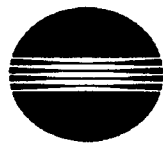# CHROMA METER
CR-300/CR-310/
CR-321/CR-331/CR-331C

INSTRUCTION MANUAL

MINOLTA

Minolta Chroma Meters CR-300, CR-310, CR-321, CR-331, and CR-331C are compact tristimulus color analyzers for measuring reflective colors of surfaces. Each Chroma Meter consists of the respective measuring head and the Data Processor DP-301. The measuring head of the Chroma Meter CR-300 has an 8mm-diameter measuring area and uses diffuse illumination and a 0° viewing angle (specular component included) for accurate measurements of a wide variety of subjects. The measuring head of the Chroma Meter CR-310 uses wide-area illumination and a 0° viewing angle (specular component included), and has a 50mm-diameter measuring area to average the reading over a wide area for measuring cloth or textured surfaces. Chroma Meter CR-321 has a 3mm diameter measuring area and uses 45° circumferential illumination and a 0° viewing angle for measuring precise areas of printed matter and other glossy surfaces. The measuring heads of the Chroma Meter CR-331 (bidirectional illumination) and CR-331C (circumferential illumination) use a 45° illumination angle and 0° viewing angle for measuring glossy surfaces; their 25mm-diameter measuring are asaverage the reading over a wide area to provide a more uniform response. All five Chroma Meters have the following characteristics.

A pulsed xenon arc lamp in a mixing chamber provides illumination on the sample surface. Six high-sensitivity silicon photocells, filtered to match the CIE (Commission Internationale de l'Eclairage) Standard Observer Response, are used by the meter's double-beam feedback system to measure both incident and reflected light. The meter thus detects any slight deviation in the light output by the pulsed xenon arc lamp, and compensates automatically.

Absolute measurements can be displayed as Yxy (CIE 1931), L*a*b* (CIE 1976), L*C*H°, Hunter Lab, or XYZ tristimulus values; color difference can be displayed as Δ(Yxy), Δ(L*a*b*)/ΔE^*_{ab}, Δ(L*C*H*)/ΔE^*_{ab}, or Hunter Δ(Lab)/ΔE values. Data can be converted between color systems or between absolute and difference measurements by the data processor, and each measurement can also be printed out in all color spaces if desired. Either CIE Illuminant C or D_{65} lighting conditions can be used for measurements. The Data Processor can based measurement calculations on all calibration standards stored in memory (up to 20 different calibration standards can be stored) to provide consistently high accuracy. For measuring color difference, up to 20 different target colors may also be stored.

Data Processor DP-301 offers several different functions for greater convenience and versatility. Up to 300 measurements may be stored in memory and memory can be divided into up to 20 pages; each measurement is automatically stored at the time of measurement as both an absolute measurement and a color-difference measurement. Data can be printed out at the time of measurement, in all color spaces, while it is displayed, or from memory at a later time. Statistical calculations can be performed on all data in memory or on only the data on a selected page of memory. Data can be output to a separate computer if desired, and the meter can be operated by remote control. The Data Processor also includes a timer for automatic measurements at user-selected intervals, plus an alarm to indicate when the color difference of a specimen is beyond preset limits.

The meter is powered by six AA-size batteries or by the included AC adapter. Data is kept in memory until cleared or changed by the user, even if the meter's batteries are removed or the AC adapter is disconnected.

Please read and study this manual before using the Minolta Chroma Meter CR-300, CR-310, CR-321, CR331, or CR-331C for the first time, and keep it handy for future reference.

WARNING

- DO NOT USE THIS INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE, SUCH AS ONE CONTAINING GASOLINE FUMES. USE IN SUCH AN AREA MAY RESULT IN AN EXPLOSION.
- DO NOT DISASSEMBLE THIS UNIT OR ATTEMPT TO REPAIR IT YOURSELF. THIS INSTRUMENT CONTAINS HIGH-VOLTAGE ELECTRICAL CIRCUITS AND THERE IS A RISK OF ELECTRICAL SHOCK IF THIS UNIT IS DISASSEMBLED BY UNQUALIFIED PERSONNEL.

  Any necessary repairs should be done only by a Minolta-authorized service facility.

Caution

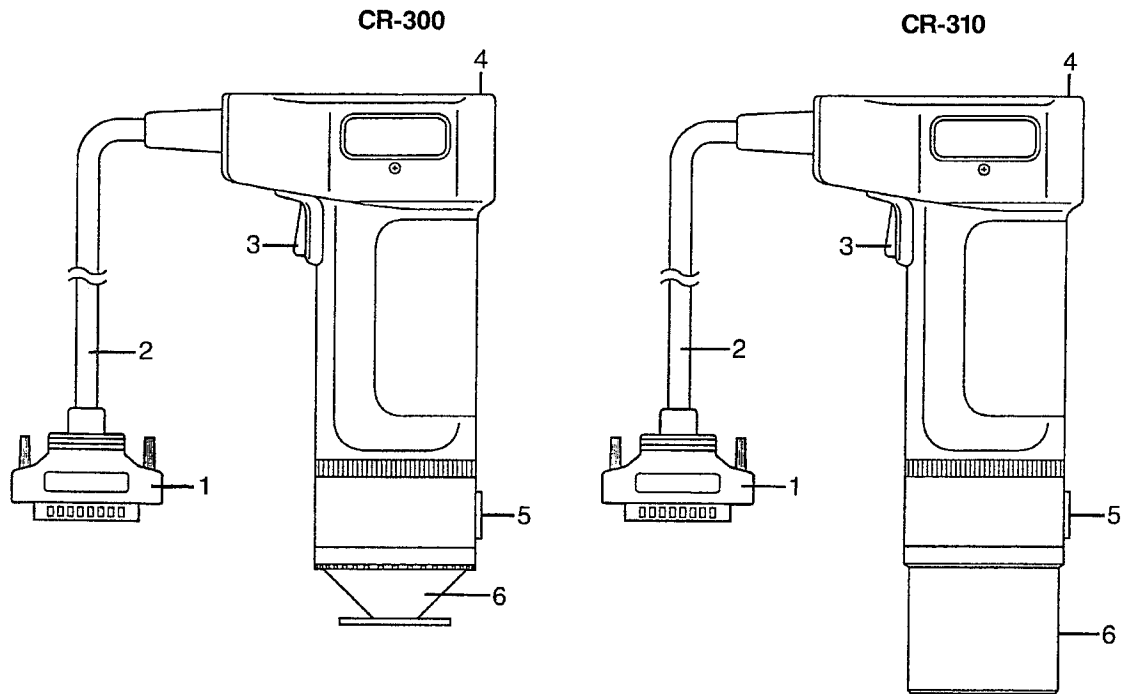To avoid damage to the instrument, please note the following points:

- Do not subject the meter to shock or vibration.
- Do not press on or damage the liquid crystal display window.
- Do not operate the meter in places subject to high humidity or temperatures higher than 40°C (104°F) (such as inside a closed motor vehicle), or lower than 0°C (32°F).
- Do not spill liquid on the meter; the meter is not waterproof. If a liquid is accidentally spilled on the meter, wipe the meter dry immediately with a dry cloth.
- When disconnecting the AC adapter from the meter, pull on the plug. Never pull on the cord, as doing so could damage the wires.
- When connecting a cord to or disconnecting a cord from the meter, be sure that the power switch of the meter (and of the instrument, if any, at the other end of the cord) is at OFF.
- Do not touch the connector pins or apply a strong force to the connector or connector pins.
- Do not operate this instrument in extremely humid areas or in extremely dusty areas.
- Do not leave the meter in places subject to high humidity or temperatures higher than 40°C (104°F) (such as inside a closed motor vehicle), or lower than −20°C (−4°F).

CONTENTS

NAMES OF PARTS

Measuring Heads

CR-300

CR-310

1. Cable connector
2. Cable
3. Measuring button
4. Ready lamp
5. Tripod socket
6. Light-projection tube

1. Cable connector
2. Cable
3. Measuring button
4. Ready lamp
5. Tripod socket
6. Light-projection tube

NOTE: If the measuring head is changed, perform system reset (p. 23) before any other operation.

This manual is for Chroma Meter CR-300, Chroma Meter CR-310, Chroma Meter CR-321, Chroma Meter CR-331, and Chroma Meter CR-331C. Chroma Meter CR-300 will be shown in most of the illustrations in this manual.

CR-321
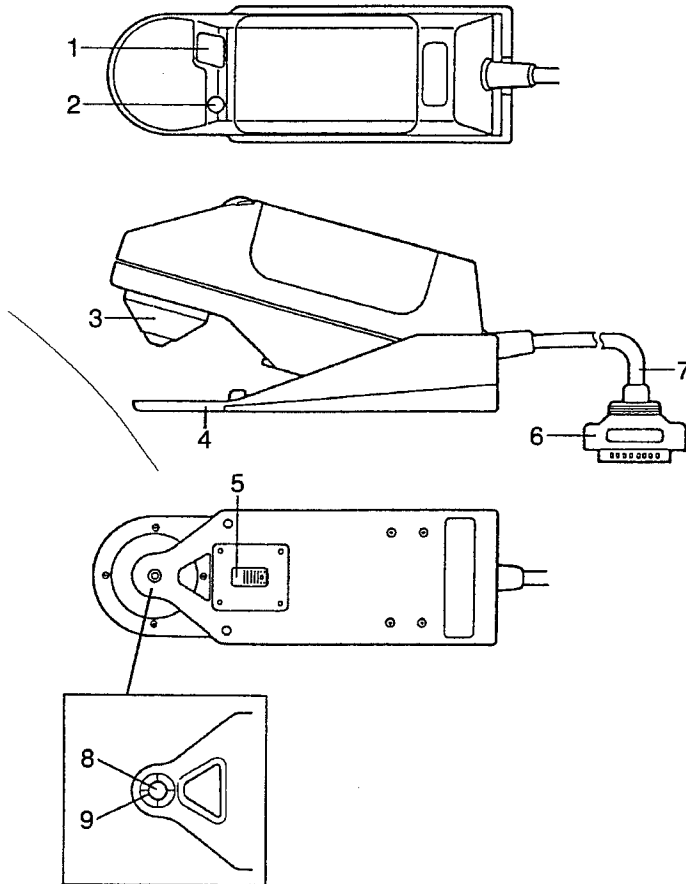
CR-331/CR-331C

1. Measuring button
2. Ready lamp
3. Light-projection tube
4. Baseplate
5. Baseplate lock
6. Cable connector
7. Cable
8. Measurement point
9. Target area
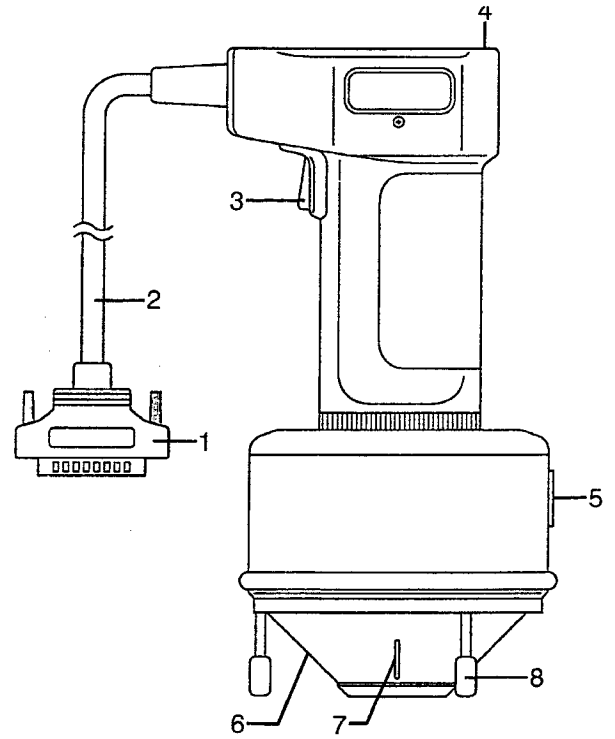
1. Cable connector
2. Cable
3. Measuring button
4. Ready lamp
5. Tripod socket
6. Light-projection tube
7. Optical-fiber-location mark*
8. Measuring-head supports

*CR-331 only

Data Processor DP-301
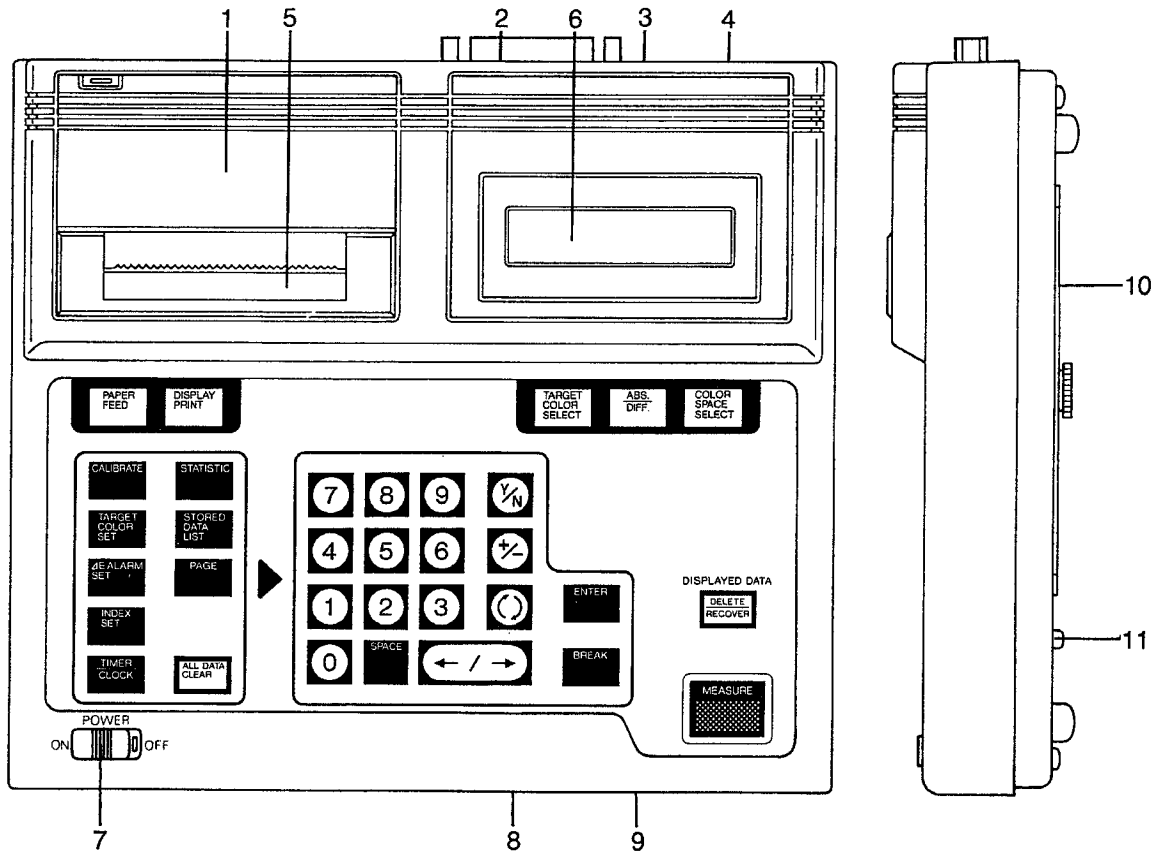
1. Paper chamber
2. Connector
3. Remote-control socket
4. AC-adapter socket
5. Printer
6. Display
7. POWER switch
8. ΔE ALARM output socket
9. RS-232C terminal
10. Battery-chamber cover
11. Viewing-angle adjustment lever

SYSTEM DIAGRAM

Adapter Cord MA-A10*
Adapter Cord MA-A11*

Thermal paper
DP-A21*

Pivoting Base CR-A12*

Glass Light-Projection Tube
CR-A33* (for CR-300)

Data Processor DP-301

Calibration Plate
CR-A43
(for CR-300)

Granular-Materials
Attachment CR-A50*

Glass Light-Projection Tube
CR-A33e* (for CR-310)

Calibration Plate
CR-A44
(for CR-310)

Calibration Plate
CR-A45
(for CR-321)

Color tiles

Case CR-A60 (for CR-300)
Case CR-A61 (for CR-331,CR-331C)
Case CR-A63 (for CR-321)
Case CR-A64 (for CR-310)

Shoulder Case CR-A62*

AC Adapter AC-A10 (AC-A10 worldwide except N. America ; AC-A10 N in N. America)

CR-300

CR-310

CR-321

CR-331

CR-331C

Calibration Plate
CR-A46
(for CR-331,CR-331C)

*Optional accessories

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SUMMARY OF OPERATION

Preparations

1. Insert cable connector of measuring head into the connector on the back of the Data Processor. Be sure that the connector is positioned correctly. Tighten the two screws of the connector until snug.
2. Install six AA-size batteries in the battery chamber in the bottom of the Data Processor. Be sure that the battery positions are correct.
3. Install a roll of thermal paper in the paper chamber of the Data Processor as follows:
   a. Slide POWER switch of Data Processor to ON.
   b. Remove cover of paper chamber and start paper leader into the slot at the bottom front of the paper chamber.
   c. Press and hold **PAPER FEED** until paper comes through printer.
   d. Replace cover of paper chamber.

Operation

INDEX SET: Displays menu of functions; use **Y/N** to change settings.

1. Press **INDEX SET.**
   "Print:" Y (automatic printing after each measurement)/N (no automatic printing)
   "Color Space:" N (printout only in color space in use)/Y (printout in all available color spaces)
2. Press ( ) (scroll key).
   "Data Protect:" N (after 300 measurements, further measurements will write over oldest measurement)/Y (measurement data not stored after 300 measurements have been taken)
   "Multi Measure:" N (one measurement taken when **MEASURE** or measuring button is pressed)/ Y (three measurements taken and averaged when **MEASURE** or measuring button is pressed; average used as measurement data)
3. Press ( ) (scroll key).
   "Multi Cal.:" N (measurement will be based on calibration channel selected by user)/Y (measurement will be based on all calibration channels in which calibration data has been stored)
   "ch00" (calibration channel; displayed only when the "Multi Cal." index set to "N"; select using number keys)
4. Press ( ) (scroll key).
   "Light Source:" C (CIE Illuminant C)/D$_{65}$ (CIE Illuminant D$_{65}$); select using ←/→ (cursor keys).
5. When all indexes have been set as desired, press **ENTER.**

CALIBRATE: Set white calibration data, then take measurement.

1. Press **CALIBRATE.**
2. Use the number keys to input the Y, x, and y values of the calibration data (shown on the inside cover of the included Calibration Plate) for the "Light Source" index setting (C or D$_{65}$) being used. If no value is given for a decimal place, skip that space using ←/→ (cursor keys).
3. After numbers have been input, place the measuring head on the white calibration plate and press **MEASURE** or the measuring head's measuring button. Three consecutive measurements will be taken; do not move measuring head until all three measurements have been completed. The calibration data which was input will be stored in memory.

TARGET COLOR SET: Set target color data by measurement or by inputting data.

1. Press **TARGET COLOR SET.**
2. Select target color number. Also set calibration channel if "Multi Cal." index is set to "N" or if target color data will be input using number keys.
3. Place measuring head on target specimen and press **MEASURE** or measuring head's measuring button. One measurement of the specimen will be taken and the data stored in memory.
          OR
   If the values of the target color data are known, use the number keys and ←/→ (cursor keys) to input the data directly. After inputting the data, press **ENTER.**

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TARGET COLOR SELECT: Selects target color to be used for color-difference measurements.

1. Press **TARGET COLOR SELECT.**

2. Use ←/→ (cursor keys) and number keys to select target color number.

COLOR SPACE SELECT: Selects the color space to be used for measurements; displayed measurement data is automatically converted to the new color space. Color space changes in the following order each time **COLOR SPACE SELECT** is pressed:

ABS. mode: Yxy→L*a*b*→L*C*H°→XYZ→Hunter Lab→Yxy...

DIFF. mode: Δ(Yxy)→Δ(L*a*b*)→Δ(L*C*H*)→Hunter Δ(Lab)→Δ(Yxy)...

• In Δ(L*a*b*) and Δ(L*C*H*) color spaces, ΔE^*_{ab} is also displayed; in Hunter Δ(Lab) color space, ΔE is also displayed.

ΔE ALARM SET: Set ΔE^*_{ab} limit value so meter will sound alarm and output signal when measured data vary from the target-color data by more than the ΔE^*_{ab} limit value.

1. Press **ΔE ALARM SET.**

2. Select the target color number for which the ΔE^*_{ab} alarm will be set.

3. Use ←/→ (cursor keys) to move the cursor under the "N" of "Alarm:N".

4. Press **Y/N** to change setting to "Alarm: Y".

5. Use ←/→ (cursor keys) to move the cursor under the (.) and use the number keys to set the ΔE^*_{ab} value (up to 99.99).

6. When setting has been completed, press **ENTER.**

TIMER/CLOCK: Timer can be used for automatic measurements at selected intervals; clock includes a calendar and 24-hour clock.

To use timer:

1. Press **TIMER/CLOCK.**

2. Press **Y/N** to set "t = Y".

3. Use ←/→ (cursor keys) to move the cursor under the first digit of "I = 00" and use number keys to set the interval time (up to 99); to change unit of time ("S" for seconds, "M" for minutes), use ←/→ (cursor keys) to move cursor under present time-unit setting and press ( ) (scroll key).

4. When setting has been completed, press **ENTER.**

5. Position measuring head on specimen and press **MEASURE** to start automatic measurements with interval timer. Press **BREAK** to stop automatic measurements.

To set calendar/clock:

1. Press **TIMER/CLOCK.**

2. Use ←/→ (cursor keys) to move cursor to bottom line of display.

3. Use number keys and ←/→ (cursor keys) to set correct month (M), day (D), and time (in 24-hour format).

4. When setting has been completed, press **ENTER.**

STATISTIC: Calculates the maximum, minimum, mean, and standard deviation of measurement data in memory.

1. Press **STATISTIC.**

2. Use ←/→ (cursor keys) and number keys to set the page number of data to be used for calculations; to use all data for calculations, use ←/→ (cursor keys) and **SPACE** to set page number to blanks.

3. Press **COLOR SPACE SELECT** repeatedly to select the desired color space.

4. Press **ABS./DIFF.** to select absolute or color-difference data for calculations.

5. Press **ENTER.**

STORED DATA LIST: Depending on the selected operation, recalls data from memory to the display, prints out data in memory, or outputs data in memory through the RS-232C terminal.

To recall data from memory to the display:

1. Press **STORED DATA LIST.**

2. Press ( ) (scroll key) repeatedly until "Display" is shown in the bottom line of the display.

3. Press **ABS./DIFF.** to select recall of absolute or color-difference data.

4. Use ←/→ (cursor keys) and number keys to set the page number from which data will be recalled; to recall data from all pages, use ←/→ (cursor keys) and **SPACE** to set page number to all blanks.

5. Press **ENTER.**

To print out data in memory:

1. Press **STORED DATA LIST.**

2. Press ( ) (scroll key) repeatedly until "Print Out" is shown in the bottom line of the display.

3. Press **ABS./DIFF.** to select printing of absolute or color-difference data.

4. Use ←/→ (cursor keys) and number keys to set the page number from which data will be printed; to print data from all pages, use ←/→ (cursor keys) and **SPACE** to set page number to all blanks.

5. Press **ENTER.**

To output data in memory:

1. Press **STORED DATA LIST.**

2. Press ( ) (scroll key) repeatedly until "Output" is shown in the bottom line of the display.

3. Press **ABS./DIFF.** to select output of absolute or color-difference data.

4. Use ←/→ (cursor keys) and number keys to set the page number from which data will be output; to output data from all pages, use ←/→ (cursor keys) and **SPACE** to set page number to all blanks.

5. Press **ENTER.**

PAGE: Closes present page and starts new page.

1. Press **PAGE.**

2. Press **ENTER** to complete page change; to cancel page change, press **BREAK.**

• It is not possible to return to a page and add data once that page has been closed.

ALL DATA CLEAR: Deletes from memory all measurement data, or all data, including calibration and target-color data.

To delete all measurement data:

1. Press **ALL DATA CLEAR.**

2. Press **ENTER.**

To delete all data, including calibration and target-color data:

1. Slide POWER switch to OFF.

2. Wait a few seconds.

3. Slide POWER switch to ON while holding **ALL DATA CLEAR** pressed.
Do not release **ALL DATA CLEAR** until tone sounds.

DISPLAYED DATA **DELETE/RECOVER:** Temporarily deletes displayed data from memory; recovers temporarily deleted data if pressed again.

For more detailed information on any of these operations, refer to the appropriate section in this manual.

FUNCTIONS OF KEYS AND SWITCHES
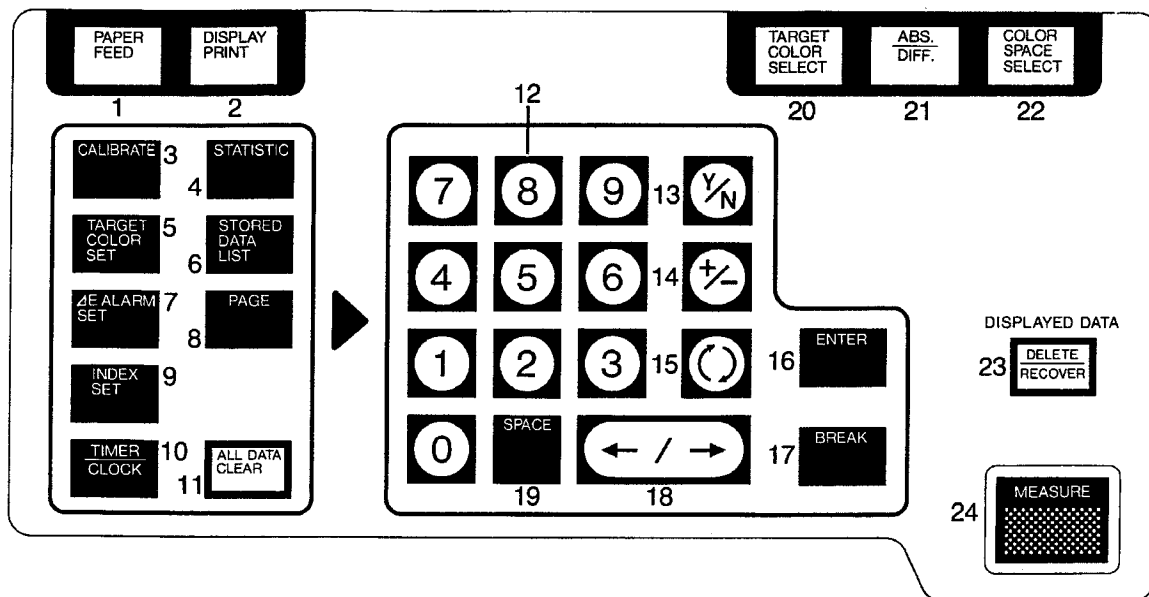
1. **PAPER FEED**

   Advances paper through printer.

2. **DISPLAY PRINT**

   Prints data or message shown in display.

3. **CALIBRATE**

   Enters calibration mode. Channel to be calibrated can be selected and calibration data can be checked or changed. Data set immediately after this key is pressed will be stored in the selected calibration channel when calibration surface is measured.

4. **STATISTIC**

   Prepares Data Processor for calculation, output, and printing of the maximum, minimum, mean, and standard deviation values of data in memory.

5. **TARGET COLOR SET**

   Enters mode for setting target color data. Target color number can be selected and the target color data can be input by measurement or by using number keys.

6. **STORED DATA LIST**

   Prepares Data Processor for recall, printing, or output of data stored in memory. After pressing this key, the desired function can be selected using ( ) (scroll key).

7. **ΔE ALARM SET**

   Displays settings of ΔE^*_{ab} alarm function. Settings can be checked or changed while displayed.

8. PAGE

Prepares Data Processor to close present page and start new page. Present page number, next page number, and remaining number of measurement spaces in memory are displayed if "Data Protect" index is set to "Y" and present page number is less than 19; present page number and next page number are displayed if "Data Protect" index is set to "N" (all data previously stored on next page will be deleted if page change is completed).

9. INDEX SET

Displays indexes. Settings can be checked or changed while displayed.

10 TIMER/CLOCK

Displays settings of timer function, calendar, and clock. Settings can be checked or changed while displayed.

11. ALL DATA CLEAR

Prepares Data Processor to delete all measurement data in memory.
Performs system reset if held pressed while sliding POWER switch from OFF to ON.

12. Number keys

Set numerical data directly from keyboard.

13. Y/N

Changes "Y" (yes) to "N" (no) or "N" to "Y" when changing index, timer, or ΔE^*_{ab} alarm functions.

14. + / −

Changes " + " to " − " or " − " to " + " when setting calibration data in L*a*b* color space and target-color data in L*a*b* or Hunter Lab color space.

15. ( ) (scroll key)

Advances display through indexes when indexes are displayed.
Changes interval-time unit from "S" (seconds) to "M" (minutes) or from "M" to "S" when timer function is displayed.
Selects whether data in memory will be recalled to the display, printed out, or output via the RS-232C terminal after **STORED DATA LIST** has been pressed.
Stops display change when data is recalled from the memory to the display.

16. ENTER

Completes process being performed; stores applicable settings in memory.

17. BREAK

Interrupts and cancels function in process; returns display to measurement mode; previous settings are retained.

18. ←/→ (cursor keys)

Moves cursor to previous or next available space which can be set by the user.
Causes the display to show the previous or next set of measurement data in memory when recalling data to the display; if held pressed until tone sounds when recalling data to the display, causes display to automatically and continually change to previous or next measurement data every 0.5 seconds.

19. SPACE

Replaces data above cursor with a blank space when setting numerical data.
•When page number is set to all blanks after pressing **STORED DATA LIST** or **STATISTICS**, the selected operation will be performed on all pages of memory.

20. TARGET COLOR SELECT

Selects the target color number containing the target color data to be used for color-difference measurements.

21. ABS./DIFF.

Selects absolute (ABS.) or color-difference (DIFF.) measurement mode.

22. COLOR SPACE SELECT

Selects the color space to be used for measurements. Color space changes in the following order each time COLOR SPACE SELECT is pressed:

ABS. mode: Yxy→L*a*b* →L*C*H°→XYZ→Hunter Lab→Yxy...

DIFF. mode: Δ(Yxy)→Δ(L*a*b*)→Δ(L*C*H*)→Hunter Δ(Lab)→ Δ(Yxy)...

• In Δ(L*a*b*) and Δ(L*C*H*) color spaces, ΔE*$_{ab}$ is also displayed; in Hunter Δ(Lab) color space, ΔE is also displayed.

23. DISPLAYED DATA DELETE/RECOVER

Temporarily deletes displayed data from memory when pressed once; recovers data if pressed while measurement number for which data was temporarily deleted is displayed.

24. MEASURE

Takes measurement and/or starts timer-controlled measurements.

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DISPLAYS AND INDICATIONS

Chromaticity Measurements

Yxy

```
┌─001      Y 80.54
│ x .3120  y .3180
```
└─Measurement number

Y = 80.54
   (% reflectance)
x = 0.3120
y = 0.3180

L*a*b*

```
002       L 84.56
a+53.42   b-12.36
```

L* = 84.56
   (Metric lightness)
a* = +53.42
b* = −12.36

L*C*H°

```
003 (R )  L 75.46
C 80.43   H° 23.5
```

(R) = Munsell hue
   notation ("Light
   Source: C" only)
L* = 75.46
   (Metric lightness)
C* = 80.43
   (Metric chroma)
H° = 23.5
   (Metric hue angle)

XYZ

```
004       X 37.56
Y 39.88   Z 27.49
```

X = 37.56 (% reflectance)
Y = 39.88 (% reflectance)
Z = 27.49 (% reflectance)

Hunter Lab

```
005       HL 63.15
a -4.35   b+18.40
```

L = 63.15 (lightness)
a = −4.35
b = +18.40

Color-Difference Measurements

Δ (Yxy)

```
006   Yxy      T01 ──── Target-color number
               ch00 ──── Calibration channel
```

↓

```
006 T01   Y +5.33
x+.0034   y-.0025
```

ΔY = +5.33 (%)
Δx = +0.0034
Δy = −0.0025

Δ (L*a*b*)

```
007 Lab        T02
               ch00
```

↓

```
E  6.80   L +5.33
a +4.21   b +0.21
```

ΔE^*_{ab} = 6.80
ΔL^* = +5.33
Δa^* = +4.21
Δb^* = +0.21

Δ (L*C*H*)

```
008   LCH      T03
               ch00
```

↓

```
E  5.78   L +4.33
C +3.57   H −1.95
```

ΔE^*_{ab} = 5.78
ΔL^* = +4.33
ΔC^* = +3.57
ΔH^* = −1.95

Hunter Δ(Lab)

```
009   HLab     T04
               ch00
```

↓

```
E 15.97 HL −7.79
a −3.48   b+13.51
```

ΔE = 15.97
ΔL = −7.79
Δa = −3.48
Δb = +13.51

Error Indications

```
ch00
   CAL Please !
```

Calibration channel 00 has not been calibrated. Calibrate to standard white plate before proceeding.

```
Change Battery
```

Battery power is almost exhausted and measurement cannot be taken. Replace batteries with new ones or use AC Adapter AC-A10 (worldwide except N. America) or AC-A10N (in N. America).

```
Charge not Ready
```

The lighting circuit has not finished charging. Wait until ready lamp is lit before pressing **MEASURE** or measuring head's measuring button.

```
Check Connector
```

Measuring head and Data Processor are not connected properly. Slide POWER switch to OFF and reconnect properly.

```
Data Set Error
```

Data which cannot be used has been set.
   Calibration or target-color data are not within the allowable range. Values which cannot be set include:
   In Yxy color space:
      Either x or y = 0.
      Both x and y < 0.09
      $x + y \geq 1$
      Y > 120%
      Y = 0
   In L*a*b* color space:
      $L^* > 107.26$
      a* or b* > 199.99
      $L^* < 0.09$
   In Hunter Lab color space:
      L > 109.54
      L < 0.36
   Other settings which exceed the calculation capacity of the data processor.
   Nonexistent time setting for clock or timer (e. g., time > 23:59:59)
   Nonexistent date setting for calendar (e. g., month > 12)
If this display occurs, check data and change if necessary.

```
Illumination
   Error
```

The pulsed xenon arc lamp did not illuminate specimen properly. Take measurement again; if this message continues to be displayed, contact the nearest Minolta-authorized service facility.

```
NO Data Page xx
```

The indicated page contains no data (when attempting to recall, print, or output data in memory). Select a page which contains data.

```
┌──────────────────────┐
│ Yxy      ABS   Pxx   │
│ NO  Data             │
└──────────────────────┘
```

There is no data in the selected color space and measurement mode on the selected page (when performing statistical calculations). Select a different color space, measurement mode, or page.

```
┌──────────────────────┐
│ NO More Data         │
│     On Page          │
└──────────────────────┘
```

The selected page contains no more data.

```
┌──────────────────────┐
│ NO Store Space       │
│                      │
└──────────────────────┘
```

The number of stored measurements has reached 300 and the "Data Protect" index is set to "Y". The present measurement will not be stored and page cannot be changed. If it is not necessary to keep the presently stored measurement data in memory, set "Data Protect" index to "N" (oldest data in memory will be replaced by data for new measurements) or delete all measurement data in memory by pressing **ALL DATA CLEAR**.

```
┌──────────────────────┐
│ Over Flow            │
│                      │
└──────────────────────┘
```

Calculations for the measurement exceed the calculation capacity of the Data Processor, possibly due to incorrect calibration. Recalibrate meter and take measurement again. If this display reappears, the specimen cannot be measured with the Chroma Meter.

```
┌──────────────────────┐
│ Page End             │
│                      │
└──────────────────────┘
```

"Data Protect" index is set to "Y" and present memory page number is 19. If it is desired to change to page 00 and it is not necessary to keep presently stored data, set "Data Protect" index to "N".

```
┌──────────────────────┐
│ Sample Too Dark      │
│                      │
└──────────────────────┘
```

Reflectance of specimen is too low for measurement with the Chroma Meter.

```
┌──────────────────────┐
│ Txx                  │
│   NO Target Color    │
└──────────────────────┘
```
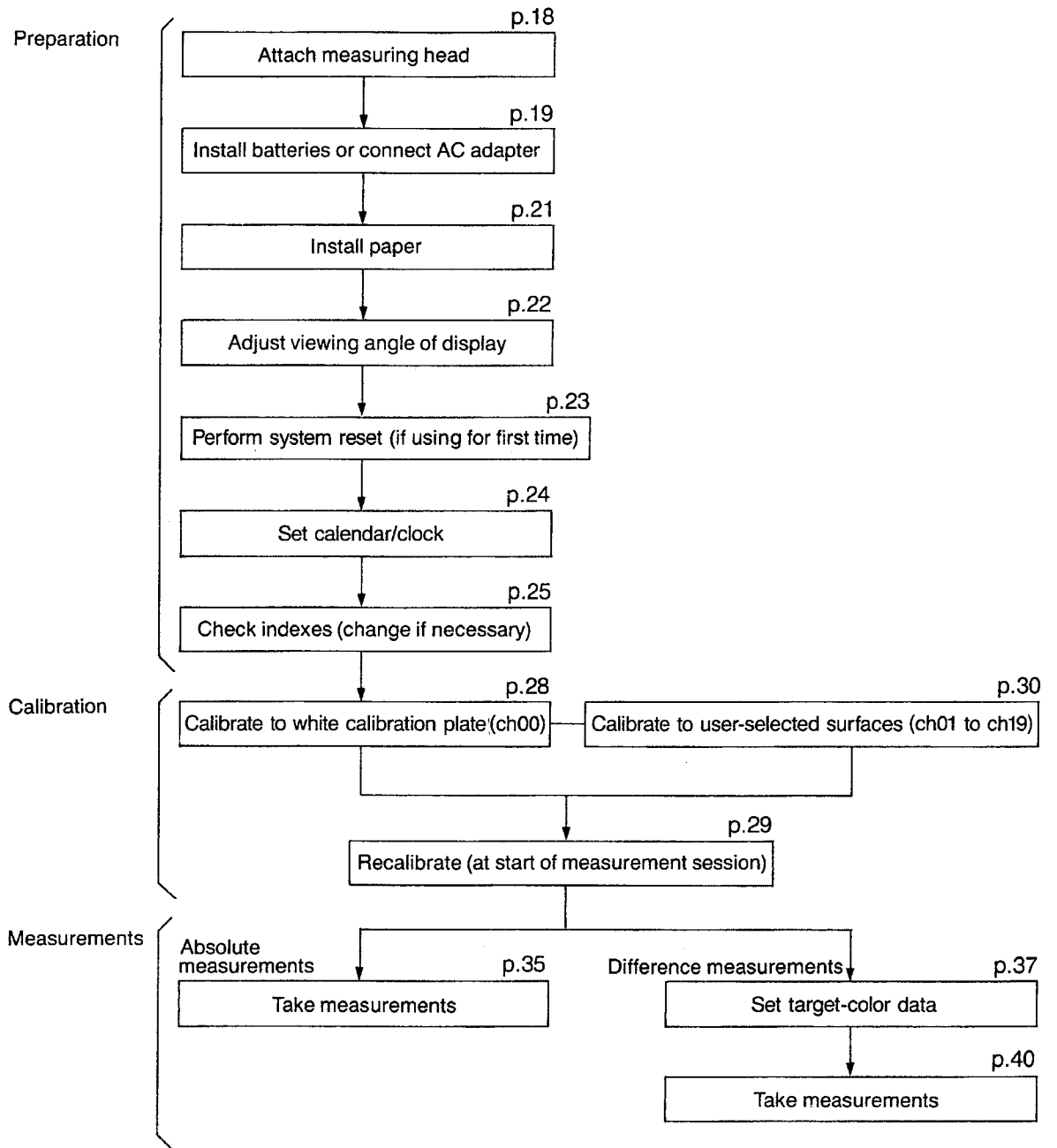
No target-color data has been stored in the selected target-color channel. Store target-color data in the selected target-color channel or choose another target-color channel.

```
┌──────────────────────┐
│ Use Another          │
│  Color Space         │
└──────────────────────┘
```

Color space is set to $L^*C^*H°$ when inputting target-color data using number keys. Change to a different color space to input target-color data using number keys.

OPERATION FLOWCHART

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PREPARATIONS

### Attaching Measuring Head to Data Processor

Connect the CR-300 series measuring head to the Data Processor DP-301 according to the steps below.

1. Check that POWER switch is at OFF.
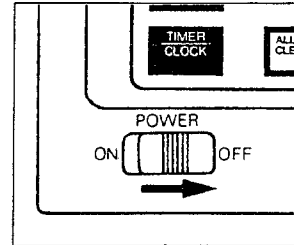
2. Align the cable connector with the connector of the Data Processor and push the cable connector into the connector of the Data Processor in a straight line as shown.

   • The connectors can be put together in only one orientation. Do not force the connectors together.

   • Be sure to push the connectors together in a straight line to avoid damaging them.
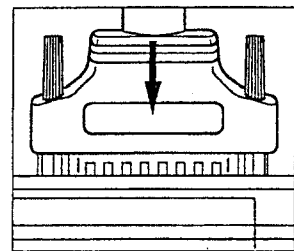
3. Tighten the two screws of the cable connector by turning them clockwise as shown.

   • The screws should be tightened only until snug. Do not overtighten them.
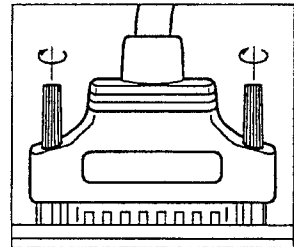
   • To avoid damaging the connectors, the measuring head, or the Data Processor, do not touch the connecting pins.

   • Protect connectors from dust, moisture, etc.

To disconnect the two units, reverse the above procedure. Be sure that the POWER switch is at OFF before disconnecting.
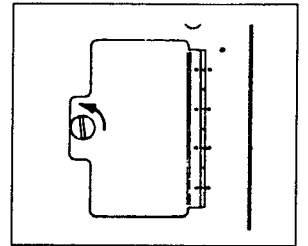
Power

CR-300 series Chroma Meters can be powered by either six AA-size batteries installed in the Data Processor or by the AC Adapter AC-A10 connected to an AC outlet.

INSTALLING BATTERIES
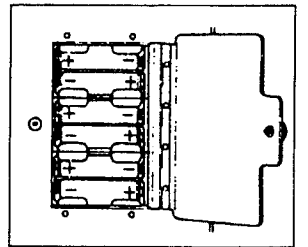1. Slide the POWER switch to OFF.
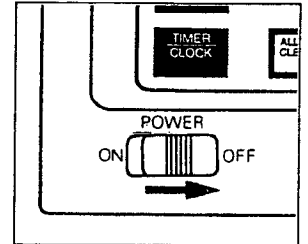
2. Turn the screw of the battery-chamber cover counterclockwise as shown and open the battery-chamber cover.
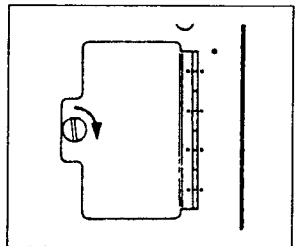
3. Install six AA-size alkaline-manganese, carbon-zinc, or nickel-cadmium batteries in the battery chamber with their polarities as indicated inside the chamber.

   • Do not mix battery types.

4. Close the battery-chamber cover and tighten the screw of the battery-chamber cover by turning the screw clockwise as shown.

USING AC ADAPTER

AC Adapter AC-A10 (220V AC input) or AC-A10N (120V AC input) is included as a standard accessory with CR-300 series Chroma Meters. The AC adapter can be used with or without batteries installed in the battery chamber of the Data Processor.

- If the AC adapter is to be used for extended periods of time, the batteries should be removed from the battery chamber.
- Do not use AC adapters other than the AC-A10 (220V AC input) or AC-A10N (120V AC input) to supply power to the Data Processor DP-301.

To use AC Adapter:

1. Slide the POWER switch of the meter to OFF.
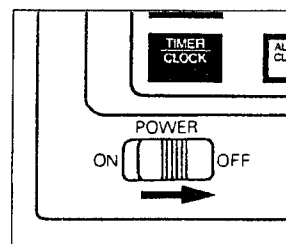
2. Insert the output plug of the AC adapter into the AC-adapter socket of the Data Processor.

AC-adapter socket
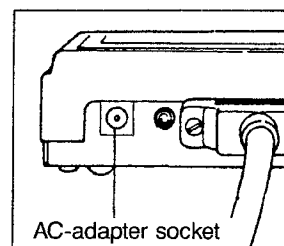
3. Plug the AC adapter into the AC outlet.

SWITCHING POWER OFF

To avoid memory errors or other problems, the POWER switch should be slid from ON to OFF only while the meter is in measurement mode. If the meter is not in measurement mode, press **BREAK** repeatedly until the measurement mode display is shown.

Installing Paper

The Data Processor uses a thermal dot-matrix printer for operation without an ink ribbon.

1. Slide the POWER switch to ON.
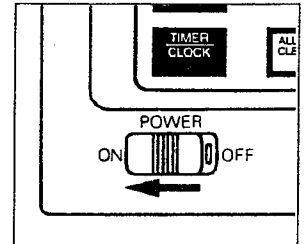
2. Press on the paper-chamber cover at the area labeled PUSH and remove the paper-chamber cover.
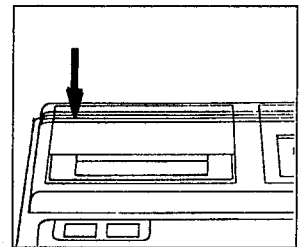
3. Pull out a short length from the roll of thermal paper and trim the tip as shown.
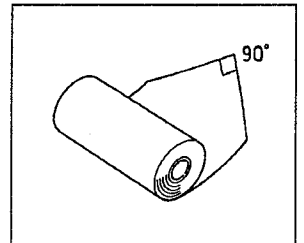
4. While holding the roll of paper as shown, insert the tip of paper into the slot at the bottom front of the paper chamber and press and hold **PAPER FEED**.
   - Be sure the inner surface of the paper faces the printer.

5. When the tip of the paper comes out of the printer, release **PAPER FEED**.
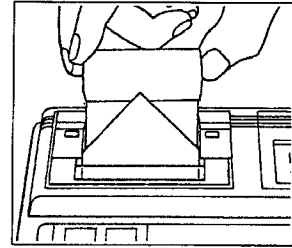
6. Put the roll of thermal paper into the paper chamber and replace the paper-chamber cover.
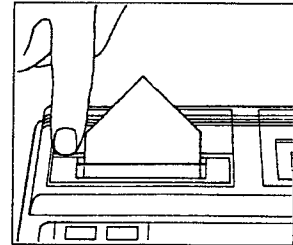
- Thermal paper is not suitable for long-term storage. If the printed data is to be kept for a long period of time, it is suggested that photocopies be made.
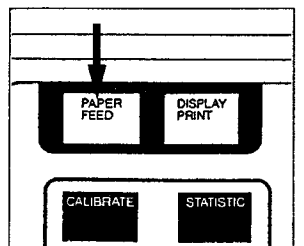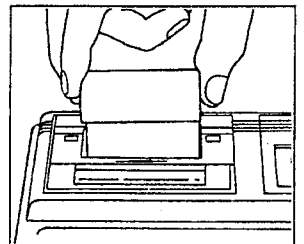- If thermal paper whose color has changed due to age and storage conditions is used for printing, the printed characters may be difficult to read. For this reason, it is recommended that the thermal paper used be as new as possible.

Adjusting Viewing Angle of Display

The appearance of the liquid crystal display varies according to the angle from which it is viewed. The viewing-angle adjustment lever on the bottom of the Data Processor may be used to set the display for easiest viewing.

Viewing-angle adjustment lever
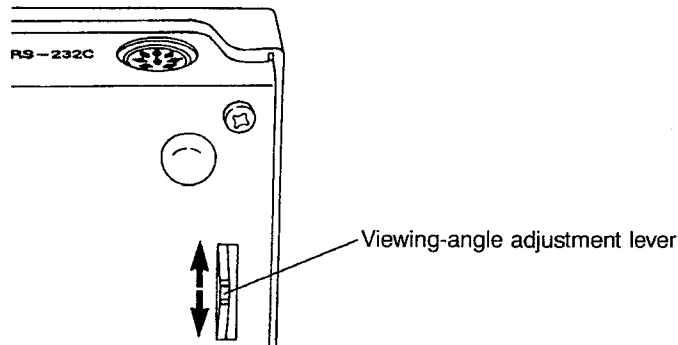
- When the power of the batteries becomes somewhat low (but not low enough to cause "Change Battery" to appear), the display may become difficult to see. Move the viewing angle adjustment lever for easiest viewing. Operation of the meter can continue until "Change Battery" appears in the display.

System Reset

When using this unit for the first time, or when it is desired to reset all functions and delete all data for calibration, target colors, and measurements, follow the steps below.

1. While holding **ALL DATA CLEAR** pressed, slide the POWER switch from OFF to ON. Do not release **ALL DATA CLEAR** until the tone sounds.

   • If the POWER switch is already at ON, slide switch to OFF and wait a few seconds before performing step 1.
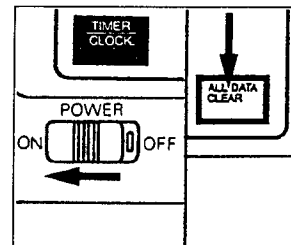
2. When initial setting has been completed, the display shown at right will appear.

```
Initial Set OK.
CR-300 Series
```

When system reset is performed, all calibration data, target-color data, and measurement data will be deleted and all functions will be reset as shown below.

RESET VALUES

General Operation:

Color space:	Yxy
ABS./DIFF.:	ABS.
Calibration:	ch00
Target color:	T00
Page:	P00

Indexes (see p. 25):

"Print":	Y
"Color Space":	N
"Data Protect":	N
"Multi Measure":	N
"Multi Cal.":	N
"Light Source":	C

ΔE^*_{ab} Alarm (see p. 42)

"Alarm":	N
"dev E":	blank

Timer (see p. 45)

"t = " (timer):	N
"I = " (interval):	00S
End time:	blank

Data List (see p. 49)

Function:	Print Out
ABS./DIFF.:	ABS.
Page:	P00

Statistics (see p. 61)
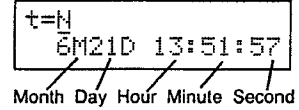
Color space:	Yxy
ABS./DIFF.:	ABS.
Page:	P00

• Date and time settings of calendar/clock are not reset when system reset is performed.

Setting Calendar/Clock
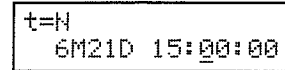
The Chroma Meter has a built-in calendar/clock which should be set by following the steps below.

1. Press **TIMER/CLOCK**. The display shown at right will appear.

```
t=H
   6M21D 13:51:57
```
Month Day Hour Minute Second
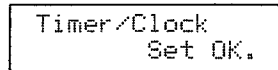
2. Use ←/→ (cursor keys) to move the cursor to the first digit of the month setting. Set present date and time by using the number keys and **SPACE**. Cursor will automatically move to the right after a number key or **SPACE** is pressed. Time should be set in 24-hour format (e. g., 1:00:00PM would be set as "13:00:00"). After last digit of time is set, cursor will return to the present setting of "t = " in the upper left corner of the display.
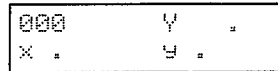
   • Although the internal clock continues to run, clock display will be halted while date and time are being set.

```
t=H
   6M21D 15:00:00
```

3. Press **ENTER**. The display shown at right will appear for about three seconds before changing to the measurement-mode display.

```
Timer/Clock
        Set OK.
```

```
000        Y   .
X  .       y  .
```

• Calendar/clock setting can be checked by pressing **TIMER/CLOCK**.
• To return to the measurement display without resetting the calendar/clock, press **BREAK**.

INDEXES

The Chroma Meter has six indexes for controlling certain functions. These indexes and their functions are shown below.

Index	Setting	Effect
"Print"	Y	Measured data are automatically printed out and output after each measurement.
	N	Measured data are not automatically printed out but data are still output after each measurement.
"Color Space"	Y	Measured data are output (and printed out if "Print" index is set to "Y") in all color spaces.
	N	Measured data are output (and printed out if "Print" index is set to "Y") only in the color space shown in the display.
"Data Protect"	Y	New data are not stored and page cannot be changed after measurement number equals 300; new page cannot be started after page number equals 19.
	N	If measurement number is greater than 300, the oldest data in memory will be replaced by the newest measurement data; if more than one page is used, all data previously stored in the oldest page will be deleted as necessary or when a new page is created by pressing **PAGE** and then pressing **ENTER**.
"Multi Measure"	Y	Three readings are automatically taken and averaged when **MEASURE** or measuring head's measuring button is pressed; average values used as measurement data.
	N	A single reading is taken to determine measurement data when **MEASURE** or measuring head's measuring button is pressed.
"Multi Cal."	Y	Measurement calculations are based on all calibration channels in which data is stored.
	N	Measurement calculations will be based only on the calibration channel selected by the user.
"Light Source"	C	CIE Standard Illuminant C is used for measurement.
	D_{65}	CIE Standard Illuminant D_{65} is used for measurement.

Changing Indexes

Indexes may be changed at any time by following the steps below.

1. Check that the POWER switch is at ON.
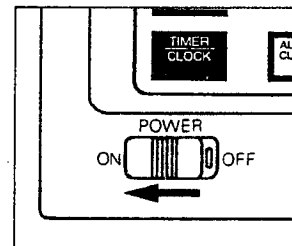
2. Press **INDEX SET**. As shown at right, the "Print" and "Color Space" indexes will appear in the display, followed by their present settings.

```
Print:Y
Color Space:N
```

3. Use ←/→ (cursor keys) and **Y/N** to change settings if desired.

4. Press ( ) (scroll key). As shown at right, the "Data Protect" and "Multi Measure" indexes will appear in the display, followed by their present settings.

```
Data Protect:N
Multi Measure:N
```

5. Use ←/→ (cursor keys) and **Y/N** to change settings if desired.

6. Press ( )(scroll key). As shown at right, the "Multi Cal." index will appear in the top line of the display, followed by its present setting. If the "Multi Cal." index is set to "N", the bottom line of the display will show "CAL ch" followed by the calibration channel selected.
   • If the selected calibration channel has not been previously calibrated, the calibration channel will automatically be set to ch00 when **ENTER** is pressed.

```
Multi Cal. :N
       CAL ch00
```

7. Use ←/→ (cursor keys) and **Y/N** to change the setting of the "Multi Cal." index if desired. Use ←/→ (cursor keys) and number keys to set the calibration channel if necessary.

8. Press ( ) (scroll key). As shown at right, the "Light Source" index will appear in the display, followed by its present setting.

```
Light Source:C
  (C/D65)
```

9. Use ←/→ (cursor keys) to move cursor under the desired illuminant conditions (under "C" for Standard Illuminant C conditions, under "D" for Standard Illuminant D_{65} conditions).
   • The setting of the "Light Source" index cannot be changed if calibration has already been performed. If it is desired to change this setting after calibration has been performed, perform system reset (see p. 23), then change the setting of the "Light Source" index and calibrate the Chroma Meter again.

10. Press **ENTER** to store changes in memory and finish changing index settings. The display shown at right will appear for a few seconds before changing to the measurement-mode display.

```
Index Set OK.
```

```
000       Y  .
X .           y .
```

Changing indexes is now complete.

• If it is decided not to change indexes in the middle of the above procedure, press **BREAK** before step 10 or instead of **ENTER** in step 10. Display will immediately return to measurement-mode display and any changes in the index settings will not be stored.

CALIBRATION

The Chroma Meter has 20 different calibration channels numbered from 00 to 19. Channel 00 must be calibrated to the included white calibration plate (Calibration Plate CR-A43 for the CR-300, Calibration Plate CR-A44 for the CR-310, Calibration Plate CR-A45 for the CR-321 or Calibration Plate CR-A46 for the CR-331 or the CR-331C); channels 01 through 19 may be calibrated to any user-selected surface.

- When using several units of the same model, the spectral response of the meters can be standardized by using the calibration channels for user-selected surfaces and calibrating all the meters to the same standards.
- For best results, calibration and measurements should be performed under the same conditions (ambient temperature, etc.)
- When you use Color Calibration Plate Set to perform multi calibration on several Chroma Meters, please use the same Calibration Plate Set for all Chroma Meters.

Selecting Calibration Surfaces

Calibration channel 00 must be calibrated to the included white calibration plate (Calibration Plate CR-A43 for the CR-300, Calibration Plate CR-A44 for the CR-310, Calibration Plate CR-A45 for the CR-321, or Calibration Plate CR-A46 for the CR-331 or the CR-331C). The white calibration plate used for calibration of channel 00 is used as the primary working standard for the Chroma Meter. When any of the other calibration channels (01 through 19) are calibrated, the correction factor for the calibration channel is calculated in relation to the calibration data in channel 00. For this reason, calibration channel 00 must be calibrated to the white calibration plate before calibrating any of the other calibration channels. For the same reason, recalibrating channel 00 to the white calibration plate at the start of the measuring session is sufficient; it is not necessary to recalibrate all calibration channels.

Calibration channels 01 through 19 may be calibrated to any surface selected by the user. In general, the surfaces selected for calibration should be of the same material and have the same surface conditions (texture, gloss, etc.) as the specimens which will be measured. Also, the surfaces selected should be reproducible and resistant to fading, and should be stored under conditions which will minimize color changes due to fading, aging, etc.. The surfaces should be selected to provide a wide variety of calibration points within the range of colors to be measured.

When using multi-calibration (when the "Multi Cal." index is set to "Y"), the calibration surfaces should be selected so that all measured values will occur within the area surrounded by the calibration points. When measurements are to be compared, or are part of a series of measurements, it is extremely important that the meter be calibrated to the same set of calibration surfaces for all measurements. If the calibration data in one or more channels is changed or deleted, subsequent measured values will be different.

When manually selecting the calibration channel (when the "Multi Cal." index is set to "N"), best results will be obtained by using a calibration surface which is very close to the specimens to be measured. When measurements are to be compared or are part of a series of measurements, the same calibration channel and calibration data should be used for all measurements.

- The optional Color Calibration Plate Set CR-A47 consists of nine color plates (red, orange, yellow, yellow-green, green, cyan, purple, deep pink, and brown) which can be used as calibration surfaces if desired. Calibration values are printed inside the cover of each plate.

Calibration to White Calibration Plate

1. Slide POWER switch to ON.
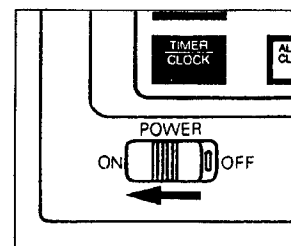
2. Press **CALIBRATE**. The upper display shown at right will appear for about five seconds, and then change to the lower display, showing previously set calibration values. If no calibration values have been previously set, no values will appear.

- Pressing +/−, **Y/N**, **SPACE**, ←/→ (cursor keys), () (scroll key), or any of the number keys will cause the display to immediately change from the upper display to the lower one.

3. If the displayed color space is not Yxy, press **COLOR SPACE SELECT** repeatedly to change to Yxy color space.

4. Use ←/→ (cursor keys) and number keys to set calibration channel ("ch") to 00.

5. Set the calibration data listed inside the cover of the white calibration plate by using the number keys. The cursor will automatically move to the next position after a number key is pressed. Use ←/→ (cursor keys) to move back to a previously set position if corrections are required.

- Calibration values for both CIE Standard Illuminant C and CIE Standard Illuminant D_{65} conditions are listed inside the cover of the white calibration plate. Be sure to input the calibration data for the illuminant conditions being used (for the selected setting of the "Light Source" index).
- Be sure to use the correct calibration plate for the meter being used (Calibration Plate CR-A43 for the CR-300, Calibration Plate CR-A44 for the CR-310, Calibration Plate CR-A45 for the CR-321, or Calibration Plate CR-A46 for the CR-331 or the CR-331C).

6. Place tip of measuring head flat against the surface of the white calibration plate.

- Since the calibration data was originally measured at the center of the white calibration plate, the center of the white calibration plate should be measured when performing calibration.

If using CR-321, position target area of baseplate over the center of the white calibration plate and tilt the body of the measuring head toward the baseplate so that the tip of the light-projection tube is against the surface of the white calibration plate.

7. Press **MEASURE** or measuring head's measuring button after ready lamp on measuring head lights. Display at right will appear and three measurements will automatically be taken for better accuracy. Do not move the measuring head until all three measurements have been completed.

8. After about five seconds, "CAL" in the display will be replaced by "End" as shown at right. Calibration of channel 00 is now complete.
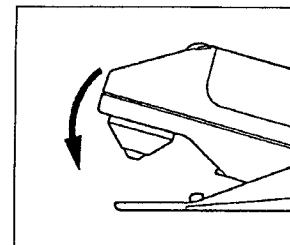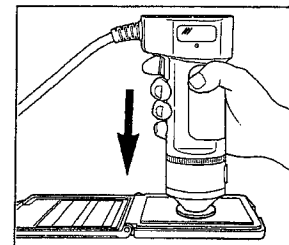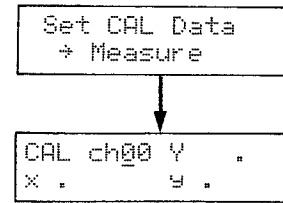
Recalibration

For greater accuracy, the Chroma Meter should be recalibrated to the white calibration plate at the start of each measuring session. Once calibration data has been stored in memory, recalibration can be performed by following the steps below.

• For best results, recalibration and measurements should be performed under the same conditions (ambient temperature, etc.).

1. Slide POWER switch to ON.

2. Press **CALIBRATE**. The upper display shown at right will appear for about five seconds, and then change to the lower display, showing previously set calibration values.
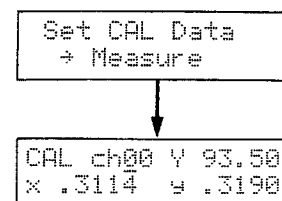
   • Pressing +/−, **Y/N**, **SPACE**, ←/→ (cursor keys), ( ) (scroll key), or any of the number keys will cause the display to immediately change from the upper display to the lower one.

3. If the displayed color space is not Yxy, press **COLOR SPACE SELECT** repeatedly to change to Yxy color space.

4. Use ←/→ (cursor keys) and number keys to set calibration channel ("ch") to 00.

   • Check that the calibration data shown in the display is correct.

5. Place tip of measuring head flat against the surface of the white calibration plate.
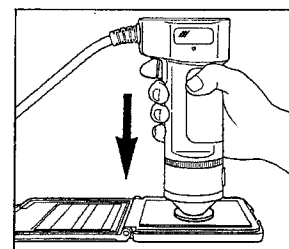
   • Since the calibration data was originally measured at the center of the white calibration plate, the center of the white calibration plate should be measured when performing recalibration.

If using CR-321, position target area of baseplate over the center of the white calibration plate and tilt the body of the measuring head toward the baseplate so that the tip of the light-projection tube is against the surface of the white calibration plate.
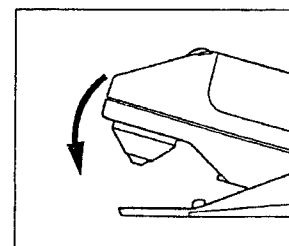
6. Press **MEASURE** or measuring head's measuring button after ready lamp on measuring head lights. Display at right will appear and three measurements will automatically be taken for better accuracy. Do not move the measuring head until all three measurements have been completed.
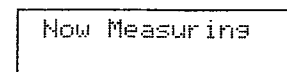
7. After a few seconds, "CAL" in the display will be replaced by "End" as shown at right. Recalibration of channel 00 is now complete.
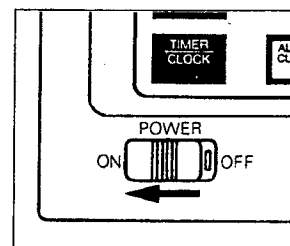
```
End        Y 93.50
x .3114   y .3190
```

If any of the other calibration channels were previously calibrated, recalibrating channel 00 to the white calibration plate automatically adjusts their calibration as necessary.

Calibration to User-Selected Surfaces

The Chroma Meter may be calibrated to as many as 19 different surfaces selected by the user.

To calibrate to a user-selected surface, follow the steps below.

- For best results, calibration and measurements should be performed under the same conditions (ambient temperature, etc.)

1. Slide POWER switch to ON.

```
Set CAL Data
→ Measure
```

```
CAL ch00 Y 93.50
x .3114   y .3190
```
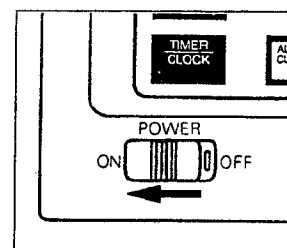
2. For greater accuracy, recalibrate the Chroma Meter to the white calibration plate (see p. 29) immediately before calibrating to a user-selected surface.

3. Press **CALIBRATE**. The upper display shown at right will appear for about five seconds, and then change to the lower display, showing previously set calibration values.

- Pressing +/−, **Y/N**, **SPACE**, ←/→ (cursor keys), ( ) (scroll key), or any of the number keys will cause the display to immediately change from the upper display to the lower one.

4. Press **COLOR SPACE SELECT** to set the desired color space (Yxy or L*a*b*).

- If calibration is performed using L*a*b* color space, the values input in step 6 may differ somewhat from the final calibration values due to internal conversion calculations during calibration.

5. Use ←/→ (cursor keys) and number keys to set desired calibration channel (01 through 19).

6. Set the calibration data for the selected surface by using the number keys. The cursor will automatically move to the next position after a number key is pressed. Use ←/→ (cursor keys) to move back to a previously set position if corrections are required.

- When inputting data in L*a*b* color space, position cursor under any digit of the a* or b* value and press +/− to change between positive and negative values.

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7. Place tip of measuring head flat against the selected surface.
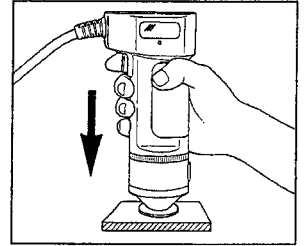
If using CR-321, position target area of baseplate over the desired area of the calibration surface and tilt the body of the measuring head toward the baseplate so that the tip of the light-projection tube is against the calibration surface.
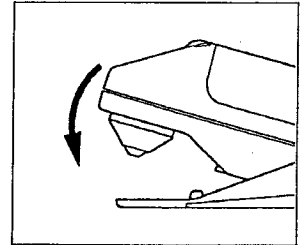
8. Press **MEASURE** or measuring head's measuring button after ready lamp on measuring head lights. Display at right will appear and three measurements will automatically be taken for better accuracy. Do not move the measuring head until all three measurements have been completed.

9. After a few seconds, "CAL" in the display will be replaced by "End" as shown at right. Calibration of the selected channel is now complete. Repeat steps 3 through 8 as required to set other calibration channels.

   • If the surface conditions of the specimens to be measured are greatly different from those of the calibration surface, some measurement error may occur.

Deleting Calibration Data

To delete the data stored in a calibration channel, follow the steps below.

1. Slide POWER switch to ON.
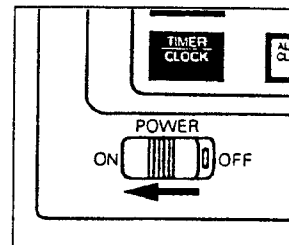
2. Press **CALIBRATE**. The upper display shown at right will appear for about five seconds, and then change to the lower display, showing previously set calibration values.

   - Pressing **+/–**, **Y/N**, **SPACE**, **←/→** (cursor keys), **( )** (scroll key), or any of the number keys will cause the display to immediately change from the upper display to the lower one.

3. Use **←/→** (cursor keys) and number keys to set desired calibration channel.

4. Use **←/→** (cursor keys) and **SPACE** repeatedly to set all calibration values for the selected channel to blanks.

5. Press **ENTER**. The display at right will appear for a few seconds, then change to the measurement-mode display.

   - When using multi-calibration (when the "Multi Cal." index is set to "Y"), changing or deleting the calibration data in one or more calibration channels will cause subsequent measured values to vary from previously measured values, even if the same subject is measured.
   - Calibration data in calibration channel ch00 cannot deleted.

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Manual Calibration-Channel Selection

The calibration channel may be selected manually by following the steps below.

1. Check that POWER switch is at ON.

2. Press **INDEX SET**. Indexes will appear in the display, followed by their present settings.

3. Press ◯ (scroll key) repeatedly until the "Multi Cal." index appears in the top line of the display as shown at right. Indexes will change in the following order:

```
┌──────────────────┐        ┌──────────────────┐
│ Print:Y          │───────▶│ Data Protect:N   │
│ Color Space:N    │        │ Multi Measure:N  │
└──────────────────┘        └──────────────────┘
         ▲                            │
         │                            ▼
┌──────────────────┐        ┌──────────────────┐
│ Light Source:C   │◀───────│ Multi Cal. :N    │
│ (C/D65)          │        │      CAL ch00    │
└──────────────────┘        └──────────────────┘
```

4. If the "Multi Cal." index is not set to "N", use ◀/▶ (cursor keys) and **Y/N** to change setting to "N".

5. Use ◀/▶ (cursor keys) and number keys to select the desired calibration channel.
   * If the selected calibration channel has not been previously calibrated, the calibration channel will automatically be set to ch00 when **ENTER** is pressed.

6. Press **ENTER**. The display shown at right will appear for a few seconds before changing to the measurement-mode display.

Multi-Calibration

CR-300 series Chroma Meters are equipped with a multi-calibration function. When multi-calibration is used, measurement calculations are based on all calibration data stored in memory, rather than on the calibration data stored in a single calibration channel. This results in extremely high accuracy and repeatability.

To use the multi-calibration function to the greatest possible advantage, a wide variety of reference colors surrounding the range of specimen colors to be measured should be used for calibration.

To use the multi-calibration function, set the "Multi Cal." index to "Y" according to the steps below.
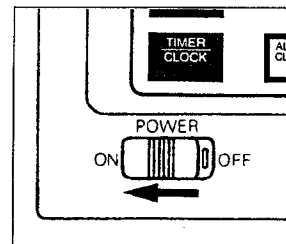
1. Check that POWER switch is at ON.

2. Press **INDEX SET**. Indexes will appear in the display, followed by their present settings.

3. Press ( ) (scroll key) repeatedly until the "Multi Cal." index appears in the top line of the display as shown at right. Indexes will change in the following order:

```
Multi Cal.  :N
      CAL ch00
```

```
Print:Y                 Data Protect:N
Color Space:N    →      Multi Measure:N


Light Source:C   ←      Multi Cal.  :N
   (C/D65)                     CAL ch00
```
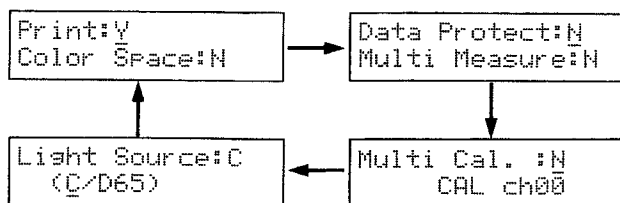
4. If the "Multi Cal." index is not set to "Y", use ←/→ (cursor keys) and **Y/N** to change setting to "Y". When the "Multi Cal." index is set to "Y", no calibration channel will be shown.

```
Multi Cal.  :Y
```

5. Press **ENTER**. The display shown at right will appear for a few seconds before changing to the measurement-mode display.

```
Index Set OK.
```

```
001        Y 80.54
x .3120  y .3180
```

ABSOLUTE MEASUREMENTS

The Chroma Meter can be used to take measurements of chromaticity in Yxy, L*a*b*, L*C*H°, XYZ, or Hunter Lab color space.

1. Check that POWER switch is at ON.
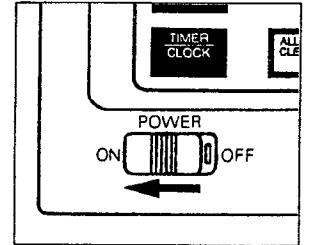
2. For better accuracy, recalibrate Chroma Meter (see p. 29) at the start of each measuring session.

3. Check that indexes are set as desired by pressing **INDEX SET** and using ◯ (scroll key) to advance through the indexes. Use ←/→ (cursor keys) and **Y/N** to change settings if necessary. (See p. 25 for a complete description of indexes.) If multi-calibration is desired, set the "Multi Cal." index to "Y"; if manual calibration-channel selection is desired, set the "Multi Cal." index to "N" and use ←/→ (cursor keys) and number keys to set desired calibration channel.

   • If the "Multi Cal." index is set to "N" and the selected calibration channel has not been previously calibrated, the calibration channel will automatically be set to ch00 when **ENTER** is pressed.

4. After all index settings are correct, press **ENTER**.

5. Press **COLOR SPACE SELECT** to set desired color space. Each time **COLOR SPACE SELECT** is pressed, the selected color space will change in the following order:

Yxy
```
┌─────────────────┐
│005        Y 46.34│
│x .4241   y .3586│
└─────────────────┘
```

L*a*b*
```
┌─────────────────┐
│005        L 73.76│
│a+24.95   b+30.90│
└─────────────────┘
```

Hunter Lab
```
┌─────────────────┐
│005       HL 68.07│
│a+24.61   b+23.19│
└─────────────────┘
```

L*C*H°
```
┌─────────────────┐
│005  (YR) L 73.76│
│C 39.71   H° 51.1│
└─────────────────┘
```
("Light Source:C" only)

XYZ
```
┌─────────────────┐
│005        X 54.82│
│Y  46.34  Z 28.08│
└─────────────────┘
```
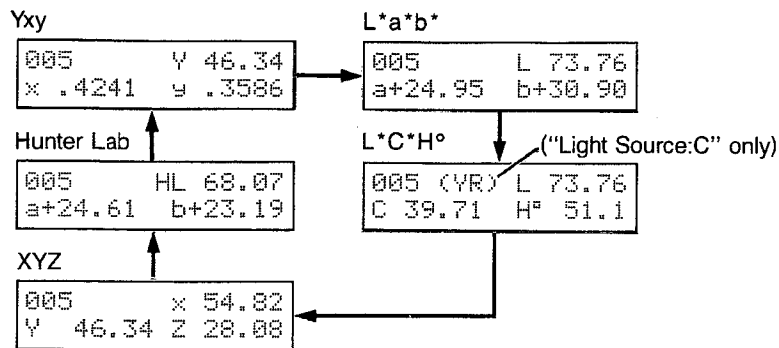
• If target-color number ("T" followed by a two-digit number) appears in the upper line of the display, Chroma Meter is in color-difference measuring mode. Press **ABS./DIFF.** to change to absolute measuring mode.
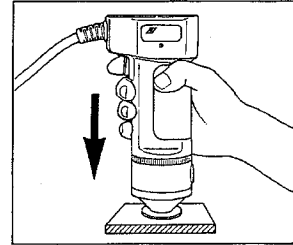
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6. Place tip of measuring head flat against the specimen surface.

If using CR-321, position target area of baseplate over the desired subject area and tilt the body of the measuring head toward the baseplate so that the tip of the light-projection tube is against the subjet to be measured.

7. Press **MEASURE** or measuring head's measuring button after the ready lamp on the measuring head lights. Display will show color space in use for a few seconds and then measured data will be displayed. Data will be automatically stored in memory.

   • If data storage is not required, press DISPLAYED DATA **DELETE/ RECOVER**; the latest measurement made will be deleted and the display shown at right will appear.

   • If data is deleted by mistake, it can be recovered by pressing DISPLAYED DATA **DELETE/RECOVER** again. However, if another measurement is taken before DISPLAYED DATA **DELETE/ RECOVER** is pressed again, the deleted data cannot be recovered.

• After a measurement has been taken, it can be converted to an equivalent reading in another color space by pressing **COLOR SPACE SELECT**.

• After a measurement has been taken, it can be converted to a color-difference reading (provided target-color data has been previously stored in memory) by pressing **ABS./DIFF.**

```
006        Y 74.17
x .3404    y .2608
```

```
* 006  Deleted *
```
—Measurement number

36

DIFFERENCE MEASUREMENTS

The Chroma Meter can be used to determine the difference between a specimen color and a target color as differences of chromaticity coordinates. In order to measure these differences, target colors must first be stored in memory.

- Color difference cannot be measured in XYZ tristimulus values.
- For best results, input of target colors should be performed under the same conditions (ambient temperature, etc.) as calibration and measurements.
- Target specimens should be stored under conditions which will minimized color changes due to fading, aging, etc.

Input of Target Colors

Target colors may be input by measuring a target surface or by using the keyboard to set Yxy, L*a*b*, or Hunter Lab color coordinates.

BY MEASUREMENT

- When inputting target colors by measurement, the original measured target-color data is stored in memory, without being adjusted according to the calibration data in memory or the setting of the "Multi Cal." index (or the calibration channel selected if the "Multi Cal." index is set to "N"). After the target-color data has been stored in memory, it will be adjusted each time a color-difference measurement is taken or the target-color data is displayed, according to the calibration data in memory and the setting of the "Multi Cal." index (and the calibration channel selected if the "Multi Cal." index is set to "N") at the time of the color-difference measurement or target-color data display.

1. Check that POWER switch is at ON.
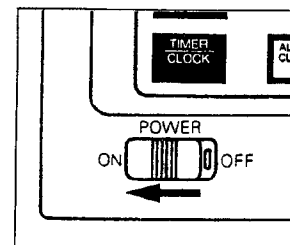
2. For better accuracy, recalibrate Chroma Meter (see p. 29) at the start of each measuring session.

3. Check that indexes are set as desired by pressing **INDEX SET** and using ( ) (scroll key) to advance through the indexes. Use ←/→ (cursor keys) and **Y/N** to change settings if necessary. (See p. 25 for a complete description of indexes.) If multi-calibration is desired, set the "Multi Cal." index to "Y"; if manual selection is desired, set the "Multi Cal." index to "N".

4. After all index settings are correct, press **ENTER**.

5. Press **TARGET COLOR SET**. The upper display at right will appear for about five seconds, and then change to the lower display.
   - Pressing +/−, **Y/N**, **SPACE**, ←/→ (cursor keys), ( ) (scroll key), or any of the number keys will cause the display to immediately change from the upper display to the lower one.

6. Press **COLOR SPACE SELECT** to set desired color space. Each time **COLOR SPACE SELECT** is pressed, the selected color space will change in the following order:
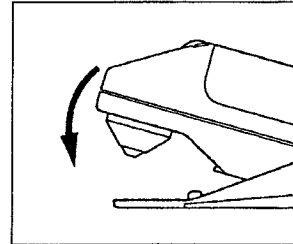
Yxy

```
T00 ch00 Y    .
x .        y .
```

L*a*b*

```
T00 ch00 L    .
a+    . b+    .
```

Hunter Lab

```
T00 ch00HL    .
a .      b    .
```

L*C*H°

```
T00 ch00 L    .
C    .   H°   .
```
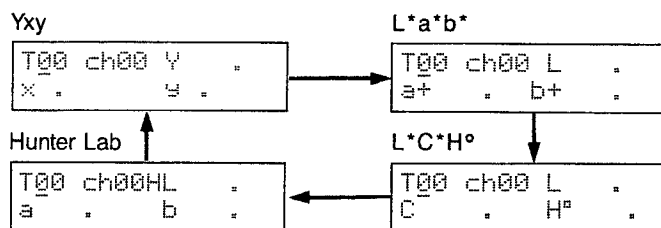
7. Use ←/→ (cursor keys) and number keys to set the desired target-color number. Previously set target-color data (if any) will appear.

- If the "Multi Cal." index is set to "N", use ←/→ (cursor keys) and number keys to set the desired calibration channel.
  If the selected calibration channel has not been previously calibrated, the calibration channel will automatically be set to ch00 when measurement is performed.

- If the "Multi Cal." index is set to "Y", "Multi" will be shown in the display instead of the calibration channel.

- The setting of the "Multi Cal." index and/or the calibration channel apply only to the display of the target-color data at the end of this procedure. They do not apply to the storage of the target-color data in memory.

8. Place tip of measuring head flat against the target surface.

If using CR-321, position target area of baseplate over the desired area of the target surface and tilt the body of the measuring head toward the baseplate so that the tip of the light-projection tube is against the target surface.
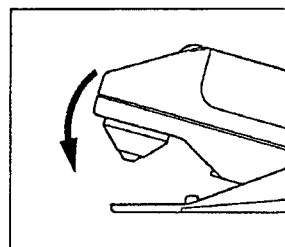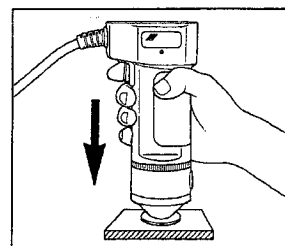
9. Press **MEASURE** or measuring head's measuring button after the ready lamp on the measuring head lights. Upper display at right will appear for a few seconds and then "End" will be displayed.

```
Now Measuring
```

ABS. mode

```
End        Y 67.81
x .4168  y .3662
```

or
Diff. mode

```
End T01   Y   0.00
x .0000  y .0000
```

Target-color data has been set for the selected target-color number. Repeat from step 5 to set data for other target-color numbers.

- When inputting the target-color data using the keyboard, it is recommended that the input data be measured with the same model of CR-300 series Chroma Meter. The DP-301 will recalculate the original measured data utilizing the calibration data in memory according to the setting of the "Multi Cal." index (and the calibration channel selected if the "Multi Cal." index is set to "N"). For this reason, it is very important to write down target-color data, calibration data (for all calibration channels if the "Multi Cal." index is set to "Y", for the selected calibration channel if the "Multi Cal." index is set to "N"), and the setting of the "Multi Cal." index when a target color is first measured. When the "Multi Cal." index is set to "Y", be sure all calibration data are the same as when the target was first measured; when the "Multi Cal." index is set to "N", be sure the calibration data in the selected calibration channel are the same as when the target was first measured.
- If the target color was not measured with a CR-300 series Chroma Meter, input the calibration data which was used when the target-color data was first measured into one of the calibration channels and select that calibration channel (with the "Multi Cal." index set to "N") when inputting the target-color data using the keyboard.

1. Check that POWER switch is at ON.
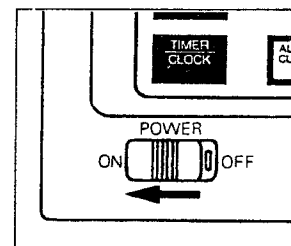
2. Press **TARGET COLOR SET**. The upper display at right will appear for about five seconds and then change to the lower display.
   - Pressing +/–, **Y/N**, **SPACE**, ←/→ (cursor keys), ( ) (scroll key), or any of the number keys will cause the display to immediately change from the upper display to the lower one.

Set Data → Enter
or Measure

Target-color number

T00 ch00 Y   .
X .   Y .

"Multi Cal.:N"

T00Multi Y   .
X .   Y .

"Multi Cal.:Y"
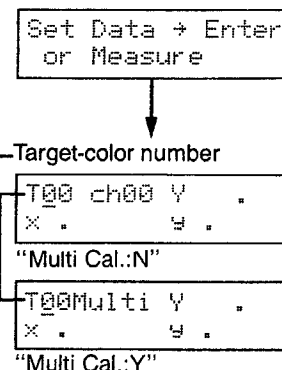
3. Press **COLOR SPACE SELECT** to set desired color space (Yxy, L*a*b*, or Hunter Lab). Each time **COLOR SPACE SELECT** is pressed, the selected color space will change in the following order:

Yxy

T00 ch00 Y   .
X .   Y .

L*a*b*

T00 ch00 L   .
a+   . b+   .

Hunter Lab

T00 ch00HL   .
a   . (b   .

L*C*H°

T00 ch00 L   .
C   . H°   .
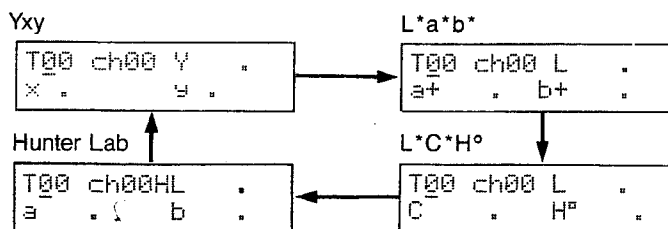
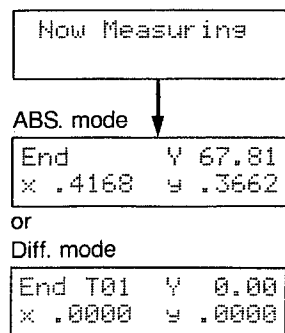- Target color cannot be set using the keyboard in L*C*H° color space.

4. Use ←/→ (cursor keys) and number keys to set the desired target-color number. Previously set target-color data (if any) will appear.
   - If the "Multi Cal." index is set to "N", use ←/→ (cursor key) and number keys to set the desired calibration channel.
   - If the "Multi Cal." index is set to "Y", "Multi" will be shown in the display.

5. Use ←/→ (cursor keys) and number keys to input the target-color data.

- When inputting data in L*a*b* or Hunter Lab color space, position cursor under any digit of the a*, b*, a, or b value and press +/– to change between positive and negative values.
- When data is input in a color space other than Yxy, the values input using the keyboard may differ slightly from the final target-color data stored in memory due to internal conversion calculations.

6. Press **ENTER**. One of the two displays at right will appear, depending on whether Chroma Meter is in **ABS.** or **Diff.** measuring mode.

ABS. mode

```
End       Y 46.14
x .3270  y .3214
```

or
Diff. mode

```
End T03  Y  0.00
x .0000  y .0000
```

Target-color data has been set for the selected target-color number. Repeat from step 2 to set data for other target-color numbers as desired.

Taking Measurements

- For best results, measurements should be performed under the same conditions (ambient temperature, etc.) as calibration and input of target colors.

1. Check that POWER switch is at ON.
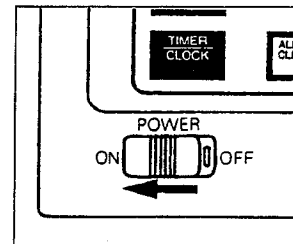
2. For better accuracy, recalibrate Chroma Meter (see p. 29) at the start of each measuring session.

3. Check that indexes are set as desired by pressing **INDEX SET** and using ( ) (scroll key) to advance through the indexes. Use ← /→ (cursor keys) and **Y/N** to change settings if necessary. (See p. 25 for a complete description of indexes.)

4. After all index settings are correct, press **ENTER**.

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5. Press **COLOR SPACE SELECT** to set desired color space. Each time **COLOR SPACE SELECT** is pressed, the selected color space will change in the following order:

Δ(Yxy)
```
001 T00  Y   .
x .      y .
```

Δ(L*a*b*)
```
E  .   L  :
a  .   b  :
```

Hunter Δ(Lab)
```
E  .   HL  .
a  .   b   .
```

Δ(L*C*H*)
```
E  .   L  .
C  .   H  .
```
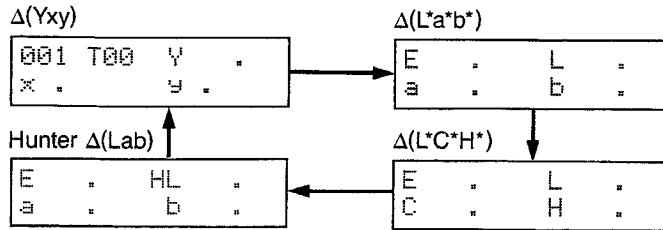
Display will show the measurement number, color space, target-color number, and calibration channel for a few seconds before changing to the above measurement-mode displays.

- If target-color number ("T" followed by a two-digit number) or "E" does not appear in the upper line of the measurement-mode display, Chroma Meter is in absolute measuring mode. Press **ABS./DIFF.** to change to color-difference measuring mode.

6. Press **TARGET COLOR SELECT.**

7. Use ◄/► (cursor keys) and number keys to select the desired target-color number.

8. Place tip of measuring head flat against the specimen surface.

If using CR-321, position target area of baseplate over the desired subject area and tilt the body of the measuring head toward the baseplate so that the tip of the light-projection tube is against the subject to be measured.
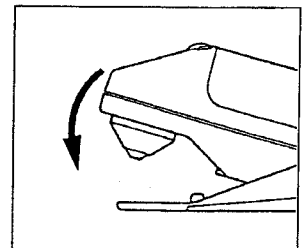
9. Press **MEASURE** or measuring head's measuring button after the ready lamp on the measuring head lights. Display will show color space in use for a few seconds and then measured data will be displayed. Data will be automatically stored in memory.

```
001 T03  Y -0.84
x-.0038  y-.0034
```

- If data storage is not required, press DISPLAYED DATA **DELETE/ RECOVER**; the latest measurement made will be deleted and the display shown at right will appear.
- If data is deleted by mistake, it can be recovered by pressing DISPLAYED DATA **DELETE/RECOVER** again. However, if another measurement is taken before DISPLAYED DATA **DELETE/ RECOVER** is pressed again, the deleted data cannot be recovered.
- After a measurement has been taken, it can be converted to an equivalent reading in another color space by pressing **COLOR SPACE SELECT**; it can be converted to an absolute reading by pressing **ABS./DIFF.**

```
* 001  Deleted *
```
└─ Measurement number

41

ΔE^*_{ab} ALARM

The Chroma Meter can be set to trigger an alarm when the difference between the color of the specimen and the target color is beyond the ΔE^*_{ab} value set by the user. ΔE^*_{ab} can be set to a different value for each target color, and the ΔE^*_{ab} alarm function can be used in both absolute and color-difference measuring modes. When a color is beyond the ΔE^*_{ab} value which was set, an audible tone sounds for about one second and signals are sent from the ΔE ALARM output socket and the RS-232C terminal. Signals will also be sent from the ΔE ALARM output socket and the RS-232C terminal if a measurement error ("Illumination Error", "Over Flow", or "Sample Too Dark") occurs. To set and use the ΔE^*_{ab} alarm, follow the steps below.

1. Press ΔE **ALARM SET**. The display shown at right will appear.

```
T00      Alarm:N
```

2. Use ←/→ (cursor keys) and number keys to set desired target-color number. Cursor will automatically move right after a number key is pressed.

Target-color number
```
T01      Alarm:Y
   dev E (   .   )
```

3. Use ←/→ (cursor keys) and **Y/N** to change the setting of "Alarm" to "Y".

```
T01      Alarm:Y
   dev E (   .   )
```

4. Use ←/→ (cursor keys) and number keys to set desired "dev E" (ΔE^*_{ab}) range. Cursor will automatically move right after a number key is pressed.
   * If no data has been stored for the selected target-color number, no "dev E" range can be set.
   * "dev E" range cannot be set in terms of the ΔE value in Hunter Δ(Lab) color space.

```
T01      Alarm:Y
   dev E ( 0.20)
```
ΔE^*_{ab} range

5. Press **ENTER**. The upper display shown at right will appear for about three seconds and then change to the measurement-mode display.

```
T01
   Alarm Set OK.
```

```
004 T01  Y +0.52
x-.0032  y+.0010
```

Repeat from step 1 to set alarm for other target-color numbers.

To cancel ΔE^*_{ab} alarm, press ΔE **ALARM SET** and use ←/→ (cursor keys) and **Y/N** to change the setting of "Alarm" to "N".
* All alarm-mode settings (target-color number, etc.) will be canceled.

ΔE ALARM Output Socket

ΔE ALARM output socket
RS-232C terminal
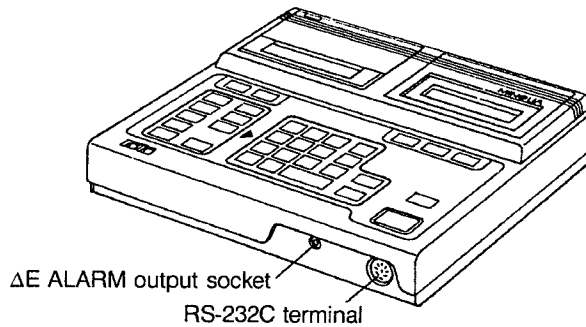
The ΔE ALARM output socket can be used for triggering external devices when using the ΔE^*_{ab} alarm. When a color is beyond the specified ΔE^*_{ab} range from the target color (or when a measurement error occurs), the signal from the ΔE ALARM output socket changes from high to low, remains low for approximately one second, and then returns to high.

* To trigger external devices when using the ΔE^*_{ab} alarm, the signal from the ΔE ALARM output socket can be used in conjunction with the signal from pin 8 of the RS-232C terminal; the signal from pin 8 of the RS-232C terminal acts as a timing signal for the signal from the ΔE ALARM output socket. At the start of each measurement, the signal from pin 8 of the RS-232C terminal changes low momentarily, and then returns to high. The signal from the ΔE ALARM output socket should be checked immediately after the signal from pin 8 of the RS-232C terminal has returned to high. If the measurement is beyond the specified ΔE^*_{ab} range, the signal from the ΔE ALARM output socket will be low at this time (for about one second); if the measurement is within the specified ΔE^*_{ab} range, the signal from the ΔE ALARM output socket will be high at this time. Circuit and timing diagrams for both outputs are as follows.

CIRCUIT DIAGRAM
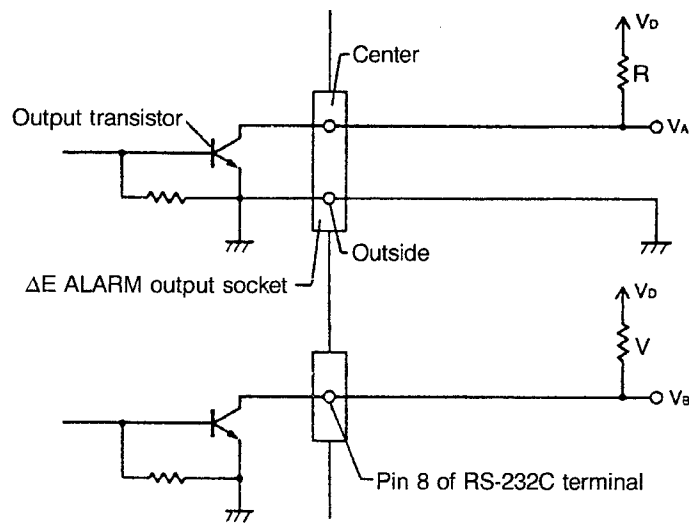
Output transistor maximum ratings:
    V_{CBO}: 50V
    Ic: 30mA
    Pc: 300mW

TIMING DIAGRAMS

Target within range:

MEASURE or measuring button pressed	Measurement and A/D conversion	Calculation	Display	Printout	

Signal from pin 8 of RS-232C terminal V_B — V_D / G

Signal from ΔE ALARM output socket V_A — V_D / G

Target outside of range:

MEASURE or measuring button pressed	Measurement and A/D conversion	Calculation	Display	ΔE*ab alarm sounds and signal sent	Printout

Signal from pin 8 of RS-232C terminal V_B — V_D / G

Signal from ΔE ALARM output socket V_A — V_D / G

About 1 second

Measurement error:

MEASURE or measuring button pressed	Measurement and A/D conversion	Error determined	Error message displayed; error tone sounds	ΔE*ab alarm signal sent	

Signal from pin 8 of RS-232C terminal V_B — V_D / G

Signal from ΔE ALARM output socket V_A — V_D / G

About 1 second

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TIMER-CONTROLLED MEASUREMENTS

The Chroma Meter has a built-in timer and calendar/clock which can be used to automatically take measurements at specific intervals. To use the timer, follow the steps below.

1. Press **TIMER/CLOCK**. The display shown at right will appear.
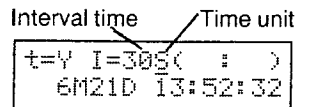
```
t=N
  6M21D 13:51:57
```
Month Day Hour Minute Second

2. Use **Y/N** to change setting of "t = " to "Y". Previously set data will appear in the display.

Interval time / Time unit
```
t=Y I=00S(  :  )
  6M21D 13:52:05
```

3. Use ←/→ (cursor keys) and number keys to set the desired interval time between the start of each measurement. Cursor will automatically move right after a number key is pressed; use ← (cursor key) to move left if necessary to correct mistakes. To change time unit from "S" (seconds) to "M" (minutes) or from "M" to "S", use ←/→ (cursor keys) to move cursor under the present time unit and press ( ) (scroll key). The minimum interval time which can be set should be determined from the chart below.
   * The interval time can be set from 03 to 99 seconds or from 01 to 99 minutes. If the interval time is set to 00 (minutes or seconds) or to 01 or 02 seconds, the interval time will automatically be set to 03 seconds when **ENTER** is pressed.

Interval time / Time unit
```
t=Y I=30S(  :  )
  6M21D 13:52:32
```

Average interval time (seconds) required:

"Multi Measure:" index		"Color Space:" index	"Print " index	
			Y	N
	N		N	8-9	3-4

"Multi Measure:" index		"Color Space:" index	"Print " index Y	"Print " index N
	N		N: 8-9	3-4
			Y: 13-16	3-4
	Y		N: 13-14	9-10
			Y: 18-21	9-10

Time intervals shorter than the above interval times will cause measurements to be taken consecutively as quickly as the Chroma Meter can reset itself for the next measurement.

4. Use number keys to set the desired end time (time of last measurement). Cursor will automatically move right after a number key is pressed; use ← (cursor key) to move left if necessary to correct mistakes. Time should be set in 24-hour format (e. g., for 1:00PM, set "13:00"). If continuous measurements are desired, set the end time to all blanks by pressing **SPACE** instead of number keys.

End time
```
t=Y I=30S(17:30)
  6M21D 13:53:10
```

5. Use number keys to set present date and time if necessary. Cursor will automatically move right after a number key is pressed; use ← (cursor key) to move left if necessary to correct mistakes. Time should be set in 24-hour format (e. g., for 1:00PM, set "13:00").
   * Although the internal clock continues to run, clock display will be halted while the date and time are being set.

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6. Press **ENTER** to complete setting. After about three seconds, timer display will change to measurement-mode display.
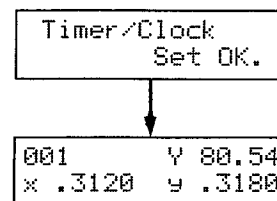
```
Timer/Clock
      Set OK.
```

```
001      Y 80.54
x .3120  y .3180
```

7. Place tip of measuring head flat against the specimen surface.
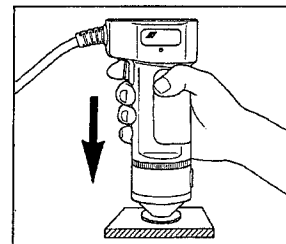
If using CR-321, position target area of baseplate over the desired subject area and tilt the body of the measuring head toward the baseplate so that the tip of the light-projection tube is against the subject to be measured.
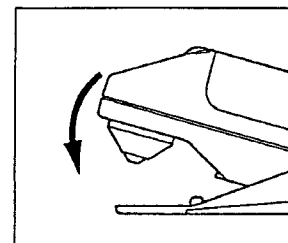
8. To start measurement cycle, press **MEASURE**.

* To start measurements at a specific time, press **TIMER/CLOCK**. Clock display will be shown. When the desired start time appears in the clock display, press **MEASURE** to start measurement cycle.

  * If the clock was set or the cursor moved after **TIMER/CLOCK** was pressed, measurement cycle will not be started when **MEASURE** is pressed.

* The measurement cycle can also be started by inputting control code "M" from a separate computer (see p. 65). However, the measurement cycle cannot be started by pressing the measuring head's measuring button or by using a switch connected to the remote-control socket.

* A tone will sound every second between measurements.

* When using the timer to control measurements, it is recommended that the AC adapter be used to provide power to the Chroma Meter.

* If the conditions for any of the following error messages occur during timer-controlled measurements, the measurement cycle will stop automatically.
  "Change Battery"
  "Check Connector"
  "Illumination Error"
  "NO Store Space"
  These error messages (with the exception of "Change Battery") will be printed out if the "Print" index is set to "Y".

To stop the measurement cycle, press **BREAK** until a tone sounds for about two seconds. Measurement cycle will start again when **MEASURE** is pressed.

To cancel timer-controlled measurements, press **BREAK** until a tone sounds for about two seconds, then press **TIMER/CLOCK**, use **Y/N** to change setting of "t = " to "N", and press **ENTER**.

MEMORY

The Chroma Meter has memory space for up to 300 sets of measurement data; this memory space can be divided into up to 20 pages (numbered 00 through 19). Data is stored automatically at the time of measurement in the color space selected for measurement and can be read out only in that color space. Both absolute and color-difference data are stored, regardless of which measurement mode was selected when the measurement was taken. Data can later be recalled to the display, printed out, used for statistical calculations, or output to a separate computer.

Pages

Data can be stored in up to 20 pages. A new page can be started when desired by following the steps below.

1. Push **PAGE**. The display at right will appear, showing the present page number and next page number.
   - Remaining data space will be shown only if the "Data Protect" index is set to "Y". If the "Data Protect" index is set to "N", remaining data space will not be shown.

Present page   Next page

```
┌──P00 → P01 ?
│  (274)Remaining
```

Remaining data space
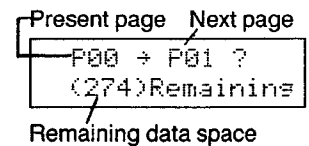
2. Press **ENTER**. The display at right will appear for a few seconds and then change to the measurement-mode display, showing measurement number 000 on the new page.
   - If it is decided not to change pages after performing step 1, press **BREAK** instead of performing step 2. After a few seconds, the display will return to the measurement-mode display.
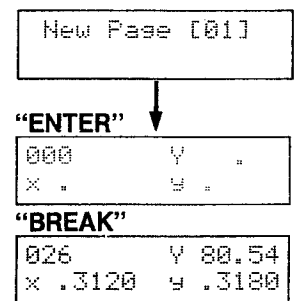
- It is not possible to return to a page and add data once that page has been closed and the next page has been started.
- If the "Data Protect" index is set to "Y", page change cannot be performed if the present page number is 19 or if the present measurement number is 300.
- If the "Data Protect" index is set to "N", all data previously stored on the next page will be deleted when the page is changed. If page change is performed when present page is 19, the new page will be page 00.

```
New Page [01]
```

"ENTER" ↓

```
000        Y   .
X  .       y   .
```

"BREAK"

```
026        Y 80.54
X .3120    y .3180
```

Data Protect

The "Data Protect" index may be used to prevent data stored in memory from being replaced by new data when memory space becomes full.
To set the "Data Protect" index, follow the steps below.
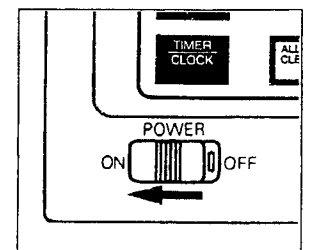
1. Check that POWER switch is at ON.

2. Press **INDEX SET**. Indexes will appear in the display, followed by their present settings.

3. Press ( ) (scroll key) repeatedly until "Data Protect" appears in the display, as shown at right. Indexes will change in the following order:

```
Data Protect:N
Multi Measure:N
```

```
Print:Y            Data Protect:N
Color Space:N  →   Multi Measure:N

         ↑                 ↓
Light Source:C     Multi Cal. :N
    (C/D65)    ←        CAL ch00
```
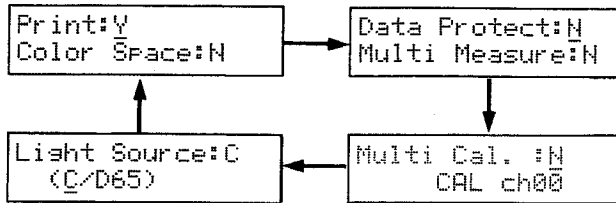
4. Use ←/→ (cursor keys) and Y/N to change "Data Protect" index to the desired setting.

   • If more than 300 measurements have been taken or all 20 pages of memory have been used, the "Data Protect" index cannot be changed from "N" to "Y".

5. Press ENTER. The display shown at right will appear for about three seconds before changing to measurement-mode display.

```
   Index Set OK.
```
↓
```
000        Y   .
x  .       y  .
```

Setting the "Data Protect" index to "Y" causes the following:

   • If a measurement is taken (or PAGE is pressed) after 300 data have been stored in memory, "NO Store Space" will appear in the display. Subsequent measurements will cause a warning tone to sound and this message to reappear. Measurement data will be displayed after the error message, but will not be stored.

```
NO Store Space
```

   • If PAGE is pressed after the page number has reached 19, "Page End" will appear in the display and no new pages may be started.

```
Page End
```

Setting the "Data Protect" index to "N" in the above circumstances will result in the following:

   • If only one page has been used for all memory, each new measurement will replace the oldest measurement stored in memory. If more than one page is used, oldest pages will be deleted as necessary to provide space for new measurements. In this case, new measurements will be stored on the last page in use unless PAGE is pressed.

   • Pressing ENTER after pressing PAGE will cause the oldest page in memory to be deleted and new data will be stored in that page. If the page becomes full, the next page will be deleted to provide more space.

Recalling Data

To recall measurement data stored in memory, follow the steps below.

- To print out measurement data stored in memory, see p. 59.
- To output measurement data stored in memory, see p. 69.

1. Check that POWER switch is at ON.

2. Press **STORED DATA LIST**. One of the three displays shown at right will appear in the display.

```
List   ABS  P02
       Print Out
```

```
List   ABS  P02
       Display
```

```
List   ABS  P02
       Output
```

3. Press ( ) (scroll key) repeatedly to select the display shown at right. The displays will change in the following order:

```
List   ABS  P02
       Display
```

```
List   ABS  P02  ──►  List   ABS  P02
     Print Out          Display
        ▲                  │
        │                  ▼
List   ABS  P02  ◄─────────
     Output
```
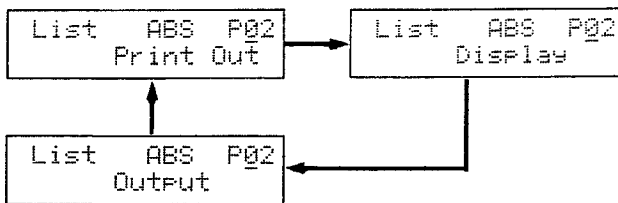
4. Press **ABS./DIFF.** to select recall of absolute or difference measurement data. The top center of the display shows the mode selected ("ABS" or "Diff").

- When data is recalled from memory in difference mode, no data will be displayed if the target color number selected at the time of measurement contained no data when the measurement was taken.

```
List   ABS  P03
       Display
```

```
List   Diff P03
       Display
```

5. Use ◄─/─► (cursor keys) and number keys to select the page to be displayed.

```
List   ABS  P01
       Display
```
Page number

If all pages are to be displayed, use **SPACE** to set the page number to all blanks.

```
List   ABS  P_
       Display
```

6. Press **ENTER** to start data recall.

Data will be recalled in the reverse order from which it was stored (data for highest measurement number is recalled first). The display will automatically change to data for the next lower measurement number every 0.5 second.

Display will stop changing and a tone will sound when the lowest measurement number on the selected page is displayed, and then the display will return to the measurement-mode display.

To stop the automatic changing of the display, press ( ) (scroll key).

After pressing ( ) (scroll key), data for the next higher or next lower measurement number can be selected using ←/→ (cursor keys). Pressing either ← or → (cursor key) until the tone sounds will cause the display to start automatically changing to the next higher or next lower measurement number every 0.5 seconds. To stop the automatic changing, press ( ) (scroll key) again. If the automatic changing is not stopped again by pressing ( ) (scroll key), display will automatically stop changing and a tone will sound when the highest or lowest measurement number on the selected page is displayed.

The tone will sound and the message at right will appear if → (cursor key) is pressed when the lowest measurement number on the selected page is displayed, or if ← (cursor key) is pressed when the highest measurement number on the selected page is displayed.

```
NO More Data
On Page
```

To cancel data recall and return to measurement mode, press **BREAK** until the tone sounds for a few seconds.

Temporarily Deleting Data from Memory

Data can be temporarily deleted from memory to exclude these data from statistical calculations. Data which have been temporarily deleted can be recovered to memory at a later time (see **Recovering Data** on p. 53). To temporarily delete data, follow the steps below.

1. Check that POWER switch is at ON

2. Press **STORED DATA LIST**. One of the three displays shown at right will appear in the display.

```
List   ABS  P02
       Print Out
```

```
List   ABS  P02
       Display
```

```
List   ABS  P02
       Output
```

3. Press ( ) (scroll key) repeatedly to select the display shown at right. The displays will change in the following order:

```
List   ABS  P02            List   ABS  P02
       Print Out                  Display

List   ABS  P02
       Output
```
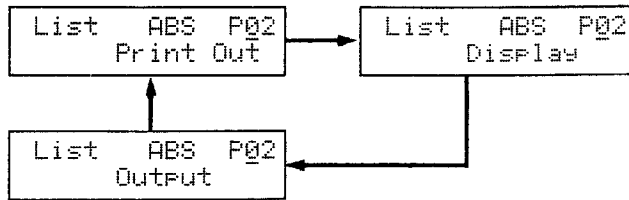
```
List   ABS  P02
       Display
```

4. Press **ABS./DIFF.** to select recall of absolute or difference measurement data. The top center of the display shows the mode selected ("ABS" or "Diff").

```
List   ABS  P03
       Display
```

```
List   Diff P03
       Display
```

5. Use ◄/► (cursor keys) and number keys to select the page from which data will be deleted.

```
List   ABS  P01
       Display
```
Page number

If the page number is not known, or if all pages contain data which are to be deleted, use **SPACE** to set the page number to all blanks.

```
List   ABS  P_
       Display
```

6. Press **ENTER** to start data recall.

Data will be recalled in the reverse order from which it was stored (data for the highest measurement number is recalled first). The display will automatically change to the data for the next lower measurement number every 0.5 second.

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7. When the data to be deleted appears in the display, press ( ) (scroll key) to stop the automatic changing of the display.

   If the data to be deleted has already been passed or has not yet been reached when ( ) (scroll key) is pressed, use either ← or → (cursor key) to select the data for the measurement number one higher or one lower than the presently displayed measurement number. Pressing either ← or → (cursor key) until the tone sounds will cause the display to start automatically changing to the next higher or next lower measurement number every 0.5 seconds. To stop the automatic changing, press ( ) (scroll key) again.

```
006        Y 74.17
x .3404   y .2608
```

8. Press DISPLAYED DATA **DELETE/RECOVER** to delete the data shown in the display. The display at right will appear.

```
* 006  Deleted *
```

9. Use ←/→ (cursor keys) to select the next data to be deleted.

10. Repeat steps 7 to 9 as needed until all desired data have been deleted.

11. Press **BREAK** until the tone sounds for a few seconds to return to measurement mode.

Recovering Data

Data which was temporarily deleted from memory can be recovered at a later time by following the steps below.
* Data which has been permanently deleted cannot be recovered.

1. Check that POWER switch is at ON.

2. Press **STORED DATA LIST**. One of the three displays shown at right will appear in the display.

```
List   ABS  P02
       Print Out
```

```
List   ABS  P02
       Display
```

```
List   ABS  P02
       Output
```

3. Press ( ) (scroll key) repeatedly to select the display shown at right. The displays will change in the following order:

```
List   ABS  P02
       Display
```

```
List   ABS  P02      →      List   ABS  P02
    Print Out                      Display

         ↑                            │
         │                            │
List   ABS  P02      ←─────────────────┘
    Output
```
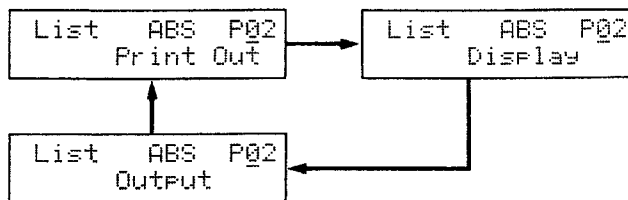
4. Press **ABS./DIFF.** to select recall of absolute or difference measurement data. The top center of the display shows the mode selected ("ABS" or "Diff").

```
List   ABS  P03
       Display
```

5. Use ◄─/─► (cursor keys) and number keys to select the page to which data will be recovered.

```
List   ABS  P01
       Display
```
Page number ─┘

If the page number is not known, or if all pages contain data which are to be recovered, use **SPACE** to set the page number to all blanks.

```
List   ABS  P_
       Display
```

6. Press **ENTER** to start data recall.
   Data will be recalled in the reverse order from which it was stored (data for the highest measurement number is recalled first). The display will automatically change to the data for the next lower measurement number every 0.5 second.

7. When the measurement number for which data is to be recovered appears in the display, press ( ) (scroll key) to stop the automatic changing of the display.

   If the measurement number for which data is to be recovered has already been passed or has not yet been reached when ( ) (scroll key) is pressed, use ←/→ (cursor keys) to select the measurement number one higher or one lower than the presently displayed measurement number. Pressing ← or → (cursor key) until the tone sounds will cause the display to start automatically changing to the next higher or next lower measurement number every 0.5 seconds. To stop the automatic changing, press ( ) (scroll key) again.

```
* 006   Deleted *
```

8. Press DISPLAYED DATA **DELETE/RECOVER** to recover the data for the measurement number shown in the display. The upper display at right will appear for a few seconds, then change to the lower display.

```
* 006 Recovered*
```
```
006        Y 74.17
x .3404   y .2608
```

9. Use ←/→ (cursor keys) to select the next measurement number for which data will be recovered.

10. Repeat steps 7 to 9 as needed until all desired data have been recovered.

11. Press **BREAK** until the tone sounds for a few seconds to return to measurement mode.

Permanently Deleting Data from Memory

All measurement data can be permanently deleted from memory by following the steps below.
- It is not possible to permanently delete selected data sets.
- Data which has been permanently deleted cannot be recovered.

1. Press **ALL DATA CLEAR**. The display at right will appear.
   - If it is decided to not delete data, press **BREAK** to return to measurement mode.

```
All Stored Data
   Delete OK ?
```

2. Press **ENTER**. The display at right will appear for a few seconds, and then return to the measurement-mode display.

```
All Stored Data
   Deleted
```
```
000        Y  .
x .        y .
```

PRINTING DATA

The Data Processor uses a 24-character thermal-dot printer for printing data. Data can be printed automatically at the time of measurement, at any time while it is displayed, or from memory at a later time. In addition, data can be printed out at the time of measurement in all color spaces if desired, and the results of statistical calculations performed on data in memory can also be printed out.

At Time of Measurement

Data is printed automatically at the time of measurement if system reset has been performed and the "Print" index has not been changed afterward. If the "Print" index has been changed and automatic printing is desired, follow the steps below.
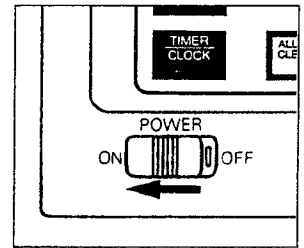
1. Check that POWER switch is at ON.

2. Press **INDEX SET**. Indexes will appear in the display, followed by their present settings.

```
Print:N
Color Space:N
```

3. Press () (scroll key) repeatedly until the "Print" index appears in the display, as shown at right. Indexes will change in the following order:

```
Print:N              Data Protect:N
Color Space:N        Multi Measure:N


Light Source:C       Multi Cal. :N
  (C/D65)              CAL ch00
```
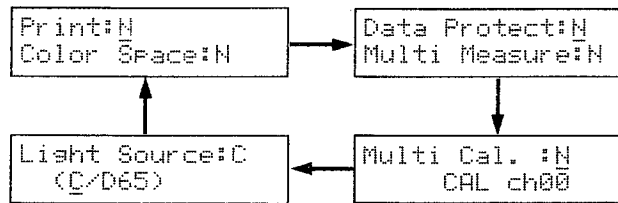
4. Use ←/→ (cursor keys) and **Y/N** to change the "Print" index to "Y". Pressing **Y/N** again will change index back to "N".

5. Press **ENTER**. The display shown at right will appear for about three seconds before changing to measurement-mode display.

```
Index Set OK.
```

```
001       Y 80.54
x .3120   y .3180
```

Data will be printed out according to the current color space and measurement mode in use. Examples are shown below.

ABSOLUTE MEASUREMENT MODE	DIFFERENCE MEASUREMENT MODE

Yxy

```
009
Y  99.76 x .3102 y .3161
```

Δ (Yxy)

```
013 T00
Y  +4.75 x+.0101 y-.0039
```

L*a*b*

```
010
L  99.91 a +0.03 b  0.00
```

Δ(L*a*b*)

```
014 T00           E  7.61
L  +1.88 a +7.37 b +0.29
```

L*C*H°   ("Light Source: C" only)

```
011                    (PB)
L  99.91 C  0.06 H°350.6
```

Δ(L*C*H*)

```
015 T00           E  7.62
L  +1.88 C -7.28 H +1.24
```

XYZ

```
018
X  30.58 Y 28.22 Z 18.61
```

Hunter Lab

```
019       Hunter
L  53.13 a +9.81 b+16.41
```

Hunter Δ(Lab)

```
023 T01  Hunter  E  0.04
L  -0.01 a -0.04 b -0.02
```

In All Color Spaces

If desired, data can be automatically printed in all color spaces. By following the steps below, data will be printed at the time of measurement in Yxy, L*a*b*, L*C*H° , XYZ, and Hunter Lab for absolute measurements or in Δ(Yxy), Δ(L*a*b*), Δ(L*C*H*), and Hunter Δ(Lab) for difference measurements.

1. Check that POWER switch is at ON.
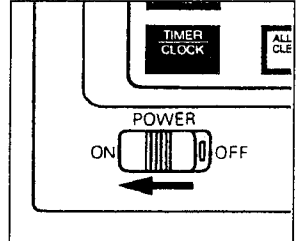
2. Press **INDEX SET**. Indexes will appear in the display, followed by their present settings.

3. Press ( ) (scroll key) repeatedly until the display shown at right appears. Indexes will change in the following order:

```
┌────────────────────┐      ┌────────────────────┐
│ Print:N            │  →   │ Data Protect:N     │
│ Color Space:N      │      │ Multi Measure:N    │
└────────────────────┘      └────────────────────┘
        ↑                            │
        │                            ↓
┌────────────────────┐      ┌────────────────────┐
│ Light Source:C     │  ←   │ Multi Cal.  :N     │
│    (C/D65)         │      │       CAL ch00     │
└────────────────────┘      └────────────────────┘
```
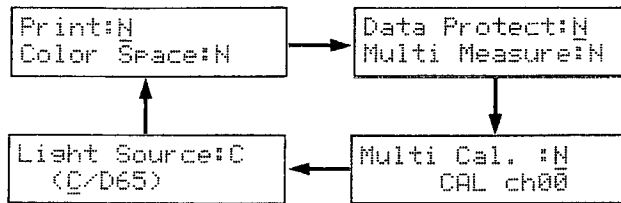
```
Print:N
Color Space:N
```

4. If necessary, use ←/→ (cursor keys) and **Y/N** to change the "Print" and "Color Space" indexes to "Y".

```
Print:Y
Color Space:Y
```

5. Press **ENTER**. The display shown at right will appear for about three seconds before changing to measurement-mode display.

```
Index Set OK.
```

```
001          Y 80.54
x .3120   y .3100
```

Each time a measurement is taken, data will be printed in all color spaces as shown below.
  • Data is stored only in the color space selected for display.

ABSOLUTE MEASUREMENT MODE

```
025
Y  21.94 x .3955 y .3706
L  53.95 a +8.62 b+22.78
L  53.95 C 24.35 H° 69.4
X  23.41 Y 21.94 Z 13.04
        Hunter
L  46.83 a +7.26 b+15.27
```

DIFFERENCE MEASUREMENT MODE

```
024 T01
Y  -6.55 x-.0001 y+.0064
L  -6.36 a -2.78 b -0.49
L  -6.36 C -1.55 H +2.35
        Hunter
L  -6.54 a -2.83 b -1.22
        HE  7.22  E  6.95
```
——ΔE*ab

Hunter ΔE

Displayed Data

Data shown in the display can be printed at any time by pressing **DISPLAY PRINT**. When this key is pressed, data is printed out exactly as it is displayed, regardless of the setting of "Print" index. Printing examples are shown below.

ABSOLUTE MEASUREMENT MODE

DIFFERENCE MEASUREMENT MODE

Yxy

```
   001      Y 99.79
   x .3101  y .3161
```

Δ(Yxy)

```
   005 T00  Y +4.79
   x+.0101  y-.0039
```

L*a*b*

```
   002      L 99.91
   a +0.04  b  0.00
```

Δ(L*a*b*)

```
   E  7.64  L +1.88
   a +7.40  b +0.28
```

L*C*H°   ("Light Source: C" only)

```
   003 (RP) L 99.90
   C  0.08  H°339.5
```

Δ(L*C*H*)

```
   E  7.62  L +1.87
   C -7.27  H +1.35
```

XYZ

```
   001      X 25.70
   Y  27.34 Z 37.31
```

Hunter Lab

```
   001      HL 52.28
   a -3.78  b -5.70
```

Hunter Δ(Lab)

```
   E  0.40 HL -0.05
   a +0.39  b +0.09
```

Data in Memory

Data stored in one page or on all pages of memory can be printed out if desired. Data is printed in the reverse order from which it was stored (latest data is printed first). To print data stored in memory, follow the steps below.
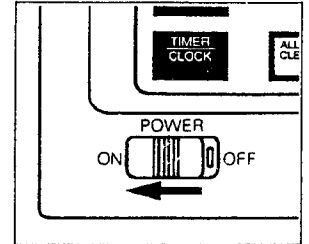
1. Check that POWER switch is at ON

2. Press **STORED DATA LIST**. One of the three displays shown at right will appear in the display.

```
List   ABS  P02
       Print Out
```

```
List   ABS  P02
       Display
```

```
List   ABS  P02
       Output
```

3. Press ( ) (scroll key) repeatedly to select the display shown at right. The displays will change in the following order:

```
List   ABS  P02          List   ABS  P02
       Print Out                Display


List   ABS  P02
       Output
```

```
List   ABS  P02
       Print Out
```
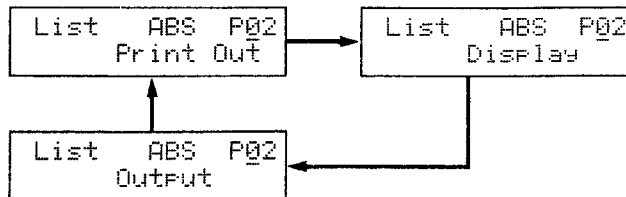
4. Press **ABS./DIFF.** to select printing of absolute or difference measurement data. The top center of the display shows the mode selected ("ABS" or "Diff").

   • When data is printed from memory in color-difference mode, no data will be printed if the target color number selected at the time of measurement contained no data when the measurement was taken.

```
List   ABS  P02
       Print Out
```

```
List   Diff P02
       Print Out
```

5. Use ←/→ (cursor keys) and number keys to select the page to be printed.

```
List   ABS  P01
       Print Out
```
Page number

If all pages are to be printed, use **SPACE** to set the page number to all blanks.

```
List   ABS  P_
       Print Out
```

6. Press **ENTER** to start printing.

 • During printing, the measurement number for which data are being printed out will be shown in the display.

 To stop printing before printout is complete, press **BREAK** until the tone sounds for about one second.

All data stored in the pages selected are printed out, even if stored using different color spaces. Printing examples are shown below.

ABSOLUTE MEASUREMENT MODE   DIFFERENCE MEASUREMENT MODE

┌─ Page number   ┌── Date and time of first measurement on page *
│   ├─ Date and time of last measurement on page

```
  _ _ _ _ _ _ _ _ _ _           _ _ _ _ _ _ _ _ _ _ _
├─P01        8M17D  6:28─┐       P04         8M17D  6:41
            8M17D  6:29─┘                   8M17D  6:46
005                             005 T01         E 31.41
X  23.81 Y 25.27 Z 34.40        L  -0.94 a+11.95 b+29.04
004                (B )         004 T01
L  57.33 C  7.34 H°236.0        Y  +4.75 x+.1142 y+.0739
003                             003 T01  Hunter  E 26.91
L  57.33 a -4.00 b -6.09        L  +4.28 a+11.01 b+24.18
002                             002 T00         E  4.65
Y  25.27 x .2852 y .3027        L  +1.12 C +3.48 H +2.87
001       Hunter                001 T02         E  5.39
L  50.25 a -3.34 b -5.38        L  +4.18 a +1.10 b +3.23
  _ _ _ _ _ _ _ _ _ _             _ _ _ _ _ _ _ _ _ _
P00         8M17D  6:27         P03         8M17D  6:39
            8M17D  6:28                     8M17D  6:41
005       Hunter                005 T00
L  54.00 a +8.91 b+16.43        Y +65.55 x-.0026 y-.0455
004                             004 T00  Hunter  E 47.36
X  31.54 Y 29.26 Z 19.94        L +43.63 a-10.76 b-14.97
003               (YR)          003 T02         E 47.27
L  60.75 C 25.33 H° 67.1        L +40.35 C-23.10 H +8.53
002                             002 T01         E 41.48
L  60.82 a+10.45 b+22.67        L +40.73 a +2.27 b +7.52
001                             001 T01
Y  28.68 x .3907 y .3642        Y +69.15 x+.0249 y+.0173
```

 * If "Data Protect" index is set to "N" and more than 300 measurements have been taken, date and time of first measurement will not be printed out.

Statistical Calculations

The Data Processor can perform statistical calculations using data stored in memory and determine the maximum, minimum, mean, and standard deviation of a series of measurements. Data on one page of memory or all data in memory may be used for calculations. The Data Processor will automatically select the data which was stored in the selected color space from among all data on the selected page or on all pages and use only the selected data for calculations.

To perform statistical calculations, follow the steps below.

1. Check that POWER switch is at ON.
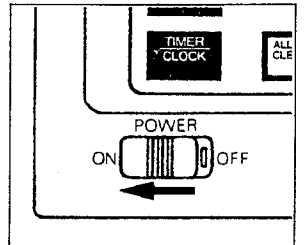
2. Press **STATISTIC.** The display shown at right will appear.

3. Use ◀━/━▶ (cursor keys) and number keys to select the page which contains the data to be used for calculations.

   Page number

   If all pages contain data to be used for calculations, use **SPACE** to set the page number to all blanks.

4. Press **COLOR SPACE SELECT** to choose the color space of the data to be used for calculations. Color space will change as follows:

ABSOLUTE MEASUREMENT MODE

Yxy   L*a*b*

Hunter Lab   L*C*H°

                             XYZ

DIFFERENCE MEASUREMENT MODE

Yxy   L*a*b*

DxDyDz   L*C*H°
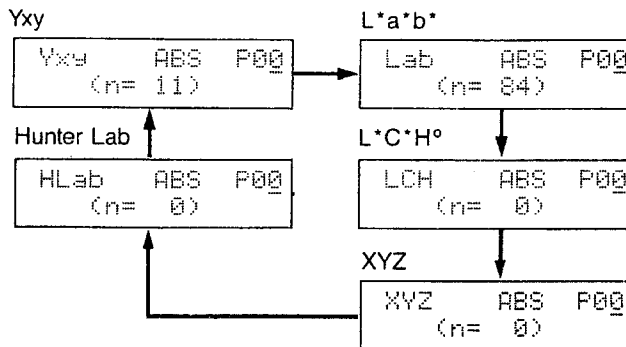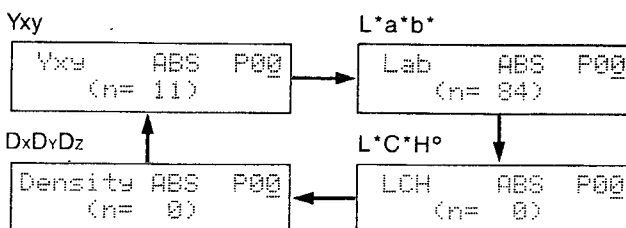
● Only data which was stored in the selected color space will be used for calculations.

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5. Press **ABS./DIFF.** to select calculations using absolute or difference measurement data. The top center of the display shows the mode selected ("ABS" or "Diff").

* If XYZ color space was selected in step 4, "Diff" cannot be selected.

```
Lab    ABS  P00
   (n= 84)
```

```
Lab    Diff P00
   (n= 84)
```

6. Press **ENTER** to start calculations. The display at right will appear. When calculations are complete, the results will be printed out and will also be output via the RS-232C terminal. Printing examples are shown on the following page.

```
Lab    ABS  P01
   Statistic
```

After printing is complete, the display will automatically return to measurement mode.

* To stop statistical calculations before they have been printed out, press **BREAK** until the tone sounds for one second. The display will then return to measurement mode in a few seconds.
* If statistical calculations are performed using L*C*H° color space and the measurement data are close to the +a* axis (for example, measurements with hue angles of H° = 5, H° = 350, etc.), the mean value of the hue angles will be close to 180°.

```
031      Y 75.43
x .3215  y .2489
```

ABSOLUTE MEASUREMENT MODE

Yxy

```
┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
│ P00          9M 7D 13:42
│ (n= 20)      9M 7D 13:44
│ MAX
│ Y  96.29 x .3121 y .3200
│ MIN
│ Y  96.25 x .3120 y .3199
│ MEAN
│ Y  96.27 x .3120 y .3199
│ SD
│ Y   0.01 x .0000 y .0000
```

❶ Page
❷ Number of data
❸ Maximum value
❹ Minimum value
❺ Mean value
❻ Standard deviation

DIFFERENCE MEASUREMENT MODE

Δ(Yxy)

```
┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
│ P00          9M 7D 15:09
│ (n= 20)      9M 7D 15:11
│ MAX
│ Y  -0.38 x-.0015 y-.0024
│ MIN
│ Y  -0.40 x-.0021 y-.0027
│ MEAN
│ Y. -0.39 x-.0019 y-.0025
│ SD
│ Y   0.00 x .0001 y .0001
```

❼ Date and time of first measurement on page*
❽ Date and time of last measurement on page

L*a*b*

```
┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
│ P00          9M 7D 13:45
│ (n= 20)      9M 7D 13:47
│ MAX
│ L  98.56 a -0.83 b +1.84
│ MIN
│ L  98.53 a -1.00 b +1.74
│ MEAN
│ L  98.54 a -0.95 b +1.79
│ SD
│ L   0.01 a  0.04 b  0.02
```

Δ(L*a*b*)

```
┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
│ P00          9M 7D 15:13
│ (n= 17)      9M 7D 15:14
│ MAX             E  0.36
│ L  +0.16 a -0.01 b +0.14
│ MIN             E  0.10
│ L  +0.02 a -0.30 b +0.07
│ MEAN            E  0.22
│ L  +0.10 a -0.16 b +0.11
│ SD              E  0.05
│ L   0.03 a  0.07 b  0.02
```

L*C*H°

```
┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
│ P00          9M 7D 13:49
│ (n= 25)      9M 7D 13:51
│ MAX
│ L  98.55 C  2.04 H°118.3
│ MIN
│ L  98.54 C  1.99 H°116.5
│ MEAN
│ L  98.54 C  2.02 H°117.6
│ SD
│ L   0.00 C  0.01 H°  0.4
```

Δ(L*C*H*)

```
┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
│ P00          9M 7D 15:18
│ (n= 22)      9M 7D 15:19
│ MAX             E  0.77
│ L  +0.16 C +0.29 H +0.69
│ MIN             E  0.33
│ L  +0.03 C +0.11 H +0.28
│ MEAN            E  0.42
│ L  +0.09 C +0.17 H +0.37
│ SD              E  0.09
│ L   0.03 C  0.04 H  0.08
```

XYZ

```
┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
│ P00          9M 7D 11:22
│ (n= 24)      9M 7D 11:25
│ MAX
│ X  12.97 Y 11.53 Z 37.30
│ MIN
│ X  12.86 Y 11.49 Z 37.06
│ MEAN
│ X  12.88 Y 11.51 Z 37.14
│ SD
│ X   0.02 Y  0.01 Z  0.04
```

Hunter Lab

```
┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
│ P00          9M 7D 11:29
│ (n= 20)    ( 9M 7D 11:32
│ MAX     Hunter
│ L  98.12 a -1.84 b +1.43
│ MIN     Hunter
│ L  98.11 a -1.91 b +1.40
│ MEAN    Hunter
│ L  98.11 a -1.89 b +1.41
│ SD      Hunter
│ L   0.00 a  0.02 b  0.01
```

Hunter Δ(Lab)

```
┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
│ P00          9M 7D 11:42
│ (n= 20)      9M 7D 11:44
│ MAX     Hunter E  0.60
│ L  -0.16 a +0.17 b +0.08
│ MIN     Hunter E  0.21
│ L  -0.29 a -0.52 b -0.24
│ MEAN    Hunter E  0.29
│ L  -0.18 a +0.01 b -0.13
│ SD      Hunter E  0.07
│ L   0.02 a  0.13 b  0.06
```

* If "Data Protect" index is set to "N" and more than 300 measurements have been taken, date and time of first measurement will not be printed out.

DATA INPUT/OUTPUT

The Data Processor is equipped with an RS-232C terminal for connection with a separate computer. When a separate computer is connected to the Data Processor, data can be transferred between the two units and all key functions of the Data Processor can be operated from the computer.

RS-232C terminal

The RS-232C terminal of the Data Processor uses a DIN 8-pin connector (included as a standard accessory). The pin diagram of the RS-232C terminal is shown below.
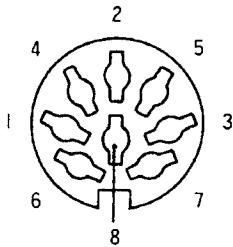
Pin number	Signal	Function
1	GND	System ground
2	TXD	Transmit data
3	RXD	Receive data
4	RTS	Request to send
5	CTS	Clear to send
6	DSR	Data set ready
7	DTR	Data terminal ready
8		Used by ΔE alarm; see p. 42

* When connecting the RS-232C terminal of the Data Processor to a separate computer, a shielded cable should be used. Connections are shown below.

Chroma Meter		Separate computer	
		Using 25-pin D-subminiature plug	Using 9-pin D-subminiature plug
1		7	5
2		3	2
3		2	3
4		5	8
5		4	7
6		20	4
7		6	6

* When connecting or disconnecting the data-output cable, be sure that the power switches of both the Data Processor and the separate computer are at OFF.

COMMUNICATION PARAMETERS

Output voltage: CMOS ±5V
Data format:
    Start bit: 1
    Data bits: 7 (ASCII code)
    Parity: Even
    Stop bits: 2

Data rate: 4800 baud (can be adjusted by authorized service personnel to between 600 and 9600 baud; 9600 baud is for data output only)

If the communication parameters (such as number of data bits, parity, stop bit or baud rate) are different from what they should be when inputting data from the computer to the Data Processor, a 2.5KHz tone will sound for three seconds.

Data Input

By inputting the control codes shown below, the functions of the Data Processor's keys can be operated from the separate computer.

Control code (output by separate computer)	ASCII code equivalent (hexadecimal)	Key function
A	41	**ABS./DIFF.**
B	42	**BREAK**
C	43	**CALIBRATE**
D	44	**DISPLAY PRINT**
E	45	**ENTER**
F	46	**PAPER FEED**
G	47	**COLOR SPACE SELECT**
H	48	**STORED DATA LIST**
I	49	**INDEX SET**
J	4A	**TIMER/CLOCK**
K	4B	**ALL DATA CLEAR**
L	4C	**←** (cursor key)
M	4D	**MEASURE**
N	4E	**TARGET COLOR SELECT**
O	4F	**SPACE**
P	50	**PAGE**
Q	51	DISPLAYED DATA **DELETE/RECOVER**
R	52	**➡** (cursor key)
S	53	**STATISTIC**
T	54	**TARGET COLOR SET**
U	55	**+/-**
V	56	**( )**(scroll key)
W	57	**ΔE ALARM SET**
X	58	Causes display to be shown on the computer monitor.
Y	59	**Y/N**
0	30	Number key **0**
1	31	Number key **1**
2	32	Number key **2**
3	33	Number key **3**
4	34	Number key **4**
5	35	Number key **5**
6	36	Number key **6**
7	37	Number key **7**
8	38	Number key **8**
9	39	Number key **9**

- If more than one control code is input from the separate computer, only the first control code input will be used and other control codes will be ignored.
- Termination of data input from the separate computer is indicated by CR (0D) and LF (0A) codes.
- Statistical calculations or data recall cannot be stopped using any of the control codes (including "B").

Data Output

The following kinds of data can be output to the separate computer from the Data Processor by using the keyboard or using a separate computer to input the control codes listed above for controlling the key functions of the Data Processor:

(a) Measurement data at the time of measurement,

(b) Measurement data stored in memory (by selecting "OUTPUT" after pressing **STORED DATA LIST**),

(c) The results of statistical calculations,

(d) Data in the display (by using **DISPLAY PRINT**),

(e) Error messages,

(f) Results of pressing **ENTER**,

(g) Display after deleting or recovering data, or

(h) Display after performing calibration or inputting target color.

In addition, inputting control code "X" from the separate computer will also cause the Data Processor's display to be output to the computer.

Data is output from the RS-232C terminal according to the RS-232C standard using ASCII code.

OUTPUT FORMAT

For output of measurement data at the time of measurement:
Each measurement consists of two lines of data. Output data are the same as the printed data.
Each line of data consists of 24 characters plus delimiter codes CR (0D hexadecimal) and LF (0A hexadecimal). An example is shown below in hexadecimal notation.

Print example

Page number

Date and time of
first measurement on page

```
- - - - - - - - - - -
P01        6M13D 16:13
001
L  98.00 a -0.05 b -0.01
```

Output example

`1 • • • 5 • • • •10 • • • •15 • • • •20 • • • •25 •`

2D	20	2D	20	2D	20	2D	20	2D	20	2D	20	2D	20	2D	20	2D	20	20	2D	20	2D	20	0D	0A
50	30	31	20	20	20	20	20	20	20	20	20	20	36	4D	31	33	44	20	31	36	3A	31	33	0D	0A
30	30	31	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	0D	0A
4C	20	20	39	38	2E	30	30	20	61	20	2D	30	2E	30	35	20	62	20	2D	30	2E	30	31	0D	0A

Delimiter codes

- A dotted line, the page number, and the date and time of the first measurement on the page will be output before the first data set when the page is changed or after performing system reset.

For output of measurement data stored in memory, or output of results of statistical calculations:

Output data are the same as the printed data. Each line of data consists of 24 characters plus delimiter codes CR (0D hexadecimal) and LF (0A hexadecimal). An example is shown below in hexadecimal notation.

Print example   Output example

Page number

```
- |- - - - - - - - - - -
F01              6M13D 16:13
(n=  5)          6M13D 16:14
MAX
L  98.00 a +0.01 b  0.00
MIN
L  98.00 a -0.05 b -0.02
MEAN
L  98.00 a -0.02 b -0.01
SD
L   0.00 a  0.02 b  0.00
```

1 • • • 5 • • • • 10 • • • • 15 • • • • 20 • • • • 25 •

2D 20 2D 20 2D	20 2D 20 2D 20	2D 20 2D 20 2D	20 2D 20 2D 20	2D 20 2D 20 0D	0A
50 30 31 20 20	20 20 20 20 20	20 20 20 36 4D	31 33 44 20 31	36 3A 31 33 0D	0A
28 6E 3D 20 20	35 29 20 20 20	20 20 20 36 4D	31 33 44 20 31	36 3A 31 34 0D	0A
4D 41 58 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 0D	0A
4C 20 20 39 38	2E 30 30 20 61	20 2B 30 2E 30	31 20 62 20 20	30 2E 30 30 0D	0A
4D 49 4E 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 0D	0A
4C 20 20 39 38	2E 30 30 20 61	20 2D 30 2E 30	35 20 62 20 2D	30 2E 30 32 0D	0A
4D 45 41 4E 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 0D	0A
4C 20 20 39 38	2E 30 30 20 61	20 2D 30 2E 30	32 20 62 20 2D	30 2E 30 31 0D	0A
53 44 20 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 0D	0A
4C 20 20 20 30	2E 30 30 20 61	20 20 30 2E 30	32 20 62 20 2D	30 2E 30 30 0D	0A
1A 20 20 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 0D	0A

└── Termination code   Delimiter codes ──┘

- The page number and the date and time of the first measurement on the page will be output before the first data set when the page is changed. If all 300 measurement data have been stored on one page, the date and time of the first measurement will not be output.
- Termination of data output is indicated by 1A (hexadecimal) followed by 23 spaces (20 hexadecimal), and delimiter codes CR (0D hexadecimal) and LF (0A hexadecimal). If "Print Out" or "Display" is selected after pressing **STORED DATA LIST**, only this line of data will be output when printout or data recall is completed.

For output of data in the display (by using **DISPLAY PRINT**), output of error messages, output after performing calibration or inputting target color, or output after pressing **ENTER**:

Each display output consists of two lines of data. Output data are the same as the data which appears in the display. Each line of data consists of 26 characters: a 4-space margin, 16 characters for displayed data, a 4-space margin, and delimiter codes CR (0D hexadecimal) and LF (0A hexadecimal). An example is shown below in hexadecimal notation.

Display example   Output example

`Data Set Error`

1 • • • 5 • • • • 10 • • • • 15 • • • • 20 • • • • 25 •

20 20 20 20 20	44 61 74 61 20	53 65 74 20 45	72 72 6F 72 20	20 20 20 20 0A	0A
20 20 20 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 20	20 20 20 20 0D	0A

4-space   Displayed data   4-space
margin   margin
                                    Delimiter codes ──┘

For output of the display after deleting or recovering data:

Output data will consist of one line of data, which is the same as the line of data which would be printed out. The line of data consists of 24 characters plus delimiter codes CR (0D hexadecimal) and LF (0A hexadecimal). An example is shown below in hexadecimal notation.

Display example   Output example

`* 003  Deleted *`
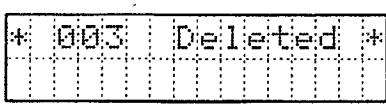
1 • • • 5 • • • • 10 • • • • 15 • • • • 20 • • • • 25 •

20 2A 2A 2A 20	20 30 30 33 20	20 44 65 6C 65	74 65 64 20 20	2A 2A 2A 20 0D	0A

Delimiter codes

For output of the display when control code "X" is input from a separate computer:

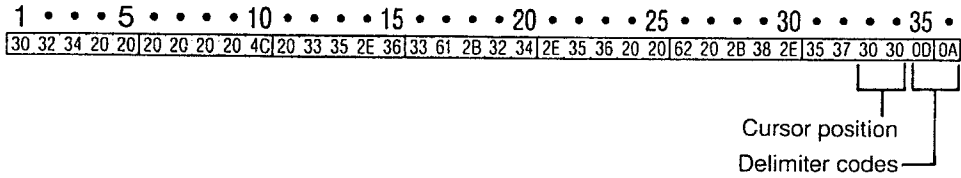The display is output as one line of data consisting of 36 characters (the 32 characters of the display, 2 characters indicating cursor position (if no cursor is in the display, 00 will be indicated), CR (0D), and LF (0A). Examples are shown below.

When no cursor is in the display:

Display example


```
1 • • • 5 • • • • 10 • • • • 15 • • • • 20 • • • • 25 • • • • 30 • • • • 35 •
30 32 34 20 20|20 20 20 20 4C|20 33 35 2E 36|33 61 2B 32 34|2E 35 36 20 20|62 20 2B 38 2E|35 37 30 30 0D|0A
```

Cursor position

Delimiter codes

When a cursor is in the display:

Display example


```
1 • • • 5 • • • • 10 • • • • 15 • • • • 20 • • • • 25 • • • • 30 • • • • 35 •
43 41 4C 20 63|68 30 30 20 59|20 39 33 2E 33|30 78 20 2E 33|31 33 37 20 20|79 20 2E 33 32|31 32 30 37 0D|0A
```

Cursor position

Delimiter codes
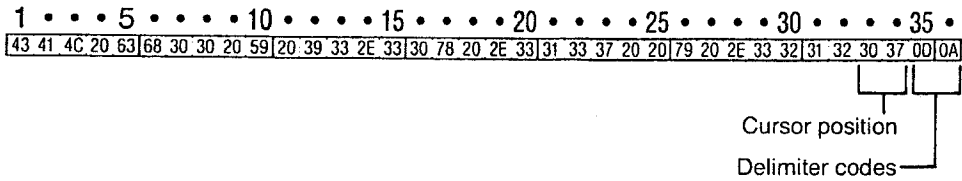
- For L*C*H° color space, " ° " is output as 7F (hexadecimal).
- For "P00→P01", "→" is output as 7E (hexadecimal).

TO OUTPUT DATA IN MEMORY

1. Check that POWER switch is at ON

2. Press **STORED DATA LIST.** One of the three displays shown below will appear in the display.

```
List   ABS  P02        List   ABS  P02        List   ABS  P02
      Print Out               Display                Output
```

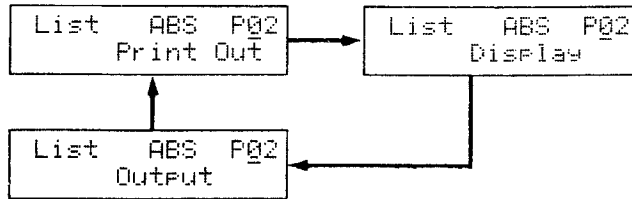3. Press ( ) (scroll key) repeatedly to select the display shown at right. The displays will change in the following order:

```
List   ABS  P02
      Output
```

```
List   ABS  P02  ──────▶  List   ABS  P02
      Print Out                  Display
        ▲                          │
        │                          │
List   ABS  P02  ◀─────────────────┘
      Output
```

4. Press **ABS./DIFF.** to select output of absolute or difference measurement data. The top center of the display shows the mode selected ("ABS" or "Diff").
   - When data is output from memory in difference mode, no data will be output if the target color number selected at the time of measurement contained no data when the measurement was taken.

5. Use ◀/▶ (cursor keys) and number keys to select the page to be output.

```
List   ABS  P02
      Output
```

```
List   Diff P02
      Output
```

```
List   ABS  P01
      Output    /
```
Page number

If all pages are to be output, use **SPACE** to set the page number to all blanks.

```
List   ABS  P_
      Output
```

6. Press **ENTER** to start output. Data will be output according to the data format on p. 67.

To stop output before output is complete, press **BREAK** until the tone sounds for about one second. Data output cannot be stopped by transmitting the control code "B" from the separate computer.

PROGRAM EXAMPLES

The following are program examples which can be used when the Data Processor is connected to an IBM-PC.

* The baud rate of the RS-232C terminal is preset to 4800 baud. The baud rate for the IBM-PC is set in the program. When using other programs or computers, be sure that the baud rate of the computer is set to 4800 baud.

For inputting data from the Data Processor to the separate computer at the time of measurement:

```
1000  DIM DT$(700)
1010  OPEN "COM1:4800, E, 7, 2, CS, DS, CD" AS #1
1020  N = 1
1030  LINE INPUT #1, DT$(N)
1040  PRINT DT$(N)
1050  N = N +1
1060  GOTO 1030
```

For inputting the data stored in memory (when listing data in memory) or the results of statistical calculations (when performing statistical calculations) from the Data Processor to the separate computer:

```
1000  DIM DT$(700)
1010  OPEN "COM1: 4800, E, 7, 2, CS, DS, CD" AS #1
1020  N = 1
1030  LINE INPUT #1, DT$(N)
1040  IF LEFT$(DT$(N), 1) = CHR$(&H1A) THEN GOTO 1070
1050  N = N +1
1060  GOTO 1030
1070  CLOSE #1
1080  A = 1
1090  FOR I = A TO A +19
1100  PRINT DT$(I)
1110  IF I = N -1 THEN GOTO 1160
1120  NEXT I
1130  INPUT "PRESS Y FOR NEXT SCREEN", C$
1140  IF C$ = "Y" THEN GOTO 1150 ELSE GOTO 1130
1150  A = I : GOTO 1090
1160  END
```

For inputting control codes from the separate computer to the Data Processor (for controlling the Chroma Meter with the computer) and displaying the results of input instructions on the computer monitor after the control code has been input:

- This program cannot be used to control statistical calculations or output of data in memory from a separate computer.

```
100  CLS                                    360  PRINT #1, K$
110  PRINT "INPUT COMMAND                   370  LINE INPUT #1,N$
          (PRESS * TO END PROGRAM)";        380  N1$ = LEFT$(N$, 16)
120  K$ = INKEY$                            390  N2$ = MID$(N$, 17, 16)
130  IF K$ = "" OR K$ = CHR$(13)            400  CURSOR = VAL(RIGHT$(N$, 2))
        THEN GOTO 120                       410  PRINT : PRINT N1$ : PRINT N2$
140  IF K$ = "H" OR K$ = "S"                420  PRINT "The location of cursor:";
        THEN GOTO 120                            CURSOR : PRINT
150  IF K$ = "*" THEN GOTO 620              430  CLOSE #1
160  IF K$ = "D" OR K$ = "E" OR             440  GOTO 200
        K$ = "M" THEN GOTO 230              450  '
170  IF K$ = "X" THEN GOTO 340              460  OPEN "COM1:4800, E, 7, 2, CS, DS, CD"
180  IF K$ = "Q" THEN GOTO 460                   AS #1
190  GOTO 550                               470  PRINT K$
200  PRINT                                  480  PRINT #1, K$
210  GOTO 110                               490  LINE INPUT #1, O$
220  '                                      500  PRINT : PRINT O$ : PRINT : PRINT
230  PRINT K$                               510  CLOSE #1
240  OPEN "COM1: 4800, E, 7, 2, CS, DS, CD" 520  K$ = "X"
        AS #1                               530  GOTO 350
250  PRINT #1,K$                            540  '
260  LINE INPUT #1,L$:LINE INPUT #1, M$     550  OPEN "COM1: 4800, E, 7, 2, CS, DS, CD"
270  IF LEFT$(L$,1) = "-" THEN GOTO 280          AS #1
                    ELSE GOTO 300           560  PRINT K$
280  PRINT : PRINT L$ : PRINT M$            570  PRINT #1, K$
290  LINE INPUT #1, L$:LINE INPUT #1, M$    580  CLOSE #1
300  PRINT : PRINT L$ : PRINT M$ : PRINT    590  K$ = "X"
310  CLOSE #1                               600  GOTO 350
320  GOTO 200                               610  '
330  '                                      620  PRINT : PRINT
340  PRINT K$                               630  PRINT "<PROGRAM END>"
350  OPEN "COM1: 4800, E, 7, 2, CS, DS, CD" 640  PRINT : PRINT
        AS #1                               650  END
```

- If control code "E" is input from the computer in calibration mode or measurement mode while running this program, the program will stop running but will not end. If this occurs, the program cannot be restarted without switching the Data Processor off and then on again and resetting the computer.

REMOTE CONTROL

Measurements with the Chroma Meter can be remotely controlled by connecting an external switch to the remote-control socket on the back of the Data Processor as shown below.
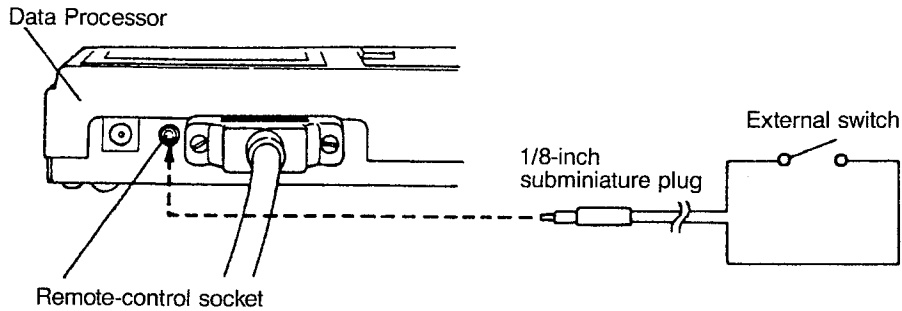
- **MEASURE** or the measuring head's measuring button can also be used to take measurements even when an external switch is connected to the remote-control socket.
- Timer-controlled measurements cannot be started using the external switch.

BASEPLATE LOCK (CR-321)

The baseplate lock of the CR-321 can be used to keep the baseplate against the tip of the light-projection tube. To use the baseplate lock, slide the baseplate lock to the LOCK position while pushing the tip of the light-projection tube against the baseplate.

Note: If the measuring head of the CR-321 is used in an inverted position (with the light-projection tube facing up), care must be taken to prevent foreign matter (such as dust, liquids, etc.) from entering the light-projection tube.
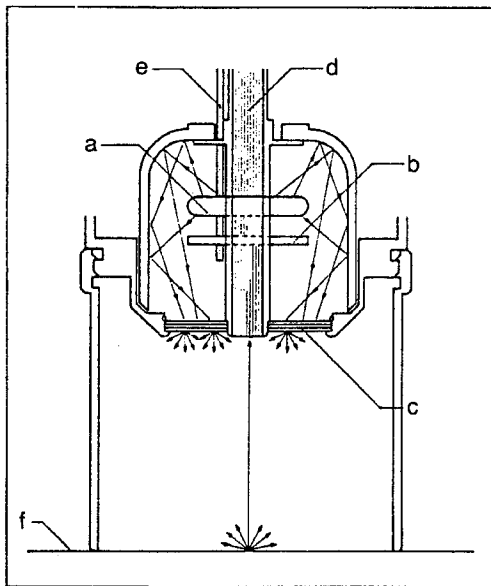
MEASURING SYSTEM

CR-300 Measuring Head
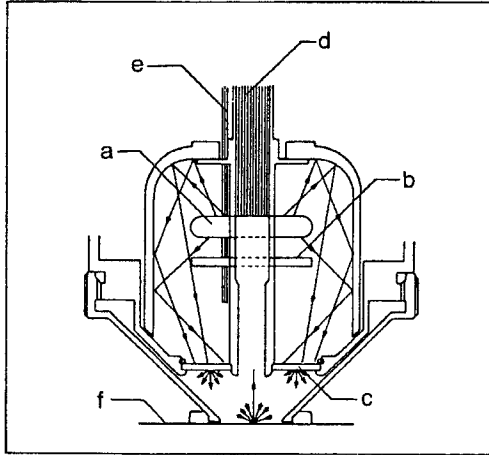
a. Pulsed xenon arc lamp
b. Baffle
c. Diffuser plate
d. Optical-fiber cable for measuring specimen
e. Optical-fiber cable for monitoring illumination
f. Specimen

The optical system of the measuring head for the CR-300 is shown above. The measuring head uses diffuse illumination, 0° viewing angle geometry (specular component included) for color measurements of a wide variety of surfaces. A pulsed xenon arc (PXA) lamp inside a mixing chamber provides diffuse, even lighting over the 8mm-diameter measuring area. Only the light reflected perpendicular to the specimen surface is collected by the optical-fiber cable for color analysis.
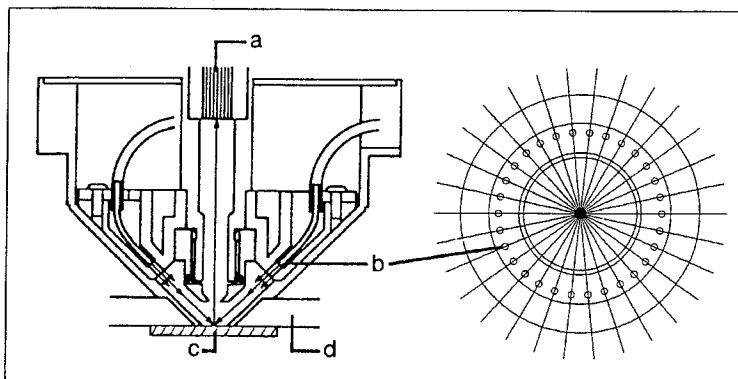
CR-310 Measuring Head

a. Pulsed xenon arc lamp
b. Baffle
c. Diffuser plate
d. Optical-fiber cable for measuring specimen
e. Optical-fiber cable for monitoring illumination
f. Specimen

The optical system of the measuring head of the CR-310 is shown above. The measuring head uses wide-area illumination, 0° viewing angle geometry to obtain readings that correlate well with color as seen under average daylight. A pulsed xenon arc (PXA) lamp inside a mixing chamber provides diffuse, even lighting over the 50mm-diameter measuring area. Only the light reflected perpendicular to the specimen surface is collected by the optical-fiber cable for color analysis.

This system's use of wide-area illumination and a large measuring area results in a reading which is greatly influenced by the amount of specular reflection present. For this reason, glossy surfaces should not be measured with this model.
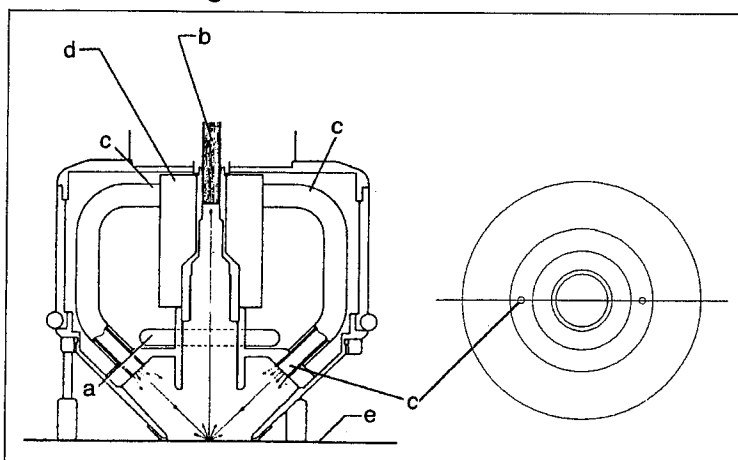
CR-321 Measuring Head

a. Optical-fiber cable for measuring specimen
b. Optical fibers for providing illumination
c. Specimen
d. Baseplate

The optical system of the measuring head for the CR-321 is shown above. The measuring head uses 45° illumination, 0° viewing angle geometry for color measurements of glossy surfaces. A pulsed xenon arc (PXA) lamp inside a mixing chamber provides diffuse, even lighting. This light enters 30 optical fibers, which are arranged in a circle to provide uniform illumination over the CR-321's 3mm-diameter measuring area. The illumination is projected onto the specimen at a controlled angle of 45°. Only the light reflected perpendicular to the surface is collected by the optical-fiber cable for color analysis. (The optical-fiber cable for monitoring illumination is at the mixing box and thus cannot be seen in the above diagram.)
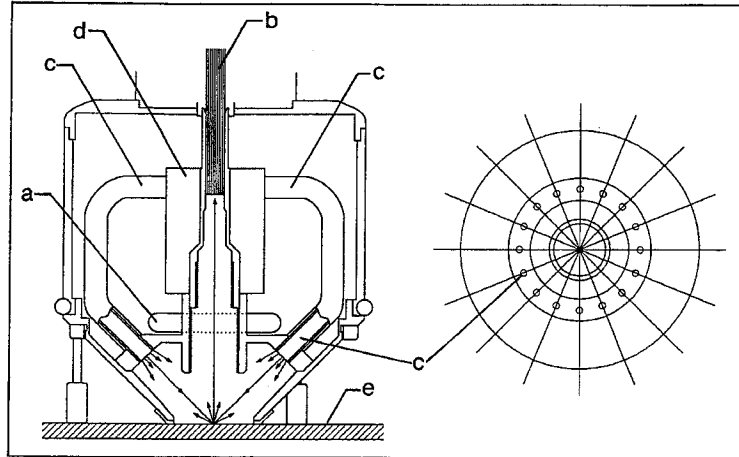
CR-331 Measuring Head

a. Pulsed xenon arc lamp
b. Optical-fiber, cable for measuring specimen
c. Optical-fiber cable for providing illumination
d. Mixing chamber
e. Specimen

The optical system of the measuring head of the CR-331 is shown above. The measuring head uses 45° illumination, 0° viewing angle geometry for color measurements of glossy surfaces. A pulsed xenon arc (PXA) lamp inside a mixing chamber provides diffuse, even lighting, which enters two separate optical-fiber cables and is projected onto the specimen surface from opposite sides of the 25mm-diameter measuring area at an angle of 45° to the specimen surface. Only the light reflected perpendicular to the specimen surface is collected by an optical-fiber cable for color analysis. (The optical-fiber cable for monitoring illumination is behind the optical-fiber cable for measuring specimen and thus cannot be seen in the diagram above.)

This system is suitable for measuring most glossy surfaces. However, highly reflective surfaces (such as metallic surfaces) may cause measurement errors since most of the incident light will be reflected at 45° and thus will not enter the optical-fiber cable for measuring specimen.

Since the specimen is illuminated from two opposite sides, measurement values may vary depending on the orientation of the specimen in relation to these optical fiber cables (particularly for linearly textured surfaces). For this reason, care should be taken that the orientation is the same for all measurements.
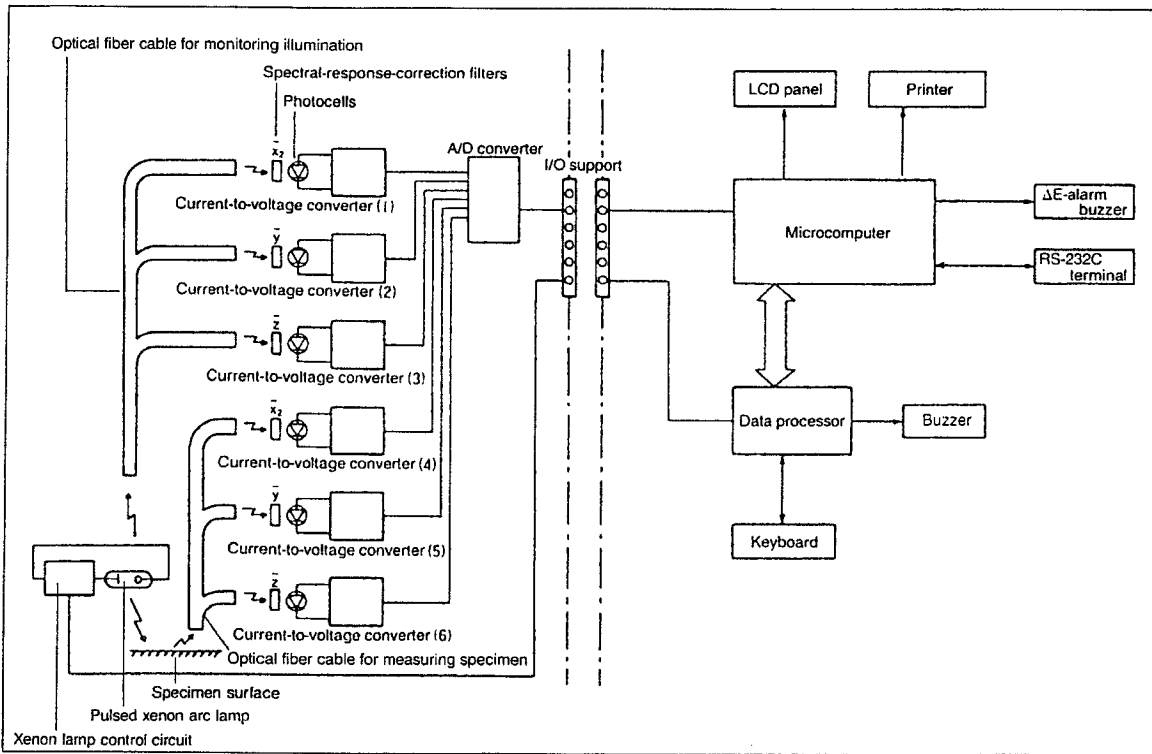
CR-331C Measuring Head

a. Pulsed xenon arc lamp
b. Optical-fiber cable for measuring specimen
c. Optical-fiber cable for providing illumination
d. Mixing chamber
e. Specimen

The optical system of the measuring head of the CR-331C is similar to that of the CR-331 measuring head, and is shown above. Both measuring heads use 45° illumination, 0° viewing angle geometry for measurements of glossy surfaces. However, in the CR-331C measuring head, the light from the pulsed xenon arc lamp is projected onto the specimen surface at an angle of 45° to the specimen surface by 16 optical fibers arranged in a circle around the measurement axis. This provides uniform illumination over the CR-331C's 25mm-diameter measuring area, and eliminates the problem of variations in measurement values according to the orientation of the specimen in relation to the optical fibers. Only the light reflected perpendicular to the specimen surface is collected by the optical-fiber cable for color analysis. (The optical-fiber cable for monitoring illumination is behind the optical-fiber cable for measuring specimen and thus cannot be seen in the diagram above.)

This system is suitable for measuring most glossy surfaces. However, highly reflective surfaces (such as polished metallic surfaces) may cause measurement errors since most of the incident light will be reflected specularly at 45° and thus will not enter the optical-fiber cable for measuring specimen.

Optical fiber cable for monitoring illumination

Spectral-response-correction filters

Photocells

$\bar{x}_2$

A/D converter

I/O support

LCD panel

Printer

Current-to-voltage converter (1)

$\bar{y}$

Microcomputer

ΔE-alarm buzzer

RS-232C terminal

Current-to-voltage converter (2)

$\bar{z}$

Current-to-voltage converter (3)

$\bar{x}_2$

Data processor

Buzzer

Current-to-voltage converter (4)

$\bar{y}$

Current-to-voltage converter (5)

$\bar{z}$

Keyboard

Current-to-voltage converter (6)

Optical fiber cable for measuring specimen

Specimen surface

Pulsed xenon arc lamp

Xenon lamp control circuit

As shown in the diagram above, a total of six silicon photocells are used by the double-beam feedback system of the Chroma Meter to ensure accurate and consistent measurements. Three of the photocells monitor the output of the pulsed xenon arc lamp; the other three photocells measure the light reflected by the surface of the specimen. Each photocell is filtered so that its spectral response closely matches one of the CIE 1931 colorimetric Standard Observer curves ($\bar{x}_2\lambda$, $\bar{y}\lambda$, or $\bar{z}\lambda$), as shown below. The photocells convert the light received by them into a current whose strength is proportional to the brightness of the light. The current is then changed into a proportional analog voltage, which is passed through an A/D converter and becomes a digital signal. This signal is used by the built-in microcomputer, which determines the tristimulus values (X, Y, and Z) of the surface and performs the calculations necessary to determine equivalent data in the desired color space. These data are automatically stored in memory and can then be shown in the LCD (liquid crystal display) panel of the Data Processor, printed out, used for further calculations, or output to another computer. The functions of the built-in microcomputer are controlled from the keyboard of the Data Processor.

Spectral response

($\bar{x}_1\lambda$ is calculated based on $\bar{z}\lambda$.)
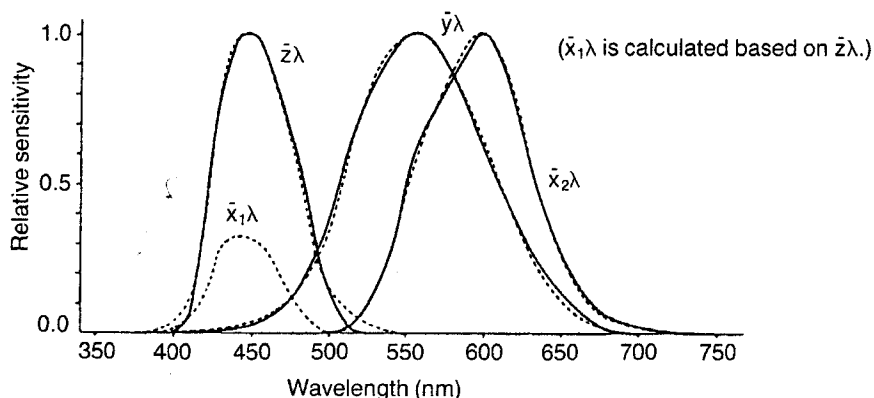
——— Spectral response of Minolta Chroma Meters

·········· CIE 1931 colorimetric Standard Observer curves

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COLOR SYSTEMS

Minolta CR-300 series Chroma Meters offer five different color systems for measuring absolute chromaticity [CIE Yxy (1931), L*a*b* (1976), L*C*H° (1976), and XYZ (1931); Hunter Lab] and four systems for measuring color difference [Δ(Yxy), Δ(L*a*b*), Δ(L*C*H*), and Hunter Δ(Lab)]. In addition, absolute color difference ΔE^*_{ab} is also displayed when color difference is displayed in the Δ(L*a*b*) or Δ(L*C*H*) color systems, and absolute color difference ΔE is displayed in the Hunter Δ(Lab) color system.

For two colors to match, three quantities defining these colors must be identical. These three quantities are called tristimulus values X, Y, and Z as determined by the CIE (Commission Internationale de l'Eclairage) in 1931.

Color as perceived has three dimensions: hue, chroma, and lightness. Chromaticity includes hue and chroma (saturation), specified by two chromaticity coordinates. Since these two coordinates cannot describe a color completely, a lightness factor must also be included to identify a specimen color precisely.

XYZ Color System

X, Y, Z: Measured tristimulus values of specimen

The XYZ tristimulus values were defined in 1931 by the CIE, and form the basis for most calculations in all CIE color-coordinate systems.

Yxy Color System

In the Yxy (CIE 1931) color system, Y is a lightness factor expressed as a percentage based on a perfect reflectance of 100%. x and y are the chromaticity coordinates of the CIE 1931 x, y Chromaticity Diagram (shown below), and are defined by the following equations:

$$x = \frac{X}{X+Y+Z} \qquad y = \frac{Y}{X+Y+Z}$$

where
X, Y, Z: Measured tristimulus values of specimen

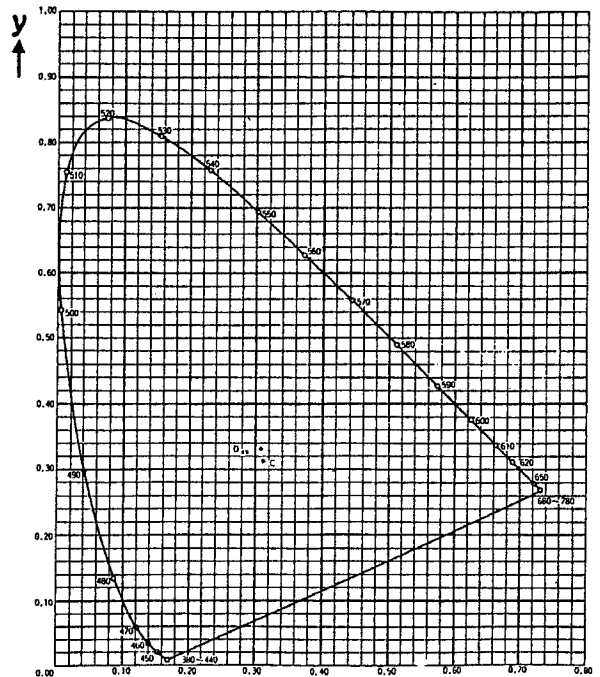Color difference values ΔY, Δx, and Δy are calculated as follows:

$$\Delta Y = Y - Y_t \qquad \Delta x = x - x_t \qquad \Delta y = y - y_t$$

CIE 1931 x, y Chromaticity Diagram

where
Y, x, y: Measured values of specimen
Y_t, x_t, y_t: Values of target color

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L*a*b* Color System

Equal distances in the CIE 1931 x, y Chromaticity Diagram do not represent equal differences in color as perceived. The CIE 1976 L*a*b* color system, however, more closely represents human sensitivity to color and is shown below. Equal distances in this system approximately equal perceived color differences. L* is the lightness variable; a* and b* are the chromaticity coordinates. Their defining equations are shown below.

$$L^* = 116 \left(\frac{Y}{Y_n}\right)^{1/3} - 16 \qquad a^* = 500 \left[\left(\frac{Y}{X_n}\right)^{1/3} - \left(\frac{Y}{Y_n}\right)^{1/3}\right] \qquad b^* = 200 \left[\left(\frac{Y}{Y_n}\right)^{1/3} - \left(\frac{Z}{Z_n}\right)^{1/3}\right]$$

where
  X, Y, Z: Measured tristimulus values of specimen
  X_n, Y_n, Z_n: Tristimulus values of the light source used (shown below)

"Light Source" index	X_n	Y_n	Z_n
"C"	98.072	100.00	118.225
"D65"	95.045	100.00	108.892

The above equations apply only when X/X_n, Y/Y_n, and Z/Z_n are greater than 0.008856. When X/X_n, Y/Y_n, and Z/Z_n are less than 0.008856, the equations below are used to replace values in the above equations.

$\left(\frac{X}{X_n}\right)^{1/3}$ is replaced by $7.787 \left(\frac{X}{X_n}\right) + \frac{16}{116}$

$\left(\frac{Y}{Y_n}\right)^{1/3}$ is replaced by $7.787 \left(\frac{Y}{Y_n}\right) + \frac{16}{116}$

$\left(\frac{Z}{Z_n}\right)^{1/3}$ is replaced by $7.787 \left(\frac{Z}{Z_n}\right) + \frac{16}{116}$

Color difference values ΔL^*, Δa^*, and Δb^* are calculated according to the following formulas:

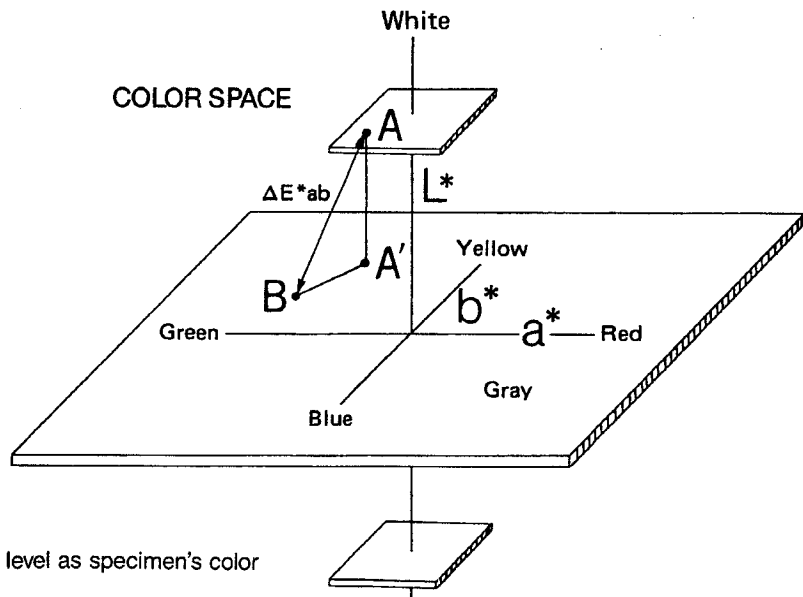$$\Delta L^* = L^* - L^*_t \qquad \Delta a^* = a^* - a^*_t \qquad b^* = b^* - b^*_t$$

where
  L*, a*, b*: Measured values of specimen
  L^*_t, a^*_t, b^*_t: Values of target color

Total color difference ΔE^*_{ab} is also measured using the L*a*b* color coordinates and defined by the equation below.

$$\Delta E^*_{ab} = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$
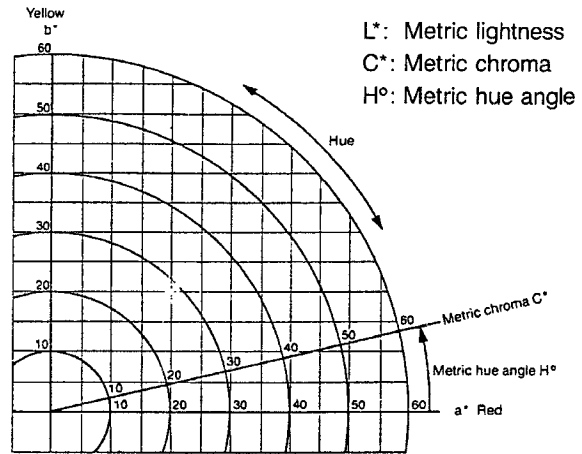
L*a*b* color space and color difference ΔE^*_{ab}

A: Target color
B: Specimen's color
A': Target color at the same lightness level as specimen's color

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L*C*H° Color System

ABSOLUTE MEASUREMENTS

L*: Metric lightness
C*: Metric chroma
H°: Metric hue angle

The CIE L*C*H° color system uses the same diagram as the L*a*b* color system, but uses cylindrical coordinates instead of Cartesian coordinates. In this system, L* is the lightness variable, C* is chroma and H° is the hue angle. Their defining equations are shown below.

$$L^* = L^*$$

$$C^* = \sqrt{(a^*)^2 + (b^*)^2}$$

$$H° = \tan^{-1}\left(\frac{b^*}{a^*}\right) \text{ when } a^* > 0 \text{ and } b^* \geq 0$$

$$H° = 180° + \tan^{-1}\left(\frac{b^*}{a^*}\right) \text{ when } a^* < 0$$

$$H° = 360° + \tan^{-1}\left(\frac{b^*}{a^*}\right) \text{ when } a^* > 0 \text{ and } b^* < 0$$

$H° = 0°$ when $a = 0$ and $b = 0$

$H° = 90°$ when $a = 0$ and $b > 0$

$H° = 270°$ when $a = 0$ and $b < 0$

DIFFERENCE MEASUREMENTS

Color difference values ΔL* and ΔC* are calculated according to the following equations:

$$\Delta L^* = L^* - L^*_t \qquad \Delta C^* = C^* - C^*_t = \sqrt{(a^*)^2 + (b^*)^2} - \sqrt{(a^*_t)^2 + (b^*_t)^2}$$

where

L*, C*, a*, b*: Measured values of specimen
L*t, C*t, a*t, b*t: Values of target color

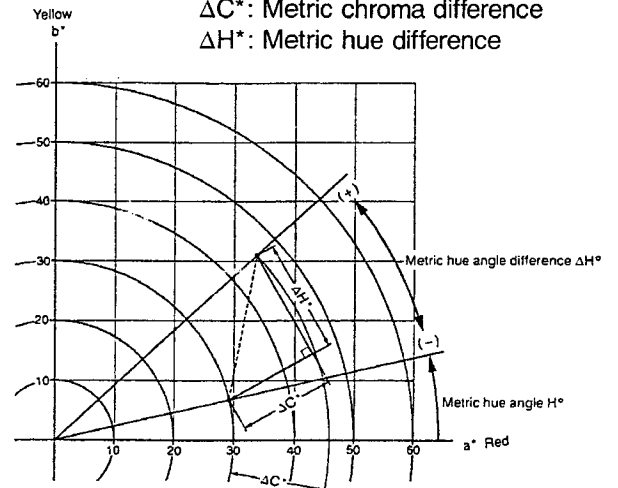When measuring color difference in this color system, ΔH° is not used.
ΔH* is used instead, and is defined by the equation:

$$\Delta H^* = \sqrt{(\Delta E^*_{ab})^2 - (\Delta L^*)^2 - (\Delta C^*)^2}$$

ΔL*: Metric lightness difference
ΔC*: Metric chroma difference
ΔH*: Metric hue difference

• ΔH* is positive if metric hue angle difference is positive (i.e., if hue angle H° of the specimen is greater than hue angle H° of the target) and is negative if metric hue angle difference is negative.

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Hunter Lab Color System

The Hunter Lab color system was developed in 1966 so that the degree of difference in measured values would more closely match the degree of perceived color difference. L is the lightness variable; a and b are the chromaticity coordinates. Their defining equations are shown below.

$$L = 100 \left(\frac{Y}{Y_n} \right)^{1/2}$$

$$a = 175 \left[\left(\frac{0.0102 X_n}{(Y/Y_n)} \right)^{1/2} \right] \left[\left(\frac{X}{X_n} \right) - \left(\frac{Y}{Y_n} \right) \right]$$

$$b = 70 \left[\left(\frac{0.00847 Z_n}{(Y/Y_n)} \right)^{1/2} \right] \left[\left(\frac{Y}{Y_n} \right) - \left(\frac{Z}{Z_n} \right) \right]$$

where
  X, Y, Z: Measured tristimulus values of specimen
  X_n, Y_n, Z_n: Tristimulus values of the light source used (shown below)

"Light Source" index	X_n	Y_n	Z_n
"C"	98.072	100.00	118.225
"D_{65}"	95.045	100.00	108.892

Color difference values ΔL, Δa, and Δb are calculated according to the following formulas:

$$\Delta L = L - L_t \qquad \Delta a = a - a_t \qquad \Delta b = b - b_t$$

where
  L, a, b: Measured values of specimen
  L_t, a_t, b_t: Values of target color

Total color difference ΔE is also measured in the Lab color system and is defined by the equation below.

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

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CARE AND STORAGE

- When dirty, the meter may be wiped with a silicone-treated cloth or other clean, dry cloth. Do not allow alcohol or chemicals to touch the meter's surface.
- Do not leave the meter in places subject to high humidity or temperatures higher than 40°C (104°F) (such as inside a closed motor vehicle), or lower than −20°C (−4°F).
- Do not leave the meter in direct sunlight or near sources of heat, such as stoves, strong lights, etc.
- When the meter is to be stored for an extended period of time, place the meter in its original packaging and put it in an air-tight container with a dehumidifying agent, such as silica gel.
- To protect calibration plate from damage or fading, be sure to close the cover of the calibration plate after use.
- If the calibration plate becomes dirty, it may be wiped with a clean, dry cloth, preferably silicone-treated. If the stain remains, a soft cloth moistened with lens-cleaning fluid may be used. After cleaning calibration plate with lens-cleaning fluid, rinse calibration plate with water and wipe dry.
- The printer of the Data Processor uses thermal paper. When using this paper, pay attention to the following points:
  - Thermal paper is not suitable for long-term storage. Data printouts should be copied if they are going to be kept for long periods of time.
  - Do not touch the paper with wet or sweaty hands.
  - Do not rub or scrape thermal paper with a hard object.
  - When writing titles on thermal paper, use either a pencil, or a pen with water-based ink (such as most ballpoint pens). Do not use a pen with oil-based ink.
  - Do not allow solvents or adhesives (such as on cellophane tape) to come in contact with the recording surface of thermal paper.
  - Do not store thermal paper in areas subject to high heat or humidity, in direct sunlight, or near sources of heat, such as stoves, strong lights, etc.
  - Do not store thermal paper with other treated copy paper (such as diazo paper).
- If thermal paper whose color has changed due to age and storage conditions is used for printing, the printed characters may be difficult to read. For this reason, it is recommended that the thermal paper used be as new as possible.

TROUBLESHOOTING GUIDE

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

Tone does not sound after POWER switch is slid to ON.	Is AC adapter connected correctly to Data Processor and to AC outlet?	Connect AC adapter correctly. (See p. 20.)
	Are batteries installed correctly?	Install batteries correctly? (See p. 19.)
	Is battery power exhausted?	Replace batteries with fresh ones. (See p. 19.)
Display is blank.	Is POWER switch at ON?	Slide POWER switch to ON.
	Is AC adapter connected correctly to Data Processor and to AC outlet?	Connect AC adapter correctly. (See p. 20.)
	Are batteries installed correctly?	Install batteries correctly. (See p. 19.)
	Is battery power exhausted?	Replace batteries with fresh ones. (See p. 19.)
	Is viewing angle adjusted correctly?	Move viewing-angle adjustment lever until display is easy to read. (See p. 22.)
Ready lamp of measuring head does not light, even after one minute.	Is AC adapter connected correctly to Data Processor and to AC outlet?	Connect AC adapter correctly. (See p. 20.)
	Are batteries installed correctly?	Install batteries correctly. (See p. 19.)
	Is battery power exhausted?	Replace batteries with fresh ones. (See p. 19.)
	Is measuring head connected correctly to the Data Processor?	Connect measuring head and Data Processor correctly. (See p. 18.)
Nothing happens when a key is pressed.	Can the key being pressed be used in the present operating mode? (Double tone sounds to indicate error if key cannot be used.)	Press a key which can be used in the present mode.
	Is the printer paper jammed?	Set POWER switch to OFF, wait for a few seconds, then switch POWER to ON again. Change the "Print" index to "N". (See p. 25.) Printing cannot be performed. Contact the nearest Minolta-authorized service facility regarding printer repair.

Nothing happens when **CALIBRATE, MEASURE,** or measuring head's measuring button is pressed.	Is the Data Processor in the middle of calculations?	Wait until calculations are complete and ready lamp lights before pressing **CALIBRATE** or **MEASURE**.
	Is the Data Processor in measurement mode?	Press **BREAK** to return to measurement mode, then press **CALIBRATE** or **MEASURE**.
	If an external switch is connected to the remote-control socket, is that switch set at ON (closed)?	Set external switch to OFF (open).
When performing calibration to a user-selected surface or inputting target-color data using the keyboard, the final calibration or target-color data are different from the data input using the number keys.	Was input of calibration or target-color data performed using a color space other than Yxy?	When calibration or target-color data are input using a color space other than Yxy, a series of conversion calculations are performed by the Data Processor before data are stored. The final data are data reconverted from the stored data, and may be different than the input data due to rounding off during calculations.
When recalling target-color data, the displayed data are different from the data which was displayed when the target color was first input.	Have any conditions relating to calibration (calibration data, setting of "Multi Cal." index, or calibration channel) been changed?	Displayed target-color data is data calculated from the original measured data according to the presently set calibration conditions (calibration data, setting of "Multi Cal." index, or calibration channel).
The message "Now Measuring" is shown in the display and display does not change, even after several minutes.		Possible malfunction. Contact Minolta-authorized service facility.
Values of measured data vary widely, even when measuring the same specimen.	Is the tip of the measuring head being held flat against the specimen surface?	Be sure to hold the tip of the measuring head flat against the specimen surface.
	Is measuring head being moved during measurement?	Do not move measuring head during measurement.
	When using multi-calibration (when the "Multi Cal." index is set to "Y"): Was the data in any of the calibration channels changed or deleted in between measurements?	When using multi-calibration, the data in all calibration channels should be kept constant for all measurements.
The edge of thermal paper is red.	The amount of paper remaining in the paper chamber is getting low.	Install new roll of thermal paper. (See p. 21.)
Data is being printed over previously printed data.	Was paper installed correctly?	Install paper correctly. (See p. 21.)

Data is not printed.	Is the paper installed in printer thermal paper?	Install thermal paper. (See p. 21.)
	Was paper loaded with back (non-sensitive side) facing printer?	Install paper correctly. (See p. 21.)
	If printout does not occur after measurement: Is "Print" index set to "Y"?	Set "Print" index to "Y". (See p. 55.)
	Printout will not occur even though **DISPLAY PRINT** is pressed if any of the following conditions are true: • Data Processor is in the middle of a procedure. • Data Processor is in the middle of calculations. • A message which appears for only 2 to 3 seconds is shown. • A message for system reset is shown.	
Data is not transmitted to a separate computer or commands are not received from a separate computer.	Is RS-232C cable connected correctly to both Data Processor and separate computer?	Connect cable correctly. (See p. 64.)
	Is the correct RS-232C cable being used?	Check that pin numbers and connections of the cable correspond to those on p. 64.
	Are the communication parameters of the Data Processor (baud rate, number of character bits, parity, and number of stop bits) set correctly on the separate computer?	Set communication parameters of separate computer to those of the Data Processor. (See p. 64.)
	Is program being used functioning correctly?	Use one of the program examples in this manual. (See p. 70.)
A tone sounds for approximately 3 seconds when a command is input to the Data Processor from a separate computer.	Communication parameters (baud rate, number of character bits, parity, and number of stop bits) set on separate computer do not match those of Data Processor.	Set communication parameters of separate computer to those of the Data Processor. (See p. 64.)

# OPTIONAL ACCESSORIES

Shoulder Case CR-A62
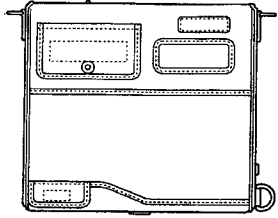
Shoulder Case CR-A62 makes it easy to carry the Data Processor DP-301 of the Chroma Meter CR-300 series when taking measurements in the field.

Color tiles

Color tiles consists of 14 plates (White, Pale grey, Middle grey, Difference grey, Deep grey, Deep pink, Red, Orange, Bright yellow, Green, Difference green, Cyan, Deep blue, Black). They can be used for periodic inspection of color-measuring instruments to determine when instrument aging has become excessive and repair is necessary.

Pivoting Base CR-A12 (For CR-300)
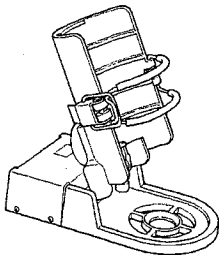
Attaching the Pivoting Base CR-A12 to the measuring head of the CR-300 ensures greater stability and accuracy in measurements. Light-Projection Tube CR-A33c is also included.
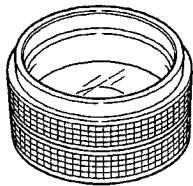
Glass Light-Projection Tube CR-A33f (For CR-300) and CR-A33e (For CR-310)
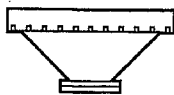
Glass Light-Projection Tubes CR-A33a and CR-A33e have a glass plate at the tip and can be used for measuring wet surfaces or for ensuring that materials such as textiles are flat during measurements.
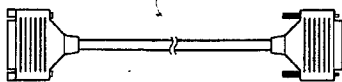
(For CR-300)

Granular-Materials Attachment CR-A50 (For CR-300 or CR-310)

With the Granular-Materials Attachment CR-A50, the color of powders, pastes, grains, and other granular substances can be easily and accurately measured.

Adapter Cord MA-A10
Adapter Cord MA-A11

These adapter cords can be connected between the Data Processor DP-301 and the CR-300 series measuring head, enabling you to separate the two units by up to one meter (MA-A10) or up to three meters (MA-A11).

TECHNICAL DETAILS

- Chroma Meter CR-300 consists of the CR-300 measuring head and Data Processor DP-301;
  Chroma Meter CR-310 consists of the CR-310 measuring head and Data Processor DP-301;
  Chroma Meter CR-321 consists of the CR-321 measuring head and Data Processor DP-301;
  Chroma Meter CR-331 consists of the CR-331 measuring head and Data Processor DP-301;
  Chroma Meter CR-331C consists of the CR-331C measuring head and Data Processor DP-301.

Measuring Head

Receptors:	6 silicon photocells (3 to measure source illumination, 3 to measure reflected light) filtered to detect primary stimulus values for red, green, and blue light.
Spectral response:	Closely matches CIE 1931 Standard Observer curves ($\bar{x}_2\lambda$, $\bar{y}\lambda$, and $\bar{z}\lambda$)
Light source:	Pulsed xenon arc lamp
Illumination/ measurement system:	CR-300: Diffuse illumination/0° viewing angle (specular component included)
	CR-310: Wide-area illumination/0° viewing angle (specular component included)
	CR-321, CR-331C: 45° circumferential illumination/0° viewing angle
	CR-331: 45° bidirectional illumination/0° viewing angle
Measuring area:	CR-300: ϕ8mm
	CR-310: ϕ50mm
	CR-321: ϕ3mm
	CR-331, CR-331C: ϕ25mm
Short-term repeatability:	Chromaticity (x, y): Within $\pm$0.0002
	Color difference (ΔE^*_{ab}): Standard deviation within 0.07
	(Measurement conditions: White calibration plate measured 30 times at 10-second intervals)
Inter-instrument agreement:	CR-300: ΔE^*_{ab} within 0.6
	CR-310, CR-331, CR-331C: ΔE^*_{ab} within 0.8
	CR-321 ΔE^*_{ab} within 1.0
	(Measurement conditions: Comparison of average measured values of 13 BCRA Series II color tiles to values measured with master body)
Temperature drift:	Less than ΔE^*_{ab} 0.05/°C (Measurement subject: white calibration plate)
Temperature range:	Operation: 0 to 40°C (32 to 104°F)
	Storage: −20 to 40°C (−4 to 104°F)
Humidity range:	Less than 85% relative humidity at 35°C/95°F with no condensation
Dimensions:	CR-300: 201 x 91 x 60mm (7-7/8 x 3-9/16 x 2-3/8 in.)
	CR-310: 229 x 91 x 60mm (9 x 3-9/16 x 2-3/8 in.)
	CR-321: 100 x 81 x 243mm (3-15/16 x 3-3/16 x 9-9/16 in.)
	CR-331: 247 x 116 x 116mm (9-3/4 x 4-9/16 x 4-9/16 in.)
	CR-331C: 262 x 116 x 116mm (10-5/16 x 4-9/16 x 4-9/16 in.)
	Connecting cable: 1300 x ϕ8.5mm (51-3/16 x ϕ5/16 in.)
Weight:	CR-300: 670g (23-5/8 oz.)
	CR-310: 690g (24-3/8 oz.)
	CR-321: 1225g (43-3/16 oz.)
	CR-331: 1050g (37 oz.)
	CR-331C: 1400g (49-3/8 oz.)
Accessories included:	CR-300: Calibration Plate CR-A43; Case CR-A60[*1]
	CR-310: Calibration Plate CR-A44; Case CR-A64[*1]
	CR-321: Calibration Plate CR-A45; Case CR-A63[*1]
	CR-331: Calibration Plate CR-A46; Case CR-A61[*1]
	CR-331C: Calibration Plate CR-A46; Case CR-A61[*1]

Optional Accessories: For CR-300, CR-310, CR-321, CR-331, CR-331C: Color Calibration Plate Set CR-A47 (set of 9 plates: red, orange, yellow, yellow-green, green, cyan, purple, deep pink, and brown)
For CR-300, CR-310: Granular Materials Attachment CR-A50
For CR-300 only: Glass Light-Projection Tube CR-A33f; Pivoting Base CR-A12
For CR-310 only: Glass Light-Projection Tube CR-A33e

[1] Case included only with purchase of measuring head and Data Processor DP-301 as a set.

Data Processor DP-301

Measurement modes:	Absolute and difference
Chromatic systems:	Absolute: CIE Yxy, L*a*b*, L*C*H°, and XYZ; Hunter Lab
	Difference: Δ(Yxy), Δ(L*a*b*)/ΔE^*_{ab}, Δ(L*C*H*)/ΔE^*_{ab}, and Hunter Δ(Lab)/ΔE
Illuminant conditions:	CIE Illuminant C or D_{65}
Calibration channels:	20; channel 00 for standard white calibration plate, channels 01 to 19 for user-selected reference colors
Calibration functions:	Multi-calibration: Data in all calibration channels utilized to determine measured values
	Manual: Data in a single calibration channel selected by user utilized to determine measured values
Target-color channels:	20; set by measurement or keyboard input
Data memory:	Space for 300 sets of measurement data; space divisible into 20 pages; data remains in memory even if POWER switch is set to OFF
Display range:	0.01 to 160% reflectance
Display:	16 characters × 2 lines; dot-matrix LCD with adjustable viewing angle
Printer:	24-character thermal-dot
Statistical calculations:	Maximum, minimum, mean, and standard deviation
Calendar/clock/timer:	Date and time of first and last measurements on each memory page stored and printed out; timer intervals user-selectable from 3 sec. to 99 min.
Data input/output:	RS-232C format, ASCII code; transmission rate: 4800 baud (selectable by authorized service personnel: from 600 to 9600 baud for data output or from 600 to 4800 baud for data input); output voltage: CMOS ±5V; RS-232C terminal uses DIN 8-pin connector
Other:	High-repeatability multiple-measurement-averaging mode; remote-control socket; ΔE ALARM output socket
Power source:	6 AA-size alkaline-manganese or carbon-zinc (1.5V) or nickel-cadmium (1.2V) batteries, or included AC adapter connected to AC power source; memory equipped with built-in Ni-Cd battery
Battery performance:	Alkaline-manganese: 690 measurements
	Carbon-zinc: 280 measurements
	Nickel-cadmium: 600 measurements
	(Measurement conditions: White calibration plate measured in ABS. measuring mode at 10-second intervals with printout in one color space after each measurement)
Temperature range:	Operation: 0 to 40°C (32 to 104°F)
	Storage: −20 to 40°C (−4 to 104°F)
Humidity range:	Less than 85% relative humidity at 35°C/95°F with no condensation
Dimensions:	50 × 220 × 200mm (2 × 8-11/16 × 7-7/8 in.)
Weight:	1300g (45-7/8 oz.) without batteries
Accessories included:	AC Adapter (AC-A10 worldwide except N. America; AC-A10N in N. America); thermal paper (one roll); DIN 8-pin plug (1); 3.5mm (1/8-inch) subminiature plug (2)
Optional accessories:	Shoulder Case CR-A62; Adapter Cord MA-A11; Roll Paper DP-A21 (package of 20 rolls)

Specifications subject to change without notice

Through The Years & Around The World: A CED Sponsored Learning Fair
Providing Age-Specific & Culturally Competent Care at St. Joseph's

Enhancing Jobs & Advancing Education

At St. Joseph's we care for patients of all ages (from neonates to geriatrics) and many different cultures. With this comes the need for all direct care providers to be knowledgeable and skillful (or as JCAHO would say...competent) about differences in the care of patients of varying ages & cultures. How do we assess a 3 year-old differently from a 12 year-old? How do we insert a peripheral IV in an 85 year-old compared to a 35 year-old? How best to teach a 10-year old about their asthma medication? How to communicate effectively with a patient or colleague from another country?

<u>Directions:</u> Review each station with content related to your job at St. Joseph's. Note that you might not provide care to all ages of patients. Complete the educational activity (fishbowl question, post-test, etc.) then have the educator at the station sign the checklist.   Have fun learning about the great ways we care for patients at St. Joseph's.

TOPIC	DATE COMPLETED	INSTRUCTOR SIGNATURE
GROWTH & DEVELOPMENT		
Erickson's Developmental Tasks; Developmental Stages		
AGE-SPECIFIC COMMUNITY RESOURCES FOR DISCHARGE PREPARATION & TEACHING		
Culturally Competent & Age-specific Patient Education, Identifying Community Resources, Identification & Reporting of Abuse: elder, child, domestic violence		
INFANT, TODDLER, PRE-SCHOOL, SCHOOL AGE & ADOLESCENT		
Assessing Age-specific Clinical Data, Performing Age-specific Treatments, Age-appropriate Communication/interactive Skills, Involvement of Family &/or Significant Other In Plan of Care		
ADULT		
Assessing Age-specific Clinical Data, Performing Age-specific Treatments, Age-appropriate Communication/interactive Skills, Involvement of Family &/or Significant Other In Plan of Care		
GERIATRIC		
Assessing Age-specific Clinical Data, Performing Age-specific Treatments, Age-appropriate Communication/interactive Skills, Involvement of Family &/or Significant Other In Plan of Care, Aging Sensitivity, Spirituality of Aging		
PHARMACY SERVICES		
Drug Therapy in the Elderly; Pediatric Medication Administration		
CULTURALLY COMPETENT CARE		
Definitions of Culturally Competent Care, Dimensions of Culture, Behavioral Health Cultural Competence PI Team, Working With An Interpreter, Pastoral Care Resources		

Once you have completed all stations, share 1 example of how you have recently provided age-specific & culturally competent care on the easels by the stage & participate in the free raffle!

Learner Signature: _____ *Job Title*_____ *Date:* _____

PLEASE GIVE THIS RECORD TO YOUR SUPEVISOR.   *Department*_____