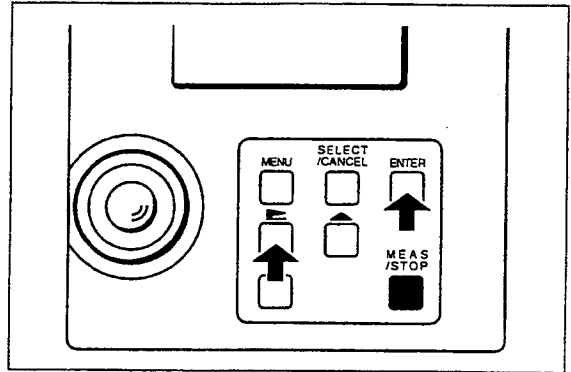
5. To delete the target data, press the **ENTER** key.

```
▶  SAVE  TARGET  :     T1
   Lv =
   x  =
   y  =
```

   ◆ The target data will be deleted.
   ● If you do not want to save the data, press the SE-
     LECT/CANCEL key.
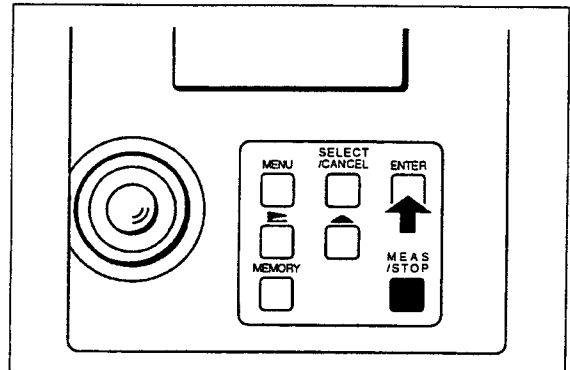
6. Press the **MEMORY** key.
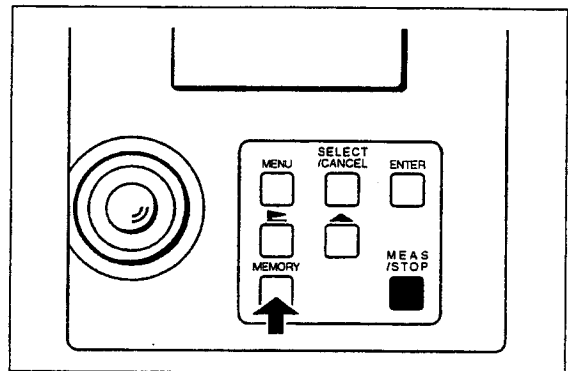
Displaying Color Difference/Relative Luminance

This section describes how to display color difference/relative luminance between measured data or saved measured data and target data.

- Color difference/relative luminance can be displayed only when Lvxy or Lvu'v' display mode is selected.
- Before carrying out the following procedure, set the desired measured data or target data. If no measured data or target data has been set, an error message will appear when the following procedure is carried out. (Refer to "ERROR MESSAGES" on page 70.)

For Measured Data

1. First, save the target data to be compared with the measured data into the desired memory no., and set it. (See pages 24 to 25.)

2. Select color difference display mode (DIFF). (See page 17.)

3. After the target data has been saved and DIFF has been selected, press the **MENU** key.

4. Start measurement.

   ◆ The color difference or relative luminance in relation to the target data set in step 1 will be displayed.
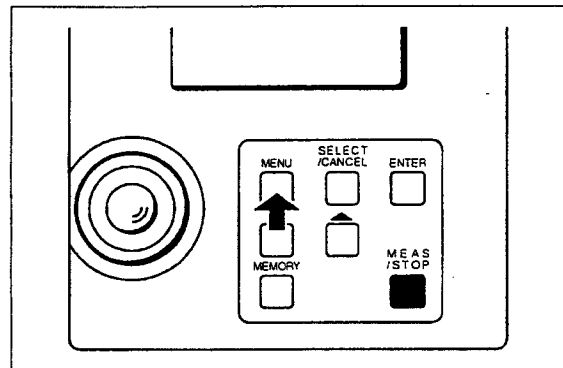
5. To switch the target data to another, press the [▲] key after completion of measurement.

   ◆ The color difference or relative luminance in relation to the target data (T2) will be displayed.

AUTO.		(T2)
Lv%	=	98.76%
Δx	=	-0.0123
Δy	=	+0.0123
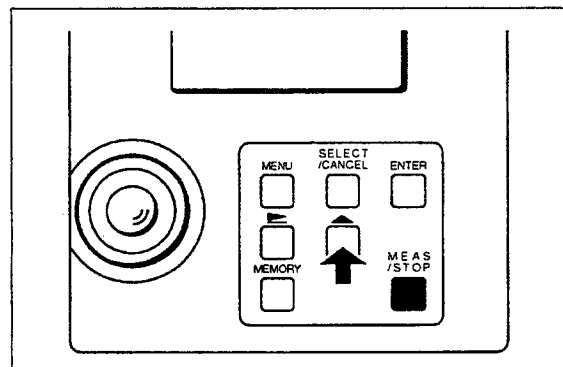
◆ Each time the [▲] key is pressed, the target data switches from one to another in the order T3, T4 up to T20 and then to T1, causing the color difference or relative luminance in relation to the selected target data to be displayed. Holding down the [▲] key will cause the memory no. to switch continuously.
● To display the absolute value of the measured data, select absolute value display mode (ABS) instead of color difference display mode (DIFF) in step 2.

For Saved Measured Data

1. Save the measured data and target data to be compared with each other into the desired memory no. (See pages 24 to 25.)

2. Select color difference display mode (DIFF). (See page 17.)

3. Press the **MEMORY** key.

◆ The memory screen will appear, and "SAVE MEAS" message appears.
◆ The color difference/relative luminance will be displayed.
(e.g.) For measured data (M1) and target data (T1)

▶ SAVE MEAS		M1(T1)
Lv%	=	98.76%
△x	=	-0.0123
△y	=	+0.0123
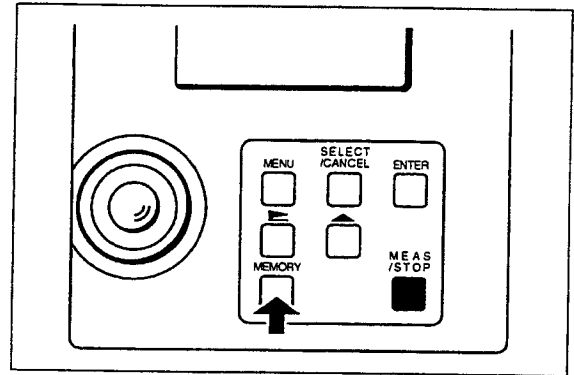
Switching the Measured Data to Another

4. Press the [▲] key.

    ◆ The color difference/relative luminance between the measured data (M2) and target data (T1) will be displayed.

```
▶ SAVE MEAS    M2(T1)
  Lv%     =    98.76%
  △x      =    -0.0123
  △y      =    +0.0123
```
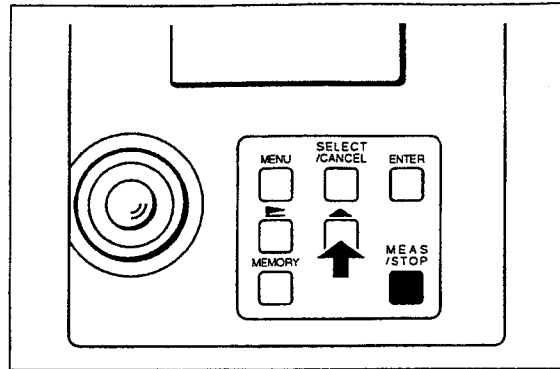
Switching the Target data to Another

5. Press the **SELECT/CANCEL** key.

    ◆ The memory screen will appear, and "SAVE TAR-GET" message appears.
    ◆ The target data (T1) will be displayed.
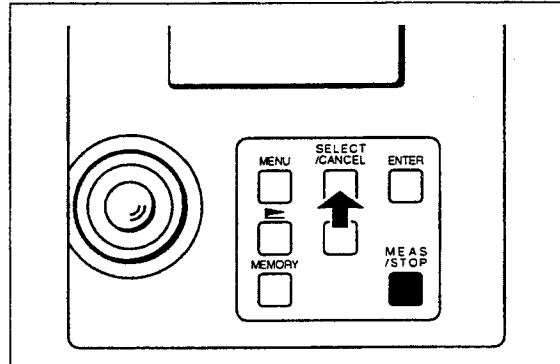
6. Press the [▲] key.

    ● The target data (T1) will switch to target data (T2).
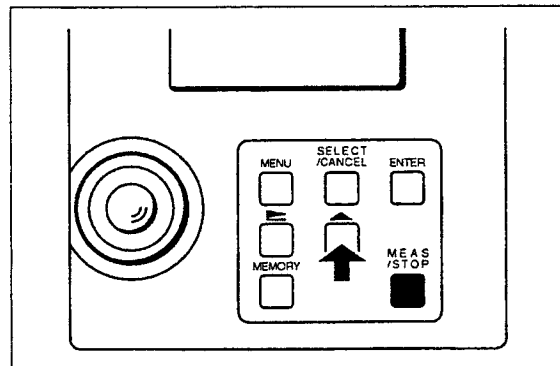
7. Press the **SELECT** key twice.

    ● The color difference/relative luminance between the measured data (M1) and target data (T2) will be displayed.
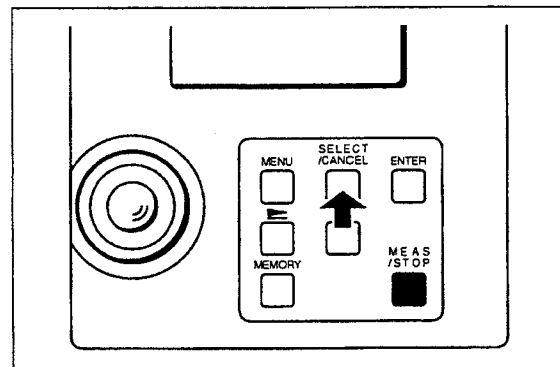
CONNECTING THE CS-1000 TO A PERSONAL COMPUTER

A 9-pin Dsub connector is provided on the CS-1000 so that the CS-1000 can be communicated with a personal computer.

Use a RS-232C cable to connect the CS-1000 to a personal computer.

* When connecting the connectors, make sure that they are correctly oriented.
* Do not touch the connector terminals with your hands or allow them to get dirty.
* Be sure that the cable has at least a small amount of slack. Stretching the cable tight may cause connection failure or wire breakage.

Pin Assignment of RS-232C Cable

CS-1000

Pin No.	Signal
1	DCD
2	RXD
3	TXD
4	DTR
5	SG
6	DSR
7	RTS
8	CTS
9	RT

Personal Computer

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

<Setting the Communication Parameters>
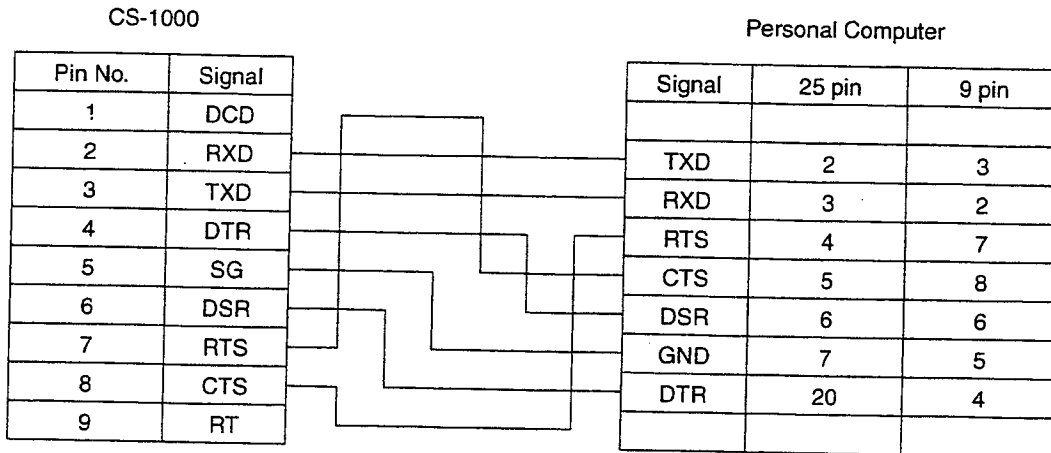
Set each communication parameter as described below.

X parameter	: Not valid
Data bit	: 8 bits
Stop bit	: 1 bit
Parity check	: None
Baud rate	: 4800, 9600, 19200 (must be the same as the baud rate set on the CS-1000)

1. Set the POWER switch of both CS-1000 and personal computer to OFF.

2. Connect the RS-232C cable to the RS-232C terminal provided on the CS-1000.
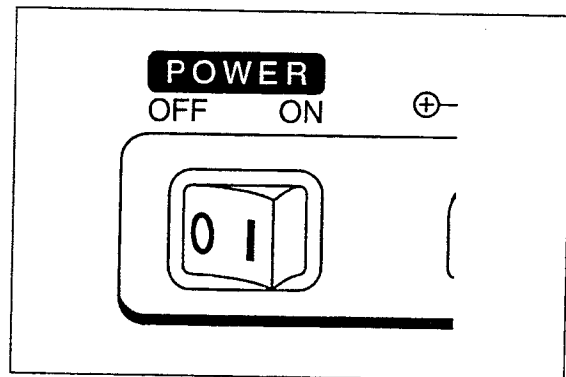
3. Set the POWER switch of the CS-1000 to ON.

4. Set the baud rate of the CS-1000. (See page 19.)

5. Set the POWER switch of the personal computer to ON.

● "Remote on" message will appear on the LCD of the CS-1000 while the CS-1000 is controlled by the personal computer via the RS-232C interface. While this message is displayed, it is not possible to operate any keys on the CS-1000. If you need to operate keys because the baud rate needs to be changed or for other reasons, press the MEAS./STOP key to cancel remote mode.
Resuming operation of the CS-1000 through the personal computer will put the CS-1000 in remote mode again, causing "Remote on" message to appear on the LCD once again.
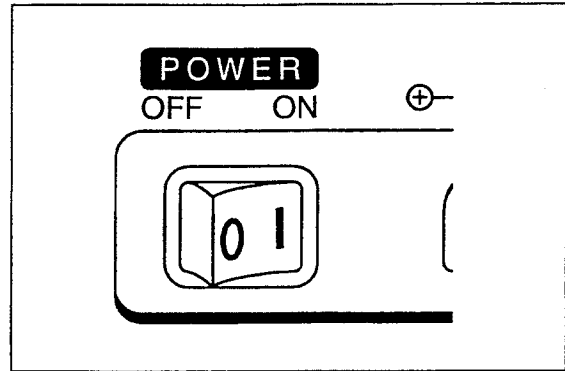
COMMAND LIST

Command	Function
RMT	Turns remote mode on/off
MES	Starts and stops measurement.
MMS	Switches measurement mode from one to another. Requires the user to set the frequency if INT.SYNC measurement mode is selected, or the integration time if MAN. measurement mode is selected.
STR	Reads the status information of the CS-1000.
BDR	Reads the measured data.
MDR	Reads the specified saved measured data.
TDR	Reads the specified saved target data.
MDD	Deletes the specified saved measured data.
TDD	Deletes the specified saved target data.
TDS	Trausfers and saves the specified target data to the memory of the CS-1000.

DELIMITER CODE

When inputting a command from the personal computer, a delimiter code must be input after the command. However, when inputting a command (e.g., TDS) which is to be accompanied by data, be sure to input a delimiter code after all the data has been input.

1. CR (Carriage Return)
2. LF (Line Feed)
3. CR LF (CR and LF)

The CS-1000 recognizes any of the above codes as a delimiter code (by using the automatic delimiter code detection function).

The same delimiter code as for the input command will be used for the output data.

INPUT/OUTPUT FORMAT

"#" and values appearing in descriptions of commands must be input in text format.

ERROR CHECK CODES

OK CODE

Code	Description	Corrective Action
OK	Processed successfully	

Error Code

Code	Description	Corrective Action
ER00	An invalid command name was input.	Input the correct command name.
	An invalid command was input.	Input the correct command.
	The command was altered.	Check the communication parameters.
ER01	Invalid command parameter was set.	Set the correct command parameter.
ER02	The command was not accepted since measurement was in progress.	Input the command after the output data is received following completion of measurement.
ER03	Overrun error or framing error has occurred.	Check the communication parameters.
ER10	The measured spectral value was outside the measuring range.	For MAN measurement mode, decrease the integration time so that no UNDER error appears. If the integration time is already set to 40 ms or this error occurs in AUTO measurement mode, decrease the luminance of the object.
	For MAN measurement mode, a value 1.2 times the integration time set in AUTO measurement mode or higher was set for a light source whose luminance was within the measuring range.	
	It was not possible to set static integration time for AUTO measurement mode due to extreme fluctuation of luminance of the object.	Stabilize luminance of the object, or switch to MAN mode and set longer integration time within the range in which no UNDER error occurs. To measure a display, switch to INT.SYNC or EXT.SYNC mode.
ER11	No external vertical sync. signal was input in EXT.SYNC measurement mode.	Input a vertical sync. signal having an appropriate frequency to the BNC terminal of the CS-1000.
	The frequency of external vertical sync. signal was outside the allowable range (20 to 250 Hz).	
ER12	No objective lens was attached.	Attach the objective lens supplied with the CS-1000.
	An objective lens other than the one supplied with the CS-1000 was attached.	
ER20	Attempted to read data, but no data was present.	
ER21	No spectral radiant luminance data was present, since the target data saved in the selected memory no. was manually entered data.	
	Attempted to read the other observer of target data which was not manually entered.	Set the right observer's target data which was not manually entered.
ER30 - ER34	Electric circuit was not operating properly.	Set the POWER switch to OFF, then set it to ON. If the same error still occurs, contact the nearest Minolta authorized service facility.

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INPUT/OUTPUT FORMAT OF EACH COMMAND

When a command is transmitted according to the specified input format, the CS-1000 will perform the specific functions of that command, and reply according to the specified output format.

<RMT>

Turns remote mode on/off
To control the CS-1000 through the personal computer, remote mode must be turned on. Once remote mode is activated, other commands can be sent to the CS-1000.
This command is also used to turn off remote mode to isolate control of the CS-1000 from the personal computer.

Input Format

The command must be specified in the following format.

RMT,　　＊　　| Delimiter code |
　　　　　　 |　　　 | (see page 39) |
　　　　　　 ①

① Remote mode ON/OFF ----- Remote mode OFF: "0"
　　　　　　　　　　　　　　 Remote mode ON: "1"

Output Format

The data is output in the following format. No data will be output if remote mode is off.

In case of no error

OK　　　　　| Delimiter code |
　　　　　　 | (see page 39) |

In case of error

| Error check code | 　　| Delimiter code |
| (see page 40) | 　　| (see page 39) |

<MES>

Starts and stops measurement.

This command is used to perform measurement under the measurement conditions set on the CS-1000. It is also used to stop measurement. If measurement is stopped, the previously measured data will also be lost.

Input Format

The command must be specified in the following format.

MES,   *   Delimiter code (see page 39)

      ①

① Measurement start/stop ----- Stop: "0"
                                   Start: "1"

Output Format

The data is output in the following formats.

In case of no error

The data can be output in the following two formats. Output data 1 returns the integration time and output data 2 indicates that measurement has been completed.

OUTPUT DATA 1

OK,   *   Delimiter code (see page 39)

      ①

① Integration time --------------- (in units of seconds): ##.###

OUTPUT DATA 2

OK   Delimiter code (see page 39)

In case of no error, the command, data 1 and data 2 are transferred between the CS-1000 and personal computer as shown below.

(Personal computer)		(CS-1000)
Input command	⟶	
	⟵	Output data 1
	⟵	Output data 2
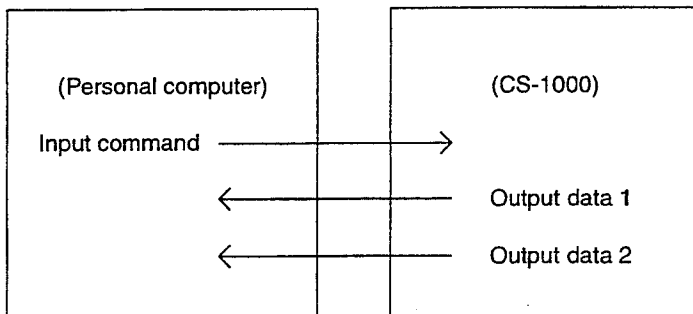
In case of output data 1 is error

OUTPUT DATA 1

Error check code (see page 40)		Delimiter code (see page 39)

In case of measurement error 1, the command is transferred from the personal computer to the CS-1000, but no data is output from the CS-1000.
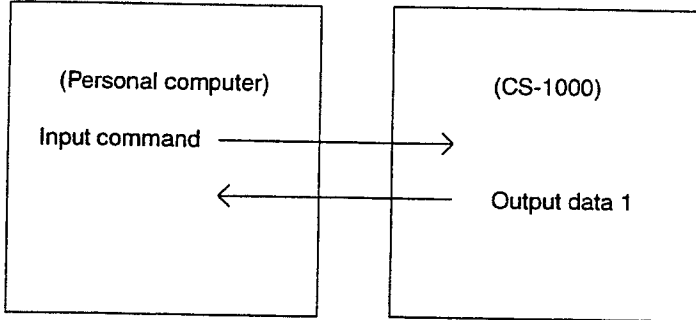
In case of output data 2 is error

OUTPUT DATA 1

MES,　　　＊　　| Delimiter code (see page 39) |
　　　　　　　　|
　　　　　　　　①
① Integration time ---------------- (in units of seconds): ##.###

OUTPUT DATA 2

Error check code (see page 40)		Delimiter code (see page 39)

In case of output data 2 is error, the command, data 1 and data 2 are transferred between the CS-1000 and personal computer as shown below.

<MMS>
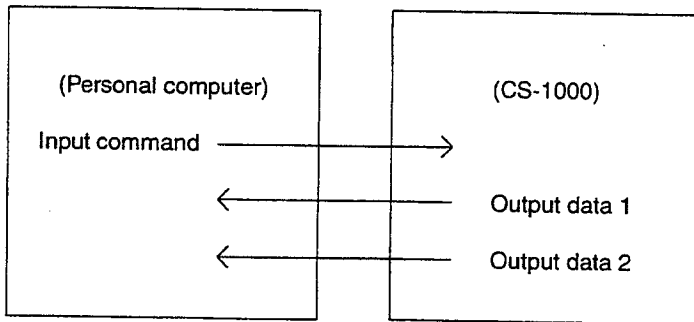
Switches measurement mode of the CS-1000 from one to another. It is necessary to set the frequency if INT.SYNC measurement mode is selected, or the integration time if MAN. measurement mode is selected.

Input Format

The command must be specified in the following format.

```
MMS,        *        *        ┌─────────────────┐
            |        |        │ Delimiter code  │
            ①        ②        │ (see page 39)   │
                             └─────────────────┘
```

① Measurement mode
   AUTO : "0"
   INT. : "1"
   EXT. : "2"
   MAN. : "3"

② Frequency or integration time --- AUTO : Not necessary to set.
                                                    INT. : Frequency (in units of Hz)
   ● Setting range: 20.00 to 250.00 Hz
   ● Up to 6 digits including the decimal point
   ● Third place below the decimal point is rounded off.
             EXT. : Not necessary to set.
          MAN. : Integration time (in units of seconds)
   ● Setting range: 0.040 to 60.000 seconds
   ● Up to 6 digits including the decimal point
   ● Fourth place below the decimal point is rounded off.

Output Format

The data is output in the following format.

In case of no error

```
OK      .   ┌─────────────────┐
            │ Delimiter code  │
            │ (see page 39)   │
            └─────────────────┘
```

In case of error

```
┌─────────────────┐    ┌─────────────────┐
│ Error check code │    │ Delimiter code  │
│ (see page 40)   │    │ (see page 39)   │
└─────────────────┘    └─────────────────┘
```

\<STR\>

Reads the status of the CS-1000.

Input Format

The command must be specified in the following format.

STR | Delimiter code (see page 39)

Output Format

The data is output in the following format.

In case of no error

OK, *, *, *, *, *, *, *, | Delimiter code (see page 39)

① ② ③ ④ ⑤ ⑥ ⑦

① Measurement mode ···································· AUTO : "0"
INT. : "1"
EXT. : "2"
MAN. : "3"

② Frequency ···································· (INT. measurement mode only)
◆ ###.##
◆ In units of Hz

③ Integration time ···································· (MAN. measurement mode only)
◆ ##.###
◆ In units of seconds

④ Display mode ···································· Lvxy : "0"
Lvu'v' : "1"
LvT△uv : "2"

⑤ Absolute value/color difference display ···················· ABS. : "0"
DIFF : "1"

⑥ Observer angle ···································· 2° : "0"
10° : "1"

⑦ Lens type ···································· Standard : "0"
Macro : "1"
Lens error : "2"

In case of error

Error check code (see page 40)   Delimiter code (see page 39)

<BDR>

Reads the measured data from the CS-1000.

Input Format

The command must be specified in the following format.

Input command 1

BDR, ∗, ∗, ∗,   Delimiter code (see page 39)

      ① ② ③

① Data display ·· Spectral radiance : "0"

                                                        Colorimetric data : "1"

② Observer angle ·· 2° : "0"

                                                        10° : "1"

③ Readout format ·· Text : "0"

                                                        Binary : "1"

Input command 2

Used to request output of the next data.

    &   Delimiter code (see page 39)

Output Format (for spectral radiance data in binary format)

Spectral radiant luminance data is output in the following format if it is binary data.

OUTPUT DATA 1

In case of no error

OK, *, *, *, *, 　| Delimiter code |
　　①　②　③　④　　| (see page 39) |

① Measurement mode ·· AUTO : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　INT. : "1"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　EXT. : "2"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　MAN. : "3"
② Integration time (MAN. measurement mode) ············· ##.### (in units of seconds)
③ Lens type ··· Standard : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　Macro : "1"
④ Under flag ··· Sufficient exposure : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　Insufficient exposure : "1"

In case of error

| Error check code |　　| Delimiter code |
| (see page 40) |　　| (see page 39) |

OUTPUT DATA 2 TO 8

Data 2 to 8 will not be output if an error code is output by data 1.

Output data 2	b380 b381 b382 •••••••••••••••••••••• b439	60 wavelength (240 bytes)
Output data 3	b440 b441 b442 •••••••••••••••••••••• b499	60 wavelength (240 bytes)
	⋮	
Output data 7	b680 b681 b682 •••••••••••••••••••••• b739	60 wavelength (240 bytes)
Output data 8	b740 b741 b742 •••••••••••••••••••••• b780	41 wavelength (164 bytes)

b✳✳✳ ···· 4-byte floating point data (IEEE format) indicating spectral radiance data of the wavelength

In case of no error, commands and data are transferred between the CS-1000 and personal computer as shown below.

```
┌─────────────────────────┐   ┌─────────────────────────┐
│                         │   │                         │
│   (Personal computer)   │   │      (CS-1000)          │
│                         │   │                         │
│  Input command 1 ───────┼───┼──→                      │
│                  ←──────┼───┼─── Output data 1        │
│  Input command 2 ───────┼───┼──→                      │
│                  ←──────┼───┼─── Output data 2        │
│  Input command 3 ───────┼───┼──→                      │
│                  ←──────┼───┼─── Output data 3        │
│            ⋮            │   │            ⋮            │
│                         │   │                         │
└─────────────────────────┘   └─────────────────────────┘
```

Output Format (for spectral radiance data in text format)

Spectral radiant luminance data is output in the following format if it is text data.

OUTPUT DATA 1

In case of no error

OK, *, *, *, *, [Delimiter code (see page 39)]
    ① ② ③ ④

① Measurement mode ··· AUTO : "0"
    INT. : "1"
    EXT. : "2"
    MAN. : "3"
② Integration time ·· ##.### (in units of seconds)
③ Lens type ··· Standard : "0"
    Macro : "1"
④ Under flag ·· Sufficient exposure : "0"
    Insufficient exposure : "1"

In case of error

[Error check code (see page 40)]   [Delimiter code (see page 39)]

OUTPUT DATA 2 TO 16

Data 2 to 16 will not be output if an error code is output by data 1.

Output data 2   t308   t381   t382 •••••••• t407 [Delimiter code (see page 39)] 28 wavelength (251 bytes + Delimiter code)

Output data 3   t408   t409   t410 •••••••• t435 [Delimiter code (see page 39)] 28 wavelength (251 bytes + Delimiter code)

⋮

Output data 15 t744   t745   t746 •••••••• t771 [Delimiter code (see page 39)] 28 wavelength (251 bytes + Delimiter code)

Output data 16 t772   t773   t774 •••••••• t780 [Delimiter code (see page 39)] 9 wavelength (80 bytes + Delimiter code)

t✳✳✳ ····· Text data ("#.###e+/-#") indicating spectral radiance data of the wavelength

In case of no error, commands and data are transferred between the CS-1000 and personal computer as shown below.

(Personal computer)	(CS-1000)
Input command 1 ⟶	
⟵	Output data 1
Input command 2 ⟶	
⟵	Output data 2
Input command 3 ⟶	
⟵	Output data 3
⋮	⋮

Output Format (for colorimetric data in text format)

OUTPUT DATA 1

In case of no error

OK, *, *, *, *, | Delimiter code (see page 39) |
     ① ② ③ ④

① Measurement mode ·· Spectral radiance : "0"
                                                                  Colorimetric data : "1"
② Integration time ··· ##.### (in units of seconds)
③ Lens type ·· Standard : "0"
                                                         Macro : "1"
④ Under flag ·· Sufficient exposure : "0"
                                                         Insufficient exposure : "1"

In case of error

| Error check code (see page 40) | | Delimiter code (see page 39) |

OUTPUT DATA 2

Data 2 will not be output if an error code is output by data 1.

Le, Lv, X, Y, Z, x, y, u', v', T, △uv | Delimiter code (see page 39) |
 ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫ ⑬ ⑭ ⑮

⑤ Le	·······	#.###e±#
⑥ Lv	·······	######.##
⑦ X	·······	#.###e±#
⑧ Y	·······	#.###e±#
⑨ Z	·······	#.###e±#
⑩ x	·······	0.####
⑪ y	·······	0.####
⑫ u'	·······	0.####
⑬ v'	·······	0.####
⑭ T	·······	#####
⑮ △uv	·······	±0.####

In case of no error, commands and data are transferred between the CS-1000 and personal computer as shown below.

(Personal computer)	(CS-1000)
Input command 1 ⟶	
Input command 2 ⟵	Output data 1
⟶	
⟵	Output data 2

\<MDR\>
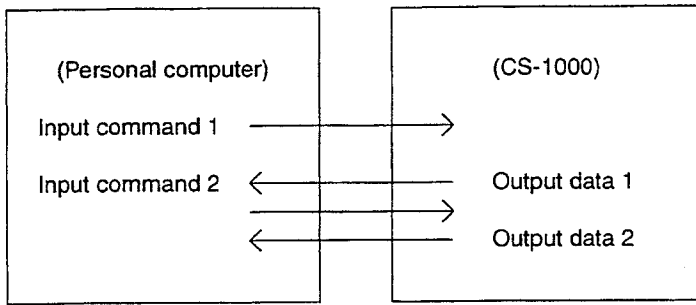
Reads the specified measured data saved on the CS-1000.

Input Format

The command must be specified in the following format.

INPUT COMMAND 1

MDR, *, *, *, *, | Delimiter code (see page 39) |
        ①   ②   ③   ④

① Data display ··· Spectral radiance : "0"
                               Colorimetric data : "1"
② Observer angle ·· 2° : "0"
                               10° : "1"
③ Readout format ·· Text : "0"
                               Binary : "1"
④ Measured data memory no. ······························· Integer (1 or 2 digits) : ##
                               ● Setting range : 1 to 30

INPUT COMMAND 2

Used to request output of the next data.

    & | Delimiter code (see page 39) |

Output Format (for spectral radiant luminance data in binary format)

Spectral radiance data is output in the following format if it is binary data.

OUTPUT DATA 1

In case of no error

OK, *, *, *, *, | Delimiter code (see page 39) |
     ①   ②   ③   ④

① Measurement mode ··· AUTO : "0"
                               INT. : "1"
                               EXT. : "2"
                               MAN. : "3"
② Integration time ·· ##.### (in units of seconds)
③ Lens type ·· Standard : "0"
                               Macro : "1"
④ Under flag ·· Sufficient exposure : "0"
                               Insufficient exposure : "1"

In case of error

Error check code (see page 40)	Delimiter code (see page 39)

OUTPUT DATA 2 TO 8

If an error code occurs during output of data, that data and subsequent data will not be output.

Output data 2   b380 b381 b382 • b439   60 wavelength (240 bytes)

Output data 3   b440 b441 b442 • b499   60 wavelength (240 bytes)

Output data 7   b680 b681 b682 • b739   60 wavelength (240 bytes)

Output data 8   b740 b741 b742 • b789   41 wavelength (164 bytes)

b✳✳✳ ···· 4-byte floating point data (IEEE format) indicating spectral radiance data of the wavelength

In case of no error, commands and data are transferred between the CS-1000 and personal computer as shown below.

Output Format (for spectral radiance data in text format)

Spectral radiance data is output in the following format if it is text data.

OUTPUT DATA 1

In case of no error

OK, *, *, *, *, | Delimiter code (see page 39) |
　　① ② ③ ④

① Measurement mode ·· AUTO : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　 INT. : "1"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　 EXT. : "2"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　 MAN. : "3"
② Integration time ·· ##.### (in units of seconds)
③ Lens type ·· Standard : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　 Macro : "1"
④ Under flag ··· Sufficient exposure : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　 Insufficient exposure : "1"

In case of error

| Error check code (see page 40) | | Delimiter code (see page 39) |

OUTPUT DATA 2 TO 16

If an error code occurs during output of data, that data and subsequent data will not be output.

Output data 2 　 t380　t381　t382 •••••••• t407 | Delimiter code (see page 39) | 28 wavelength (251 bytes + Delimiter code)

Output data 3 　 t408　t409　t410 •••••••• t435 | Delimiter code (see page 39) | 28 wavelength (251 bytes + Delimiter code)

Output data 15 　t744　t745　t746 •••••••• t771 | Delimiter code (see page 39) | 28 wavelength (251 bytes + Delimiter code)

Output data 16 　t772　t773　t774 •••••••• t780 | Delimiter code (see page 39) | 9 wavelength　(80 bytes + Delimiter code)

t✳✳ ····· Text data ("#.###e+/-#") indicating spectral radiance data of the wavelength

In case of no error, commands and data are transferred between the CS-1000 and personal computer as shown below.

```
┌─────────────────────────┐        ┌─────────────────────────┐
│                         │        │                         │
│  (Personal computer)    │        │  (CS-1000)              │
│                         │        │                         │
│  Input command 1  ──────┼────────┼──>                      │
│                   <─────┼────────┼────  Output data 1      │
│  Input command 2  ──────┼────────┼──>                      │
│                   <─────┼────────┼────  Output data 2      │
│  Input command 3  ──────┼────────┼──>                      │
│                   <─────┼────────┼────  Output data 3      │
│         ⋮               │        │         ⋮               │
│                         │        │                         │
└─────────────────────────┘        └─────────────────────────┘
```

Output Format (for colorimetric data in text format)

OUTPUT DATA 1

In case of no error

```
OK,  *,   *,   *,   *,    ┌─────────────────┐
      │    │    │    │     │ Delimiter code  │
      ①    ②    ③    ④     │ (see page 39)   │
                           └─────────────────┘
```

① Measurement mode ·· Spectral radiance luminance : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　Colorimetric data : "1"
② Integration time ·· ##.### (in units of seconds)
③ Lens type ··· Standard : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　Macro : "1"
④ Under flag ··· Sufficient exposure : "0"
　　Insufficient exposure: "1"

In case of error

```
┌──────────────────┐        ┌─────────────────┐
│ Error check code │        │ Delimiter code  │
│  (see page 40)   │        │  (see page 39)  │
└──────────────────┘        └─────────────────┘
```

## OUTPUT DATA 2

Data 2 will not be output if an error code is output by data 1.

```
Le,  Lv,   X,   Y,   Z,   x,   y,   u',  v',   T,  △uv    ┌─────────────────┐
 │    │    │    │    │    │    │    │    │    │    │       │ Delimiter code  │
 ⑤    ⑥    ⑦    ⑧    ⑨    ⑩    ⑪    ⑫    ⑬    ⑭    ⑮       │  (see page 39)  │
                                                          └─────────────────┘
```

⑤ Le　　　·······　#.###e±#
⑥ Lv　　　·······　######.##
⑦ X　　　·······　#.###e±#
⑧ Y　　　·······　#.###e±#
⑨ Z　　　·······　#.###e±#
⑩ x　　　·······　0.####
⑪ y　　　·······　0.####
⑫ u'　　　·······　0.####
⑬ v'　　　·······　0.####
⑭ T　　　·······　#####
⑮ △uv　　·······　±0.####

In case of no error, commands and data are transferred between the CS-1000 and personal computer as shown below.

(Personal computer)	(CS-1000)
Input command 1 ───────⟶	
Input command 2 ⟵───────	Output data 1
───────⟶	
⟵───────	Output data 2

\<TDR\>

Input Format

The command must be specified in the following format.

TDR,   *,   *,   *,   *, | Delimiter code (see page 39) |
         ①   ②   ③   ④

① Data display .... Spectral radiance : "0"
                                              Colorimetric data : "1"

② Observer angle .... 2° : "0"
                                              10° : "1"

③ Readout format .... Text : "0"
                                              Binary : "1"

④ Target data memory no. .... Integer (2 digits) : ##
                                              ● Setting range : 1 to 30

INPUT COMMAND 2

The command must be specified in the following format.

   & | Delimiter code (see page 39) |

Output Format (for spectral radiance data in binary format)

Spectral radiance data is output in the following format if it is binary data.

OUTPUT DATA 1

In case of no error

OK,   *,   *,   *,   *, | Delimiter code (see page 39) |
         ①   ②   ③   ④

① Measurement mode .... AUTO : "0"
                                              INT. : "1"
                                              EXT. : "2"
                                              MAN. : "3"

② Integration time .... ##.### (in units of seconds)

③ Lens type .... Standard : "0"
                                              Macro : "1"

④ Under flag .... Sufficient exposure : "0"
                                              Insufficient exposure : "1"

In case of error

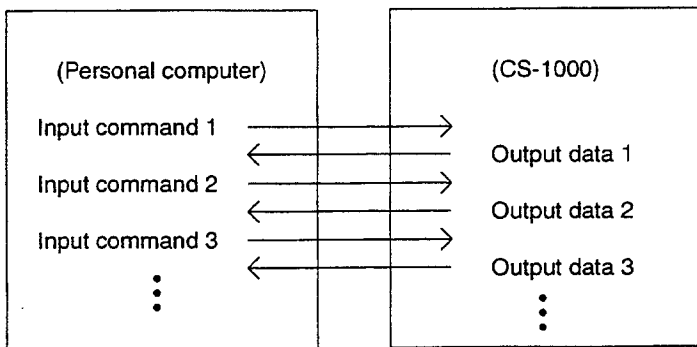| Error check code (see page 40) | | Delimiter code (see page 39) |

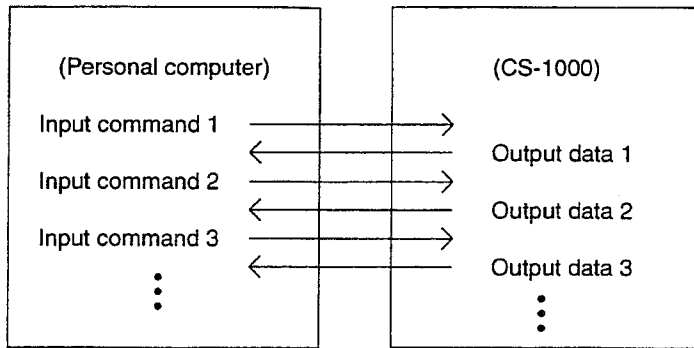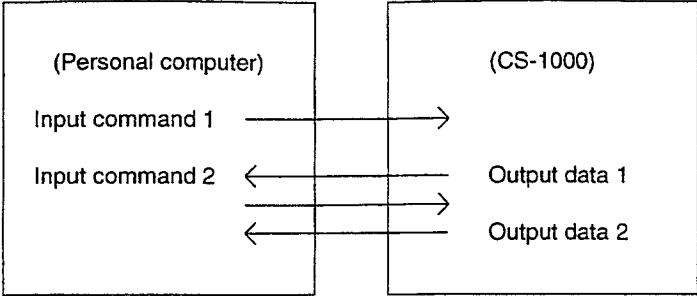## OUTPUT DATA 2 TO 8

If an error code occurs during output of data, that data and subsequent data will not be output.

Output data 2   b380 b381 b382 •••••••••••••••••••••• b439   60 wavelength (240 bytes)

Output data 3   b440 b441 b442 •••••••••••••••••••••• b499   60 wavelength (240 bytes)

Output data 7   b680 b681 b682 •••••••••••••••••••••• b739   60 wavelength (240 bytes)

Output data 8   b740 b741 b742 •••••••••••••••••••• b789   41 wavelength (164 bytes)

b∗∗∗ ···· 4-byte floating point data (IEEE format) indicating spectral radiance data of the wavelength

In case of no error, commands and data are transferred between the CS-1000 and personal computer as shown below.

```
┌─────────────────────────┐      ┌─────────────────────────┐
│                         │      │                         │
│  (Personal computer)    │      │  (CS-1000)              │
│                         │      │                         │
│  Input command 1   ─────┼──────┼──>                      │
│                    <────┼──────┼───   Output data 1      │
│  Input command 2   ─────┼──────┼──>                      │
│                    <────┼──────┼───   Output data 2      │
│  Input command 3   ─────┼──────┼──>                      │
│                    <────┼──────┼───   Output data 3      │
│         ┊               │      │          ┊              │
└─────────────────────────┘      └─────────────────────────┘
```

60

Output Format (for spectral radiance data in text format)

Spectral radiant luminance data is output in the following format if it is text data.

OUTPUT DATA 1

In case of no error

OK, *,   *,   *,   *, | Delimiter code (see page 39) |
     ①   ②   ③   ④

① Measurement mode ···································· AUTO : "0"
                                                        INT. : "1"
                                                        EXT. : "2"
                                                        MAN. : "3"
② Integration time ···································· ##.### (in units of seconds)
③ Lens type ···································· Standard : "0"
                                                        Macro : "1"
④ Under flag ···································· Sufficient exposure : "0"
                                                        Insufficient exposure : "1"

In case of error

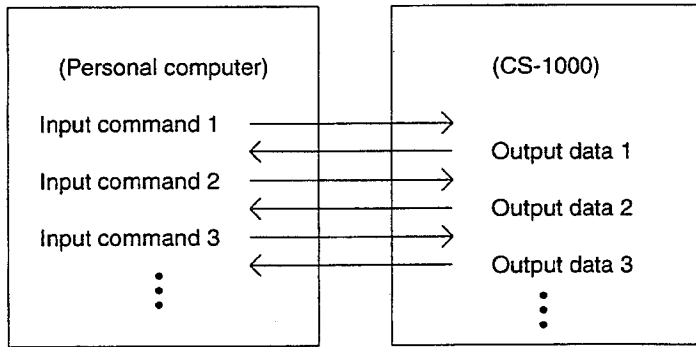| Error check code (see page 40) | | Delimiter code (see page 39) |

OUTPUT DATA 2 TO 16

If an error code occurs during output of data, that data and subsequent data will not be output.

Output data 2   t308   t381   t382 •••••••• t407 | Delimiter code (see page 39) | 28 wavelength (251 bytes + Delimiter code)

Output data 3   t408   t409   t410 •••••••• t435 | Delimiter code (see page 39) | 28 wavelength (251 bytes + Delimiter code)

⋮

Output data 15   t744   t745   t746 •••••••• t771 | Delimiter code (see page 39) | 28 wavelength (251 bytes + Delimiter code)

Output data 16   t772   t773   t774 •••••••• t780 | Delimiter code (see page 39) | 9 wavelength (80 bytes + Delimiter code)

t*** ·····Text data ("#.###e+/-#") indicating spectral radiance data of the wavelength

In case of no error, commands and data are transferred between the CS-1000 and personal computer as shown below.

(Personal computer)	(CS-1000)
Input command 1 ⟶	
⟵	Output data 1
Input command 2 ⟶	
⟵	Output data 2
Input command 3 ⟶	
⟵	Output data 3
⋮	⋮

Output Format (for colorimetric data in text format)

OUTPUT DATA 1

In case of no error

```
OK,  *,   *,   *,   *,   ┌─────────────┐
     |    |    |    |    │ Delimiter code│
     ①    ②    ③    ④    │ (see page 39) │
                          └─────────────┘
```

① Measurement mode ·· Spectral radiance : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　Colorimetric data : "1"
② Integration time ··· ##.### (in units of seconds)
③ Lens type ·· Standard : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　Macro : "1"
④ Under flag ··· Sufficient exposure : "0"
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　Insufficient exposure : "1"

In case of error

┌─────────────┐   ┌─────────────┐
│Error check code│   │ Delimiter code│
│ (see page 40) │   │ (see page 39) │
└─────────────┘   └─────────────┘

OUTPUT DATA 2

Data 2 will not be output if an error code is output by data 1.

```
Le,  Lv,   X,   Y,   Z,  ·x,   y,   u',   v',   T,   △uv    ┌─────────────┐
 |    |    |    |    |    |    |    |     |     |    |       │ Delimiter code│
 ⑤    ⑥    ⑦    ⑧    ⑨   ⑩    ⑪    ⑫     ⑬     ⑭    ⑮       │ (see page 39) │
                                                            └─────────────┘
```

⑤ Le	·······	#.###e±#
⑥ Lv	·······	######.##
⑦ X	·······	#.###e±#
⑧ Y	·······	#.###e±#
⑨ Z	·······	#.###e±#
⑩ x	·······	0.####
⑪ y	·······	0.####
⑫ u'	·······	0.####
⑬ v'	·······	0.####
⑭ T	·······	#####
⑮ △uv	·······	±0.####

In case of no error, commands and data are transferred between the CS-1000 and personal computer as shown below.

(Personal computer)		(CS-1000)
Input command 1	——————→	
Input command 2	←——————	Output data 1
	——————→	
	←——————	Output data 2

\<MDD\>

Deletes the specified measured data saved on the CS-1000.

Input Format

The command must be specified in the following format.

MDD,　　＊　　| Delimiter code (see page 39) |
　　　　　　|
　　　　　　①

① Measured data memory no. -- Integer (1 or 2 digits): ##
　　　　　　● Setting range: 1 to 30

Output Format

In case of no error

OK　| Delimiter code (see page 39) |

In case of error

| Error check code (see page 40) |　| Delimiter code (see page 39) |

\<TDD\>

Deletes the specified target data saved on the CS-1000.

Input Format

The command must be specified in the following format.

TDD,　　＊　　| Delimiter code (see page 39) |
　　　　　　|
　　　　　　①

① Target data memory no. ------- Integer (1 or 2 digits): ##
　　　　　　● Setting range: 1 to 20

Output Format

The data is output in the following format.

In case of no error

OK　| Delimiter code (see page 39) |

In case of error

| Error check code (see page 40) |　| Delimiter code (see page 39) |

\<TDS>

Transfers the specified target data from the personal computer to the CS-1000, where it is saved.

Input Format

The command must be specified in the following format.

TDS,   *,   *,   *,   *,   *,   * | Delimiter code (see page 39) |

      ①   ②   ③   ④   ⑤   ⑥

① Target data memory no. ································· Integer (1 or 2 digits): ##
- ● Setting range : 1 to 20

② Observer angle ··· 2° : "0"
                                                     10° : "1"

③ Colorimetric data ····································· xy: "0"
                                                     u'v': "1"

④ Luminance ·· cd/m²
- (e.g., "22.22")
- ◆ Up to 9 characters including decimal point
- ◆ Significant number of digits: 4 (fifth digit is rounded off)
- ◆ Third decimal place is rounded off.

⑤ Chromaticity ·· x or v'
- ◆ Up to 6 characters including decimal point
- ◆ Fifth decimal place is rounded off.

⑥ Chromaticity ·· y or v'
- ◆ Up to 6 characters including decimal point
- ◆ Fifth decimal place is rounded off.

Output Format

The data is output in the following format.
In case of no error

OK | Delimiter code (see page 39) |

In case of error

| Error check code (see page 40) | | Delimiter code (see page 39) |

MEASUREMENT PRINCIPLE

Light energy passes through the objective lens. The lights from the measurement area pass through the hole in the center of the aperture mirror to the optical fiber, while the remaining light is guided to the finder optics by the aperture mirror. As a result, the part equivalent to the measurement area looks like a black circle when observed through the finder. The light entering the optic fiber is reflected repeatedly so that it is mixed and becomes virtually uniform. It then passes through the collimator lens to the plane diffraction grating. After being dispersed by the grating, the light is focused by the condenser lens according to wavelength. An array sensor is located at this focus point.

The amount of detected energy for each wavelength is then converted to a digital value by a 16-bit A/D converter, based on which the spectral radiant luminance and chromaticity are calculated by the processing section of the CS-1000.

Sensor Section

The sensor section has a photo diode array consisting of 512 elements. The array is always kept at approximately 5 °C using a Peltier cooler, irrespective of the ambient temperature. This can reduce dark current and improve S/N ratio, thus enabling measurement of low luminance.
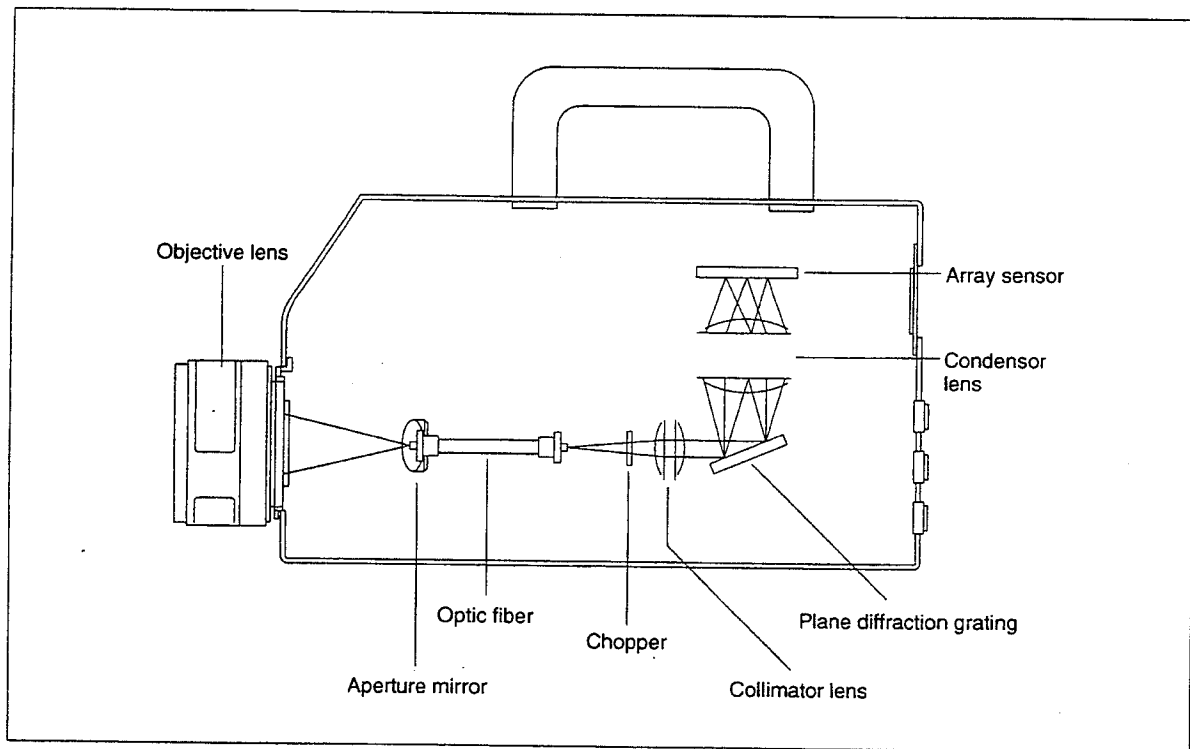
DARK MEASUREMENT

Each measurement consists of "light measurement" and "dark measurement".

"Light measurement" is performed with light from the object irradiating the sensor, while "dark measurement" is performed with no light from the object irradiating the sensor, so that detector dark current is measured.

When measurement starts, first "light measurement" is performed. When "light measurement" is complete, the shutter will close automatically, then "dark measurement" starts immediately.

"Dark measurement" is performed with the same integration time used for "light measurement". The final measured data is obtained by subtracting the measured data obtained in "dark measurement" from the one obtained in "light measurement". This method eliminates influences of dark current of the array sensor, resulting in improved measurement accuracy.

MEASURING COLOR OF THE OBJECT

Use of the CS-S1w software supplied with the CS-1000 enables simple measurement of the color of the object. For a detailed description of the operation, refer to the Software Instruction Manual. By selecting light source data stored in the software (CS-S1w) as the light source to be observed, the measured chromaticity can be evaluated against this light source.

- Place the white calibration plate and the object to be measured at the same angles in the same position. If the lighting and measuring conditions of the white calibration plate do not match those of the object, spectral data will fluctuate, resulting in incorrect measurement.
- The light source must be lit using constant-voltage power supply to ensure stable lighting during measurement.

Making Settings Necessary for Measurement of Object Color.

1. Have one or more light sources (e.g., tungsten-filament lamp), and set the white calibration plate in place as shown on the right.

   - The white calibration plate must be positioned at right angles to the CS-1000.
   - Each light source must be positioned at 45 degrees to the CS-1000.
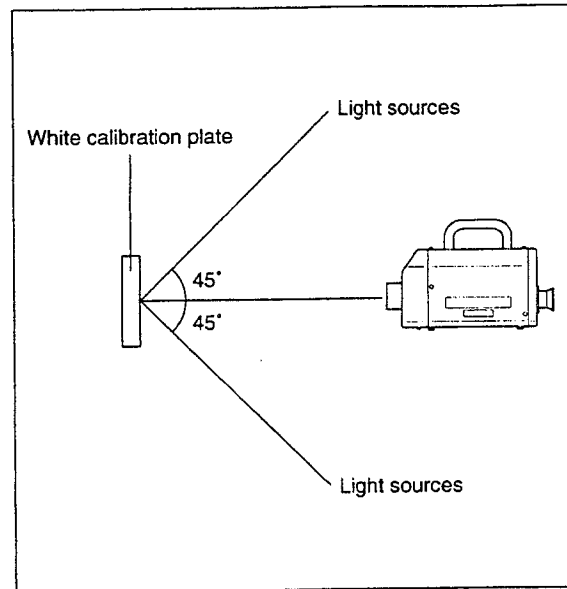
2. Start up the CS-1000, personal computer and software (CS-S1w).

Performing White Calibration

3. Select AUTO measurement mode. (See pages 13 to 14.)

4. From the CS-S1w, select "Object Color" for the color to be measured.

5. From the CS-S1w, Perform white calibration.

   ◆ For details, refer to the CS-1000 Software Instruction Manual.

Measuring the Spectral Reflectance of the Object

6. Place the object at the same angles in the same position as the white calibration plate.

7. From the CS-S1w, start measurement.

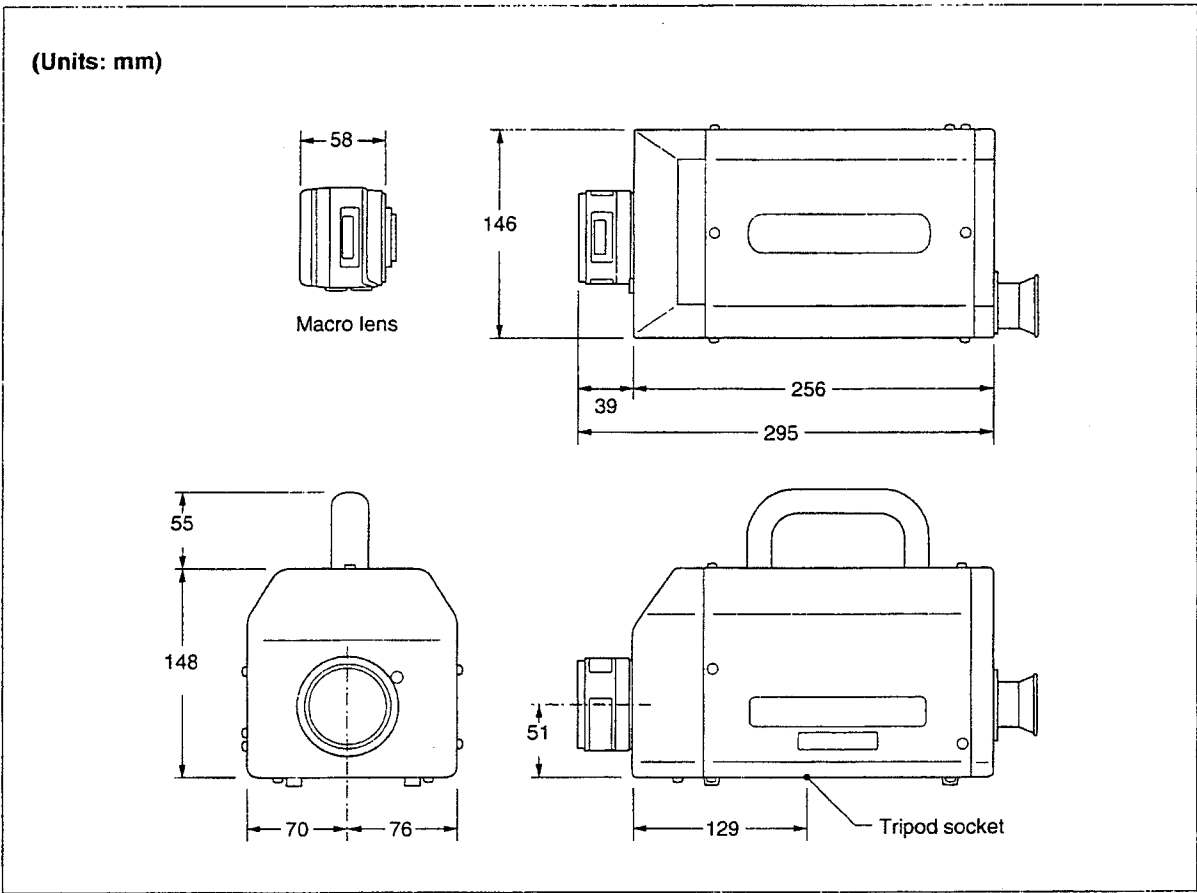   ◆ For details, refer to the CS-1000 Software Instruction Manual.

ERROR MESSAGES

Error Message	Cause	Action
OVER	The measured spectral value was beyond the sensor's saturation exposure level.	For MAN measurement mode, decrease the integration time so that no OVER error appears. If the integration time is already set to 40 ms or this error occurs in AUTO measurement mode, decrease the luminance of the object by placing a mesh filter in front of the objective lens.
	For MAN measurement mode, a value 1.3 times the integration time set in AUTO measurement mode or higher was set for a light source whose luminance was within the measuring range.	
	It was not possible to set an appropriate integration time for AUTO measurement mode due to extreme fluctuation of the object's luminance.	Stabilize luminance of the object, or switch to MAN mode and set longer integration time within the range in which no OVER error occurs. To measure a display, switch to INT.SYNC or EXT.SYNC mode.
UNDER	The peak value of measured spectral value was approximately one third of the sensor's saturation exposure level or lower.	For MAN measurement mode, increase the integration time so that no UNDER error appears. If the integration time is already set to 60 sec. or this error occurs in AUTO measurement mode, increase the luminance of the object.
	It was not possible to set an appropriate integration time for AUTO measurement mode due to extreme fluctuation of the object's luminance.	Stabilize luminance of the object, or switch to MAN mode and set longer integration time within the range in which no UNDER error occurs. To measure a display, switch to INT.SYNC or EXT.SYNC mode.
LENS ERROR	No objective lens was attached.	Attach the objective lens supplied with the CS-1000.
	An objective lens other than the one supplied with the CS-1000 was attached.	
SYNC ERROR	No external vertical sync. signal was input during EXT.SYNC measurement mode.	Input a vertical sync. signal having an appropriate frequency to the BNC terminal of the CS-1000.
	The frequency of external vertical sync. signal was outside the allowable range (20 to 250 Hz).	
NO TARGET	Color difference mode was selected without target data.	Input the target data.
DATA SET ERROR	The integration time was set below 0.040 seconds or above 60.001 seconds for MAN measurement mode.	Input an appropriate value.
	The frequency was set below 20.00 Hz or above 250.01 Hz for INT.SYNC measurement mode.	
	An attempt was made to save the manually input value not conforming to the setting conditions (see page 28) as target data.	
MEMORY ERROR	Measured data and target data saved in the memory and target data which was entered manually were destroyed.	Create the data from the beginning. If this error occurs frequently, contact the nearest Minolta authorized service facility.
ROM ERROR	The calibration data saved in the ROM was destroyed.	Set the POWER switch to OFF, then set it to ON again. If this error still occurs, contact the nearest Minolta authorized service facility.
HARDWARE ERROR	Electric circuit was not operating properly.	

TROUBLESHOOTING

Symptom	Check Points
LCD does not light up even if the POWER switch is set to ON.	Is the AC adapter connected to an AC outlet?
	Is the AC adapter connected to the CS-1000?
Nothing is observed when looking into the finder, since the field of vision is dark.	Has the protective cap been removed from the objective lens?
	Has the ND filter been removed from the finder?
"Remote on" message does not appear on the LCD or the CS-1000 cannot be controlled even if it is connected to a host computer via the RS-232C interface.	Is the RS-232C cable connected properly?
	Is the RS-232C cable of the cross type?
	Is the baud rate correct?
Measurement cannot be performed even if the MEAS/STOP key is pressed.	Measurement cannot be performed from the menu screen or memory screen, so it must be checked.
Measured values are inconsistent.	Has the CS-1000 been warmed up sufficiently? (If the power is turned off, the CS-1000 should be warmed up again for at least 15 minutes.)
	Is operation of the object stable?
	Does the ambient temperature fluctuate considerably?
	The integration time used for MAN measurement mode must not be far below the one set in AUTO measurement mode, so it must be checked.

DIMENSION DIAGRAM

(Units: mm)

Macro lens

256

39

295

146

58

55

148

70

76

51

129

Tripod socket

SPECIFICATIONS

Model Name	CS-1000		
Wavelength Range	380 to 780 nm		
Wavelength Resolution	0.9 nm/pixel		
Spectral Bandwidth	5 nm		
Spectral Method	Flat diffraction grating		
Photo Detector Element	512 linear image sensor elements (thermoelectrically cooled)		
Acceptance Angle	1 degree		
Minimum Measuring Area	7.9 mm (with standard lens)		
	1.15 mm (with macro lens)		
Minimum Measuring Distance	45 cm (with standard lens)		
	20 cm (with macro lens)		
Luminance Display Range (standard light source A)	0.01 to 80,000 cd/m2		
Accuracy:	Luminance: ±4% ±1 digit	Luminance range (standaard light source A)	3 to 8000 cd/m² (with standard lens)
	Chromaticity: x: ±0.0015, y: ±0.001		30 to 8000 cd/m² (with macro lens)
Spectral Accuracy	±0.3 nm (mean wavelength: 546.1 nm Hg lamp)		
Polarization Error	Less than 5% (400 nm to 780 nm)		
Integration Time	40 msec to 60 sec		
Display	Le, Lvxy, Lvu'v', LvTΔuv, ΔLvxy, ΔLvu'v' (Observer can be switched between 2° and 10°)		
Power	AC adapter (AC-A12)		
Interface	RS-232C		
Operating Temperature and Humidity Range	5 to 35°C, 80%RH or less (no condensation)		
Storage Temperature and Humidity Range	0 to 45°C, 80%RH or less (no condensation)		
Size and Weight	146 × 148 × 255 mm (5-3/4 × 5-13/16 × 10-1/16 in.), 4.7 kg (10.38lb.)		
Standard Accessories	Standard Lens, Macro Lens, Data Processing Software CS-S1w, RS-232C cable (2m, 9-pin for IBM PC), AC adapter (AC-A12), ND Eye-piece filter CS-A1, Hard Case CS-A2, Calibration Certificate		
Optional Accessories	Tripod CS-A3, Panhead CS-A4, White Calibration Plate CS-A5, User Calibration Software for CA-100		

● The above specifications are subject to change without notice.