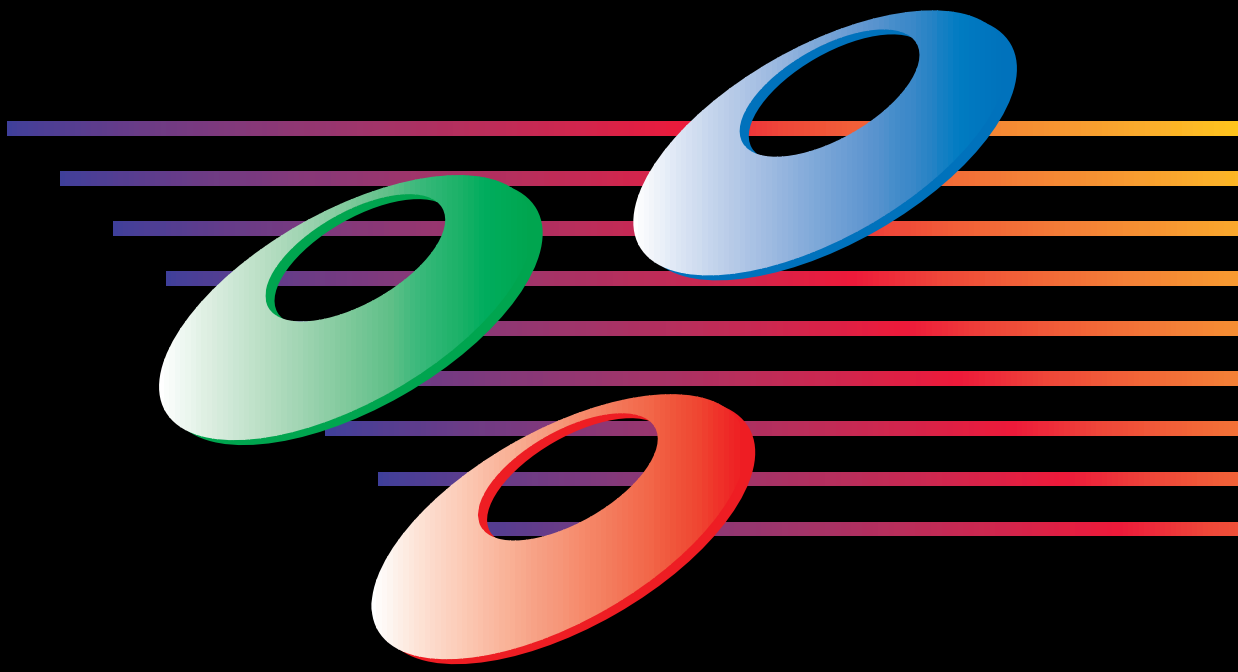
OMRON

F400

Color Vision Sensor

INTRODUCTION MANUAL



F400

Color Vision Sensor

Introduction Manual

Produced June 1999

About this Manual:

This manual describes the features and basic operations of the F400 Color Vision Sensor. This is one of three manuals used to operate the F400. Refer to the following table for the contents of each manual.

Manual	Contents	Catalog No.
1: Introduction Manual	Describes F400 capabilities and basic operating procedures for beginners by using typical applications.	Z131-E1-1
2: Setup Manual	Provides information on system hardware and installation.	Z130-E1-1
3: Operation Manual	Describes operation of the F400, including setting of criteria, communication with external devices, etc.	Z135-E1-1

Please read the above manuals carefully and be sure you understand the information provided before attempting to install or operate the F400.

⚠ WARNING Failure to read and understand the information provided in this manual may result in personal injury or death, damage to the product, or product failure. Please read each section in its entirety and be sure you understand the information provided in the section and related sections before attempting any of the procedures or operations given.

TABLE OF CONTENT

General Precautions

The user must operate the product according to the performance specifications described in the operation manuals.
Before using the product under conditions which are not described in the manual or applying the product to nuclear control systems, railroad systems, aviation systems, vehicles, combustion systems, medical equipment, amusement machines, safety equipment, and other systems, machines, and equipment that may have a serious influence on lives and property if used improperly, consult your OMRON representative.
Make sure that the ratings and performance characteristics of the product are sufficient for the systems, machines, and equipment, and be sure to provide the systems, machines, and equipment with double safety mechanisms.

Visual Aids

The following headings will help you locate different types of information.

Note Indicates information of particular interest for efficient and convenient operation of the product.

→ Indicates pages where additional information can be found.

1 Indicates a procedure. The step numbers in the procedure correspond to the numbers in any related illustrations.

SECTION 1 FEATURES

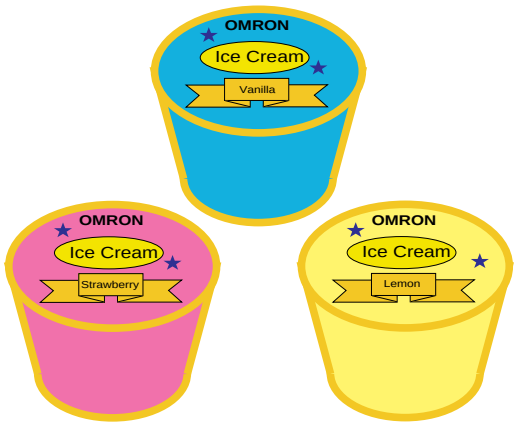
F400 measures the image using color information of color image. Select a scene mode out of two processing modes, "color pickup mode" and "color filter mode", according to the application. The information contained in this section is about scene mode.

1-1 Color Pickup Mode

Possible to measure the several colors at the same time.

<Applications>

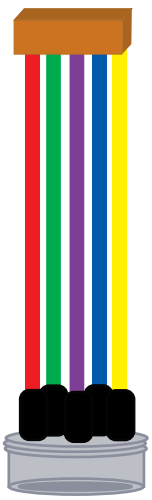
● Separation by colors



Ice creams will be separated by the colors of the lids.

Settings -> p.24

● Miswiring check of wire harnesses



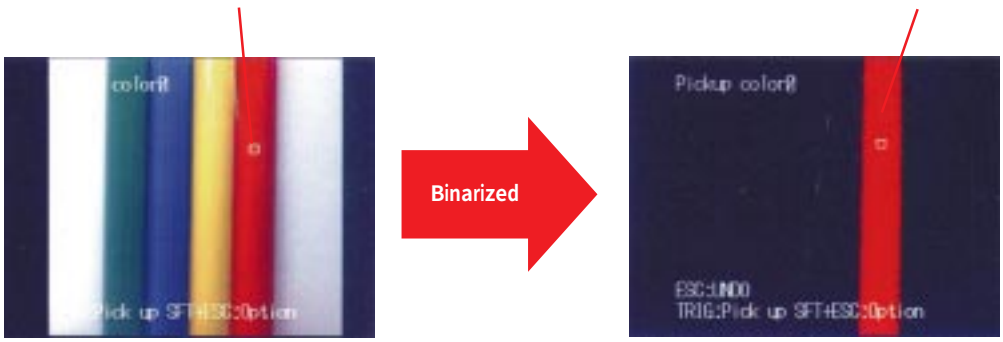
Miswiring can be checked by registering all colors of the wire harnesses.

<How to convert the image>

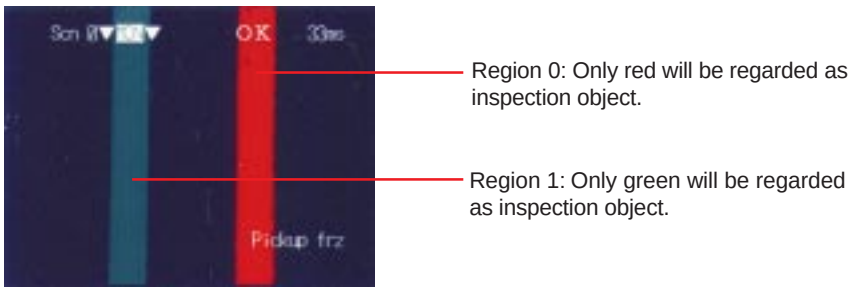
● Select the color to be picked up from color image. (Up to 8 colors can be registered.)

(Ex.) When red is selected.

Only red will be picked up.
Other colors will turn black.



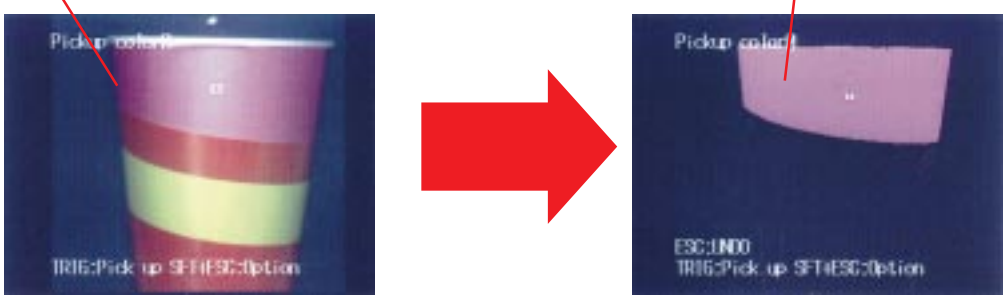
● Select the color to be inspected by region.



● Can distinguish between "shaded pink" and "red".

Even if at the end of a part of pink faded out.

Only pink will be picked up.

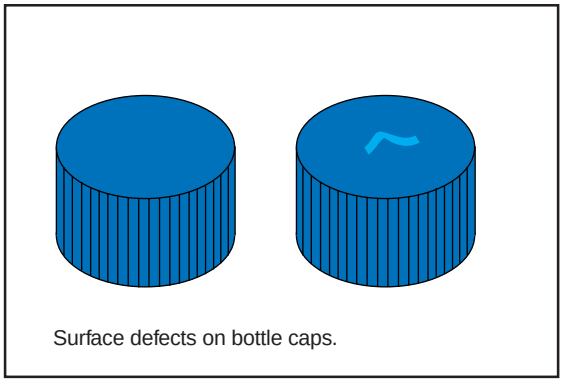


1-2 Color Filter Mode

Stable measurement of the object that is hardly detected in monochrome image.

<Applications>

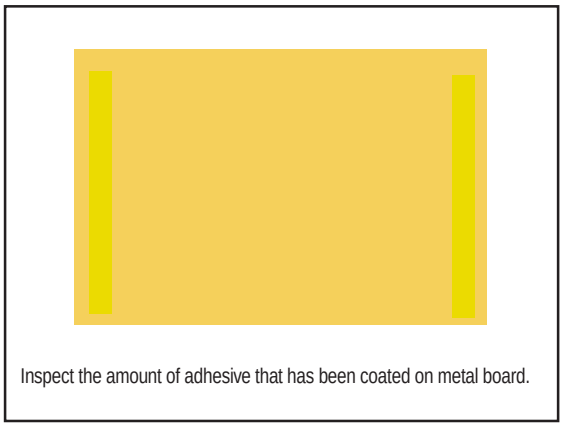
● Detection of surface defect



Surface defects on bottle caps.

Settings -> p.14

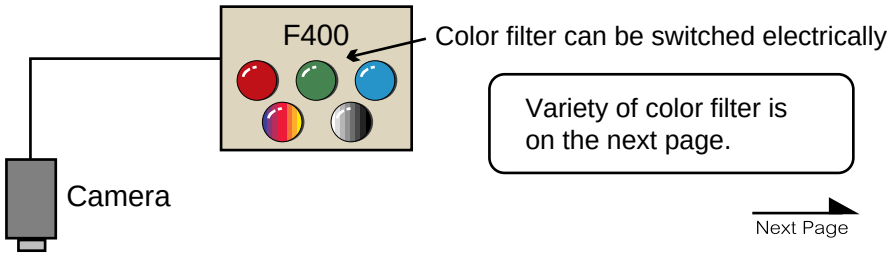
● Amount of adhesive.



Inspect the amount of adhesive that has been coated on metal board.

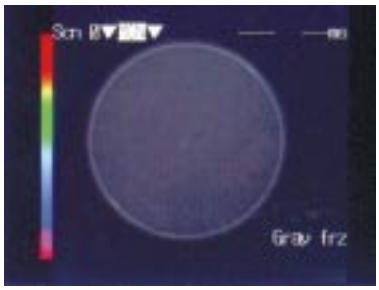
<How to convert the image>

● Can convert the image into gray image enhancing specific color using the built-in color filter.



The color to be detected will be displayed lightly.

● For only light and shade are used to process in former monochrome image, detection is hardly executed.



<Color filters>

Color image read by camera

Red filter

Take an effect the same as using optical red filter.

Green filter

Take an effect the same as using optical green filter.

Blue filter

Take an effect the same as using optical blue filter.

Red will be displayed lightly.

Green will be displayed lightly.

Blue will be displayed lightly.

Colorgray filter

The filter can be arranged according to the color to be detected. Light will be changed in accordance with hue.Use the filter with understanding of peculiarity of color.

Appendix» Peculiarity of color (p.39)

(Ex.) Measured color: red

Gray filter

Gray filter will convert the image into former gray image (monochrome image based on light and shade of color).Use this filter when measurement monochromatic image such as black, white and gray.

SECTION 2 MEASUREMENT

This section describes basic operations of F400 with typical applications.

2-1 Starting and Quitting

2-1-1 Starting

1 Be sure that the basic F400 components have been connected correctly.

NOTE: Read "Setup Manual" before attempting to setup or wire the F400 components.

Appendix » Setup Manual "2-2 Connections", "2-3 Power Supply and Ground"

2 Turn ON the power supply on the monitor.

3 Turn ON the power supply on the F400.

▶ The opening screen will appear.

See "Setup Manual" for camera setting distance and the details of lens.

Appendix » Setup Manual "2-4 Camera"

4 The image has been taken by camera will be displayed.

▶ The following screen will appear the first time power is turned ON.

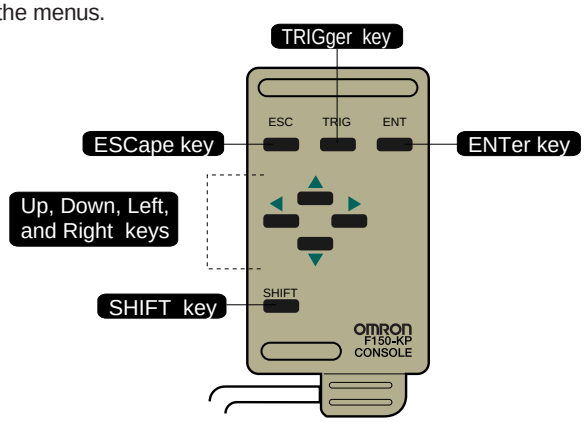
▶ The reversed part of the display is called cursor. Use the cursor keys to select items.

Trouble shooting

Camera images do not appear on the screen.
*The Camera Cable is not properly connected.
*The lens cap has not been removed.
*The lens diaphragm is opened or closed too far.

Console

The F400 is operated with selecting functions from the screen and the console is used to perform menu operations. Be sure to familiarize yourself with console operations before actually using the menus.



Menu operations can be performed with computer via RS-232C port.

Appendix » Operation Manual "6-2 RS-232C Port"

2-1-2 Quitting

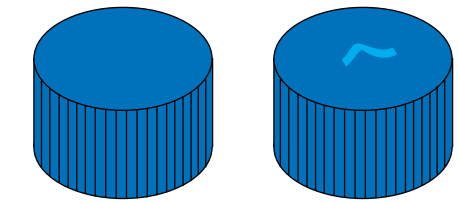
The power can be turned OFF in any mode.
But do not turn OFF the power while saving or loading the data, and be sure to save the data before turning OFF the power so as not to lose the data. See "Operation Manual" for saving the setting data.

Appendix » Operation Manual "2-2-5 Quitting"

NOTE: Do not turn OFF the power while saving the measurement conditions in the following procedure.Data in flash memory may be lost, and the F400 may not operate properly the next time when it is started.

2-2 Surface Defects on Bottle Caps

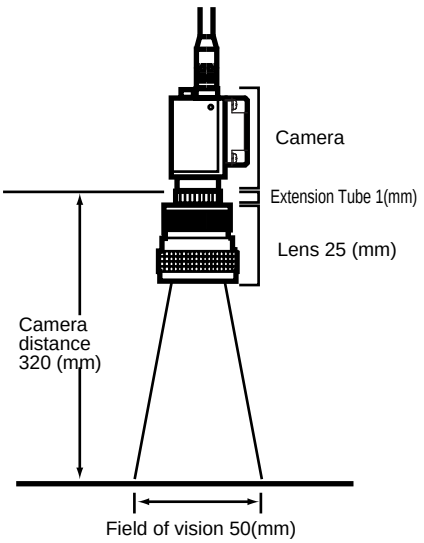
This section describes functions and setting steeps with the application of surface defects of bottle caps. Read this section with actual operation using the picture of measurement object at the end of this manual.



OK (acceptable)

NG (unacceptable)

Setting example



1. Change the operating mode. — Select "SET" mode.

2. Select the scene mode. — Select "Color filter" mode.

3. Adjust the image. — Select "Colorgray" for the color filter.

4. Set the measurement region. — Set the region with "surface defect".

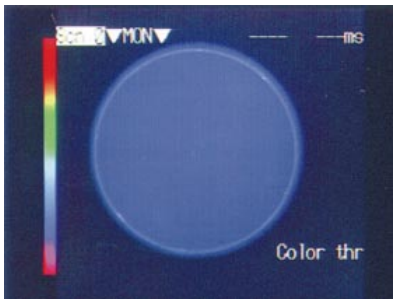
5. Measure the objects. — Select "RUN" mode.

2-2-1 Changing Operating Mode

Select "SET" mode

Select "SET" mode to set measurement condition.

1 The following screen will be displayed when the power is turned ON.



2 Use the Right Key to move the cursor to "MONitor" and press the ENTer key.

3 Use the Up Key to move the cursor to "SET" mode and press the ENTer key.

▶ The screen enters setting mode. After a short pause, the screen to select the scene mode will appear.

2-2-2 Selecting Scene Mode

Select "Color filter" mode.

Measurement conditions, such as the type of measurement object and the contents of the inspection, are input under "scenes". Up to 16 scenes can be set. "Color pickup mode" and "Color filter mode" are called scene mode. One of these will be selected to inspect in each scene. Difference between "Color pickup mode" and "Color filter mode" is described in the beginning of the book.

NOTE: Scene mode cannot be changed if scene 0 is already set.
Clear the scene or switch into another scene.

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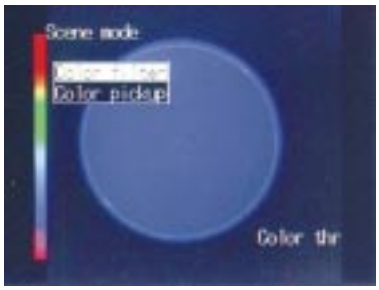
1 Select "Color filter" and press the ENTer key.

▶ "Color filter" has been set to scene 0. After a short pause, basic screen for "SET" mode will appear.

▶ Clear the scene before changing the setting already registerd.



<How to clear the scene>

1 Press the ESCape key.

▶ Leaves "SET" mode.

2 Select "Scene 0" and press the ENTer key.

▶ A selection of 9 scenes (0 to 8) will be displayed.

3 Press the SHIFT+ESCape keys at scene 0.

▶ A selection of "Copy" and "Clear" will be displayed.

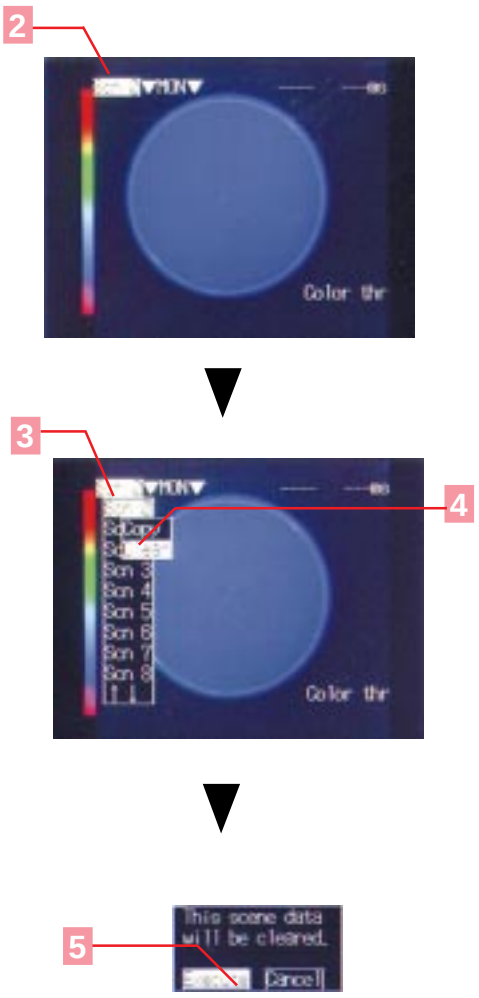
4 Select "Clear" and press the ENTer key.

▶ A confirmation message will be displayed.

5 Select "Execute" and press the ENTer key.

▶ Scene data will be cleared and the display will return to the screen of **2** .

2-2-1 Changing Operating Mode —>P.15

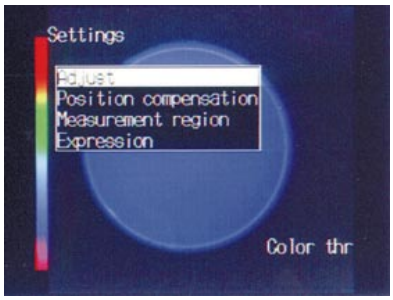


2-2-3 Adjusting Images

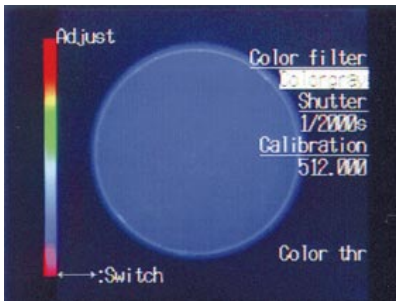
Select "Colorgray" for Color filter.

The image read by camera will be processed into the image can be easily measured.
Confirming the displayed image on the monitor, process it into "Colorgray filter" to get high-contrast between the defect and the background.

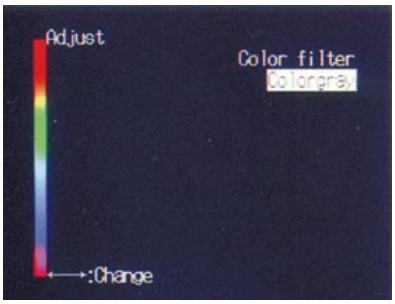
1 Select "Adjust" and press the ENTer key.



2 Select "Colorgray" and press the ENTer key.

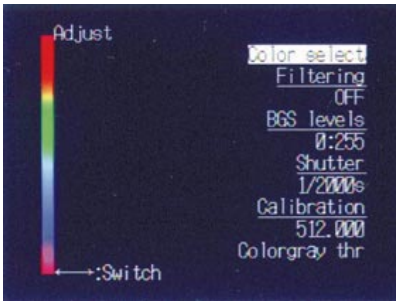


3 Press the ENTer key to set the color filter.



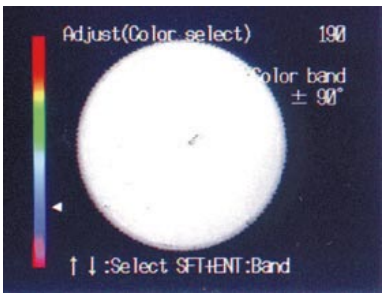
4 Select "Color select" and press the ENTer key.

▶ The screen to set the colorgray filter will be displayed.



Next Page

5 Use the Up and Down Keys to move the cursor parameter to the color bar pointer.



▶ The selected color will be lighted.
Adjust the position of cursor to get highest contrast.

6 Press the ENTer key.

▶ The screen of **4** will appear.

7 Press the ESCape key and the screen of **1** will appear.

2-2-4 Setting Measurement Region

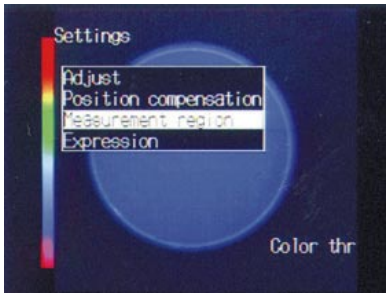
Set the measurement region with "Surface defect".

Set the measurement region in which the inspection is to be performed.
Select "Surface defect" to detect surface defect on the measurement object.

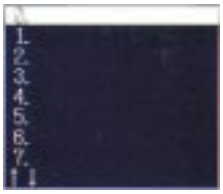
<About surface defect>
A measurement method detected by dispersion of light (density) on the object. Extremely dark or light part of the object will be detected as defect. Degree of defect will be shown by "defect" 0 to 255. Make output light for hue of measured color as close as registered color.

Setting of the Measurement Region

1 Select "Measurement region" and press the ENTer key.



2 Select "0." and press the ENTer key.



3 Select "Surface defect" and press the ENTer key.

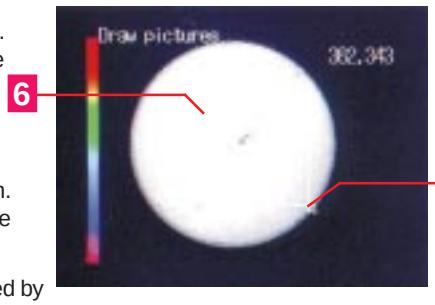
4 Select "Box" and press the ENTer key.

5 Select "Region" and press the ENTer key.

6 Specify upper-left corner of the measurement region. Use the cursor keys to move the cursor and press the ENTer key.

7 Specify lower-right corner of the measurement region. Use the cursor keys to move the cursor and press the ENTer key.

▶ The measurement region will be indicated by dotted line on the screen.

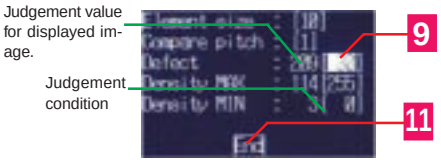


Setting the Judgement

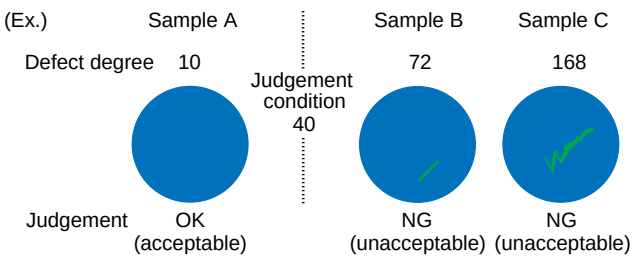
8 Select "Conditions" and press the ENTer key.

9 Change the value of defect into "30" and press the ENTer key.

▶ Change the numeral with a one-digit cursor appeared on the display.
Use the Left and Right Keys to move the cursor to the digit to be input.
Use the Up and Down Keys to change the numeral.



<Judgement condition>
Judgement condition is set for surface defect with the model to enable checking whether or not the model with no defect has been found. If the defect is larger than judgement condition, surface defect may be found.



Judgement condition is set at "10" regarding defect degree of displayed image as criterion.

10 Press the ENTer key after changing the numeral.

11 Select "End" and press the ENTer key.

12 Press the ESCape key several times and the screen of **1** will appear.

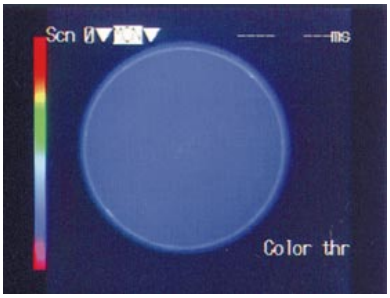
2-2-5 Measuring Objects

Select "RUN" mode.

Input measurement trigger and the measurement will be performed according to the conditions set for the current scene.
The results will be output to OR terminal of the terminal block.

1 Press the ESCape key in following screen to leave "SET" mode.

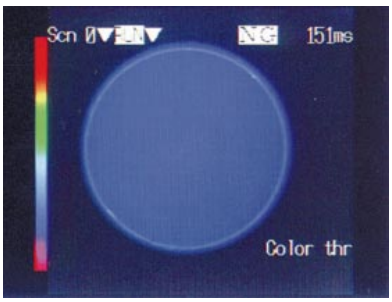
2 Select "MONitor" to enter "RUN" mode and press the ENTer key.



3 Select "RUN" and press the ENTer key.

▶ The screen enters measurement mode.

4 Press the TRIGger key.



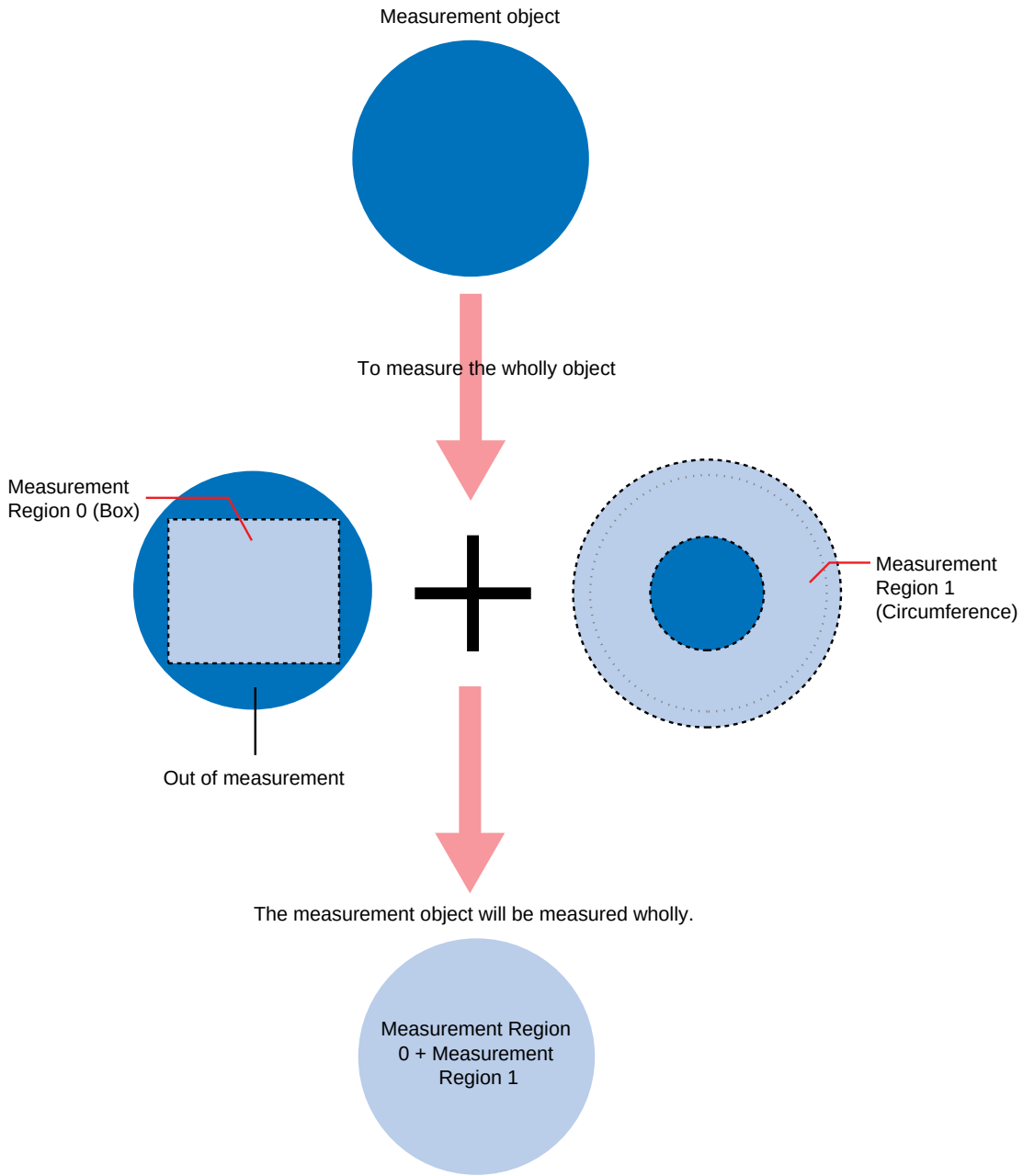
▶ One measurement will be performed.

For more stable measurements

1. Additional Measurement Region

Circle cannot be measured wholly by box measurement region.
Whole object will be measured with one more measurement region.
See "Operation Manual".

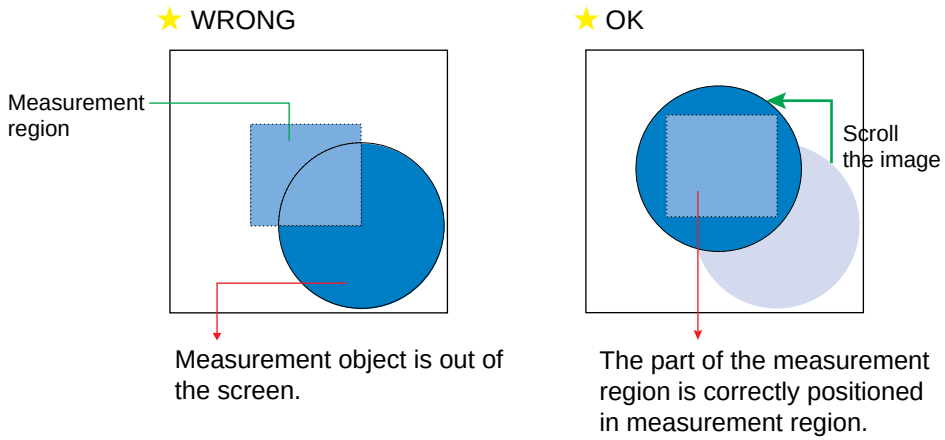
Appendix ❯❯ Operation Manual "3-3 Measurement Methods"



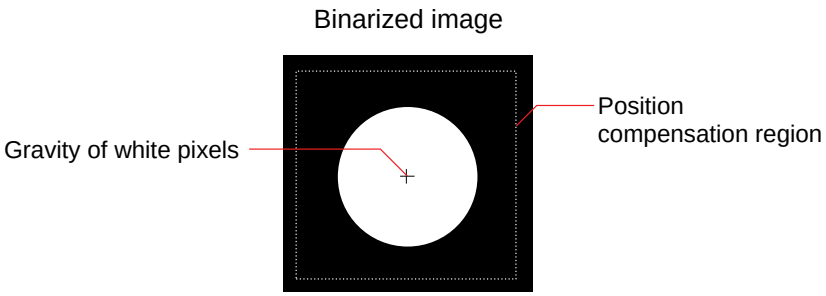
2. Position Compensation

Use the position compensation function when the orientation and displacement of the measurement objects are not consistent. If the measurement object is not in a consistent position, the image read by the camera and the measurement region will not be aligned properly and a correct judgement will not be obtained. See "Operation Manual"

Appendix» Operation Manual "3-2 Position Compensation"

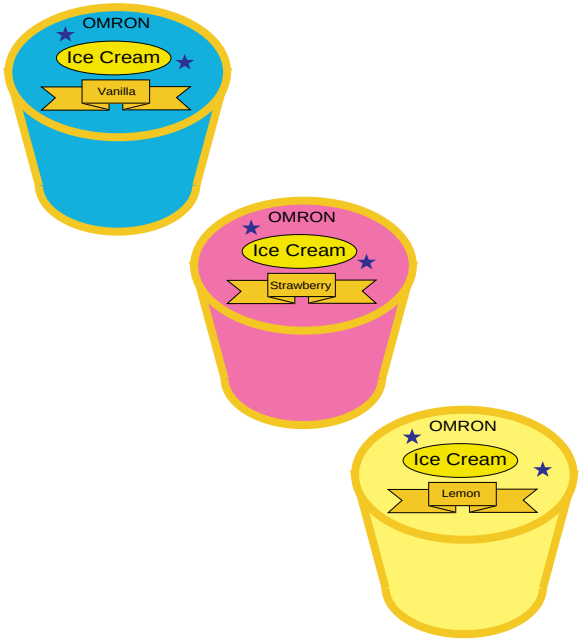


"Area & gravity" will be available for this application.
Position compensation will be performed with the gravity of white pixels in measurement region. The image must be converted (binarized) to black (0) and white (1) pixels beforehand.

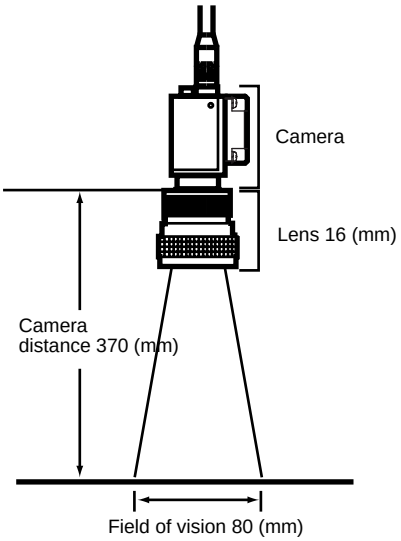


2-3 Ice Cream Separation

This section describes functions and setting steps with the application of ice cream separation. Read this section with actual operation using the picture of measurement object at the end of this manual.



Setting example



1. Change the operating mode. — Select "SET" mode.

2. Select the scene mode. — Select "Color pickup".

3. Adjust the image. — Register the color to be picked up.

4. Set the measurement region. — Set the region with "Area & gravity".

5. Set the output. — Select "Judge".

6. Check the measurement. — Select "MONitor" mode.

7. Measure the objects. — Select "RUN" mode.

2-3-1 Changing Operating Mode

Select "SET" mode.

Select "SET" mode to set measurement condition.

1 The following screen will be displayed after the power is turned ON.

2 Use the Right Key to move the cursor to "MONitor" and press the ENTer key.

3 Select "SET" and press the ENTer key.

▶ The screen enters setting mode. After a short pause, the screen to select the scene mode will appear.

2-3-2 Selecting Scene Mode

Select "Color pickup" mode.

Measurement conditions, such as the type of measurement object and the contents of the inspection, are input under "scenes". Up to 16 scenes can be set. "Color pickup mode" and "Color filter mode" are called scene mode. One of these will be selected to inspect in each scene. Difference between "Color pickup mode" and "Color filter mode" is described in the beginning of the book.

NOTE: Scene mode cannot be changed if scene 0 is already set.
Clear the scene or switch into another scene.

1 Select "Color pickup" and press the ENTer key.

▶ "Color pickup" has been set to scene 0. After a short pause, basic screen for "Set" mode will appear.

▶ Clear the scene before changing the setting already registered.

<How to Clear the Scene>

1 Press the ESCape key.

▶ Leaves "SET" mode.

2 Select "Scene 0" and press the ENTer key.

▶ A selection of 9 scenes (0 to 8) will be displayed.

3 Press the SHIFT+ESCape keys at scene 0.

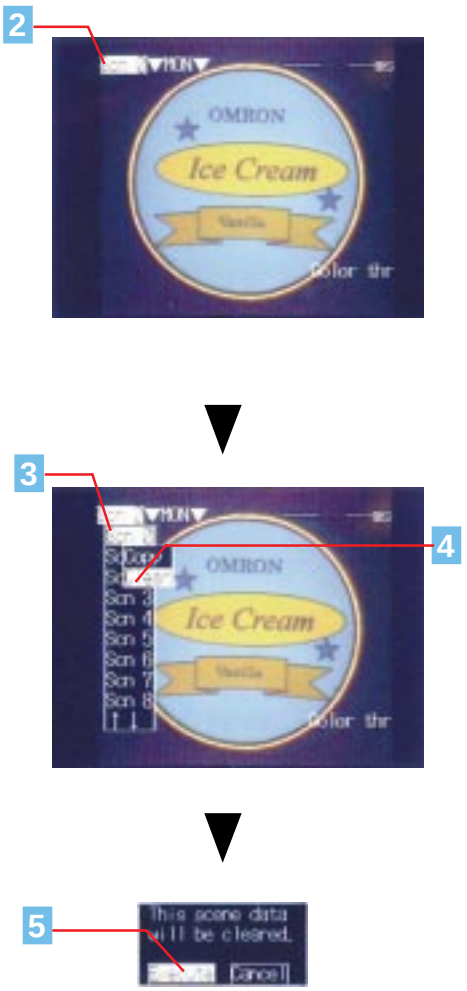
▶ A selection of "Copy" and "Clear" will be displayed.

4 Select "Clear" and press the ENTer key.

▶ A confirmation message will be displayed.

5 Select "Execute" and press the ENTer key.

▶ Scene data will be cleared and the display will return to the screen of **2** .
2-3-1 Changing Operating Mode —>P.25



2-3-3 Adjusting Images

Register the color to be picked up.

Confirming the displayed image on the monitor, register the colors (three colors) of ice cream lid in "Pickup color ".

1 Select "Adjust" and press the ENTer key.

2 Select "Pickup color" and press the ENTer key.

▶ Registering screen of pickup color 0 will be displayed.

3 Press the ENTer key to register the color of "Vanilla" in "Pickup color 0".

▶ Use the Left and Right Keys to switch the picked up color number can be switched. Other colors will be registered for picked up color 1 to 2. Picked up color 1: Register the color of "strawberry". Picked up color 2: Register the color of "lemon".

4 Use the cursor keys to move the box to the color to be picked up.

▶ Press the SHIFT+ENTer keys to change the size of box on the screen.

5 Press the TRIGger key.

▶ Color to be picked up will be displayed. Repeat above steps **4** to **5** to make the color to be picked up to be wholly displayed.

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6 Press the ENTer key.

▶ The color inside the box will be registered and the screen of **3** will appear.

7 Use the Right Key to switch the pickup color number.

▶ Register other colors repeating above steps **3** to **6**.

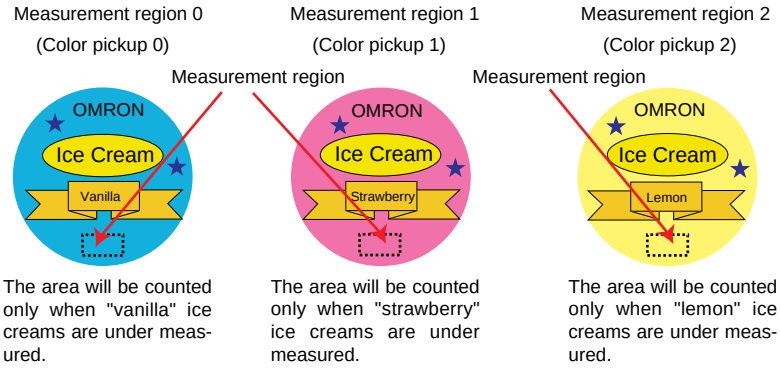
8 Press the ESCape key several times and the screen of **1** will appear.

2-3-4 Setting Measurement Region

Set the measurement region with "Area & gravity".

Set the measurement region in which the inspection is to be performed.
Set three measurement regions with "Area & gravity" which can be measured the area of the measurement object.

<Area & gravity >
The pixels of picked up color will be counted in the measurement region. The counted pixels are called "Area". Set the box of the same size at the same position in the measurement region 0 to 2. (Set the measurement region in space of no letter.) Counted area can tell the color being measured.



The area will be counted only when "vanilla" ice creams are under measured.

The area will be counted only when "strawberry" ice creams are under measured.

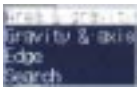
The area will be counted only when "lemon" ice creams are under measured.

1 Select "Measurement region" and press the ENTer key.

▶ The table of measurement region number will be displayed.

2 Select "0." and press the ENTer key.

3 Select "Area & gravity" and press the ENTer key.



Next Page

Selecting color to be picked up

4 Select "Color no." and press the ENTer key.

5 Use the Left and Right Keys to select color to be picked up, and press the ENTer key.

▶ Pickup color 0 will be selected for the measurement region 0.

Setting the Region

6 Select "Region" and press the ENTer key.

7 Select "New" and press the ENTer key.

8 Select "Box" and press the ENTer key.

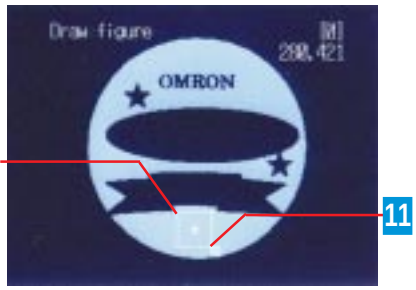
9 Select "OR" and press the ENTer key.

▶ "OR" is for setting the region, "NOT" is for partly erasure.

10 Specify upper-left corner of the measurement region. Use the cursor keys to move the cursor and press the ENTer key.

11 Specify lower-right corner of the measurement region. Use the cursor keys to move the cursor and press the ENTer key.

▶The measurement region will be indicated by dotted line on the screen.



12 Press the ESCape key several times and the screen of **2** will appear.

13 Select "1." and press the ENTer key.

▶ Repeat above steps **3** to **12** and set the measurement region 1 to 2.

14 Press the ESCape key several times and the screen of **1** will appear.

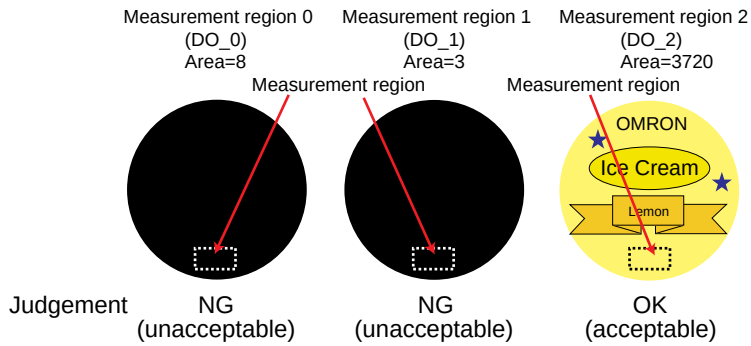
2-3-5 Setting Output

Select "Judge".

Set the output for external device.
Set so as to the results of measurement region 0 to 2 will be output to the terminal block DO_0 to 2. The color will be inspected depending on the region of OK (acceptable) result.

<Setting Judgement Condition>
Judgement condition is set for measuring the area of color pick up and of no picked up color. Refer to the measurement for the displayed image. The picked up color in the measurement region of OK result will be under inspection.

(Ex.) Yellow (lemon) is under inspection.



For counting the area may be influenced by noise, set the value a little higher.

1 Select "Expression" and press the ENTer key.

2 Select "Judge" and press the ENTer key.

3 Select "0." and press the ENTer key.

► "0." indicates DO_0 of terminal block.

4 Select [ ] and press the ENTer key.

5 Select "R0" and press the ENTer key.

▶ "R0" indicates measurement region 0.

6 Select "Area MA" and press the ENTer key.

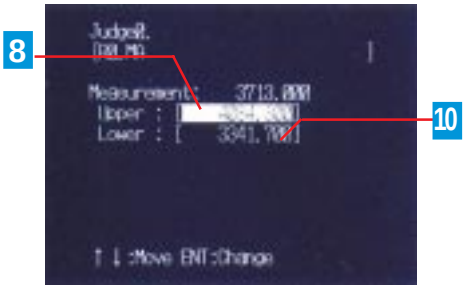
▶ R0.MA will be set.

7 Select "OK" and press the ENTer key.

▶ Operational expression will be set.
Then set the judgement condition.

Next Page

8 Select "Upper" and press the ENTer key.Then change the numeral by digits.



▶ See p.32 to set the judgement condition.

▶ Change the numeral with a one-digit cursor appeared on the display.
Use the Left and Right Keys to move the cursor to the digit to be input.
Use the Up and Down Keys to change the numeral.

9 Press the ENTer key, after changing the numeral.

10 Select "Lower" and press the ENTer key.

▼

11 Press the ESCape key and the screen of **3** will appear.

▶ First 8 letters of expression that had been set will be displayed.

12 Select "1." and press the ENTer key.

▶ Repeat the steps **4** to **11**, set "1." to "R1.MA" and set "2." to "R2.MA".

13 Press the ESCape key several times and the screen of **1** will appear.

2-3-6 Checking Measurements

Select "MONitor" mode.

With practical operation, check that the measurement would be performed correctly with the conditions already set. The results will be just displayed on the screen. Not be output to the terminal block. Measurement condition can be adjusted referring to the judgement.

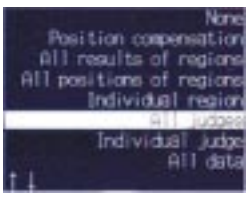
1 Press the ESCape key in following screen to leave "SET" mode.

▶Operation will be in monitor mode automatically.

2 Press the SHIFT+ESCape keys, to confirm output result in terminal block, to confirm output result in terminal block.

3 Select "Display result: None" and press the ENTer key.

4 Select "All judges" and press the ENTer key.



Next Page

5 Select "End" and press the ENTer key.

6 Press the TRIGger key.

▶ Results of DO_0 to 2 will be displayed.

Terminal block \ Ice	Vanilla	Strawberry	Lemon
DO_0	OK	NG	NG
DO_1	NG	OK	NG
DO_2	NG	NG	OK

▶ "Refer to "Operation Manual - 4-1 Checking Measurements"

2-3-7 Measuring Objects

Select "RUN" mode.

Input measurement trigger and the measurement will be performed according to the conditions set for the current scene.
The results will be output to terminal block DO_0 to 2.

1 Select "MONitor" to enter "RUN" mode and press the ENTer key.

2 Select "RUN" and press the ENTer key.

▶ The screen enters measurement mode.

3 Press the TRIGger key.

▶ One measurement will be performed.

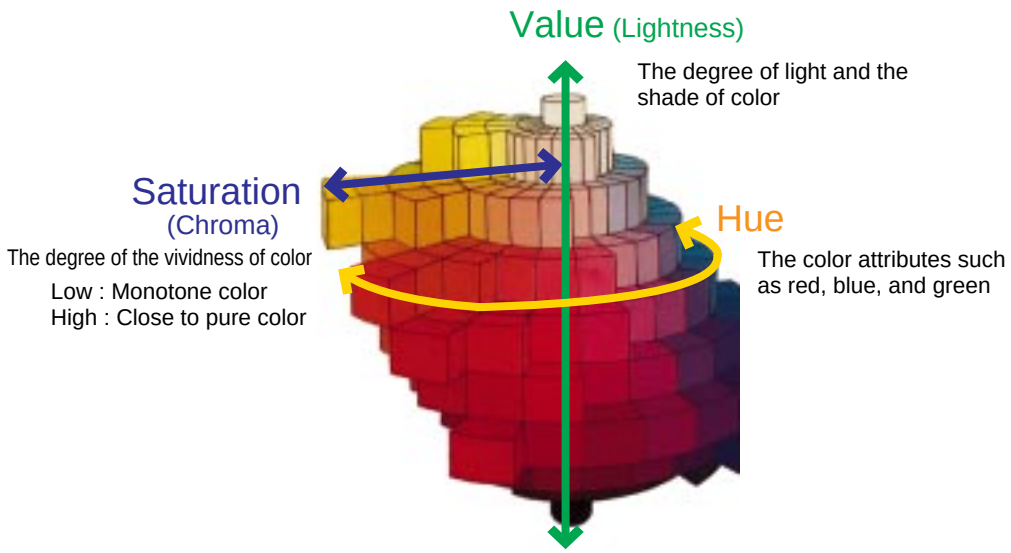
Terminal block \ Ice	Vanilla	Strawberry	Lemon
DO_0	OK	NG	NG
DO_1	NG	OK	NG
DO_2	NG	NG	OK

Memo

SECTION 3

Appendix - Peculiarity of color -

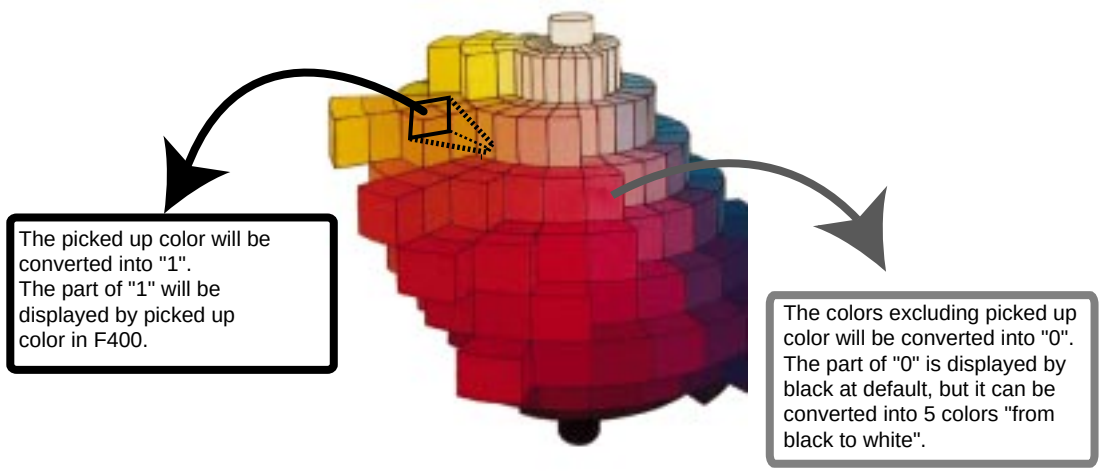
Color is expressed by hue, saturation and value.



Color Cube

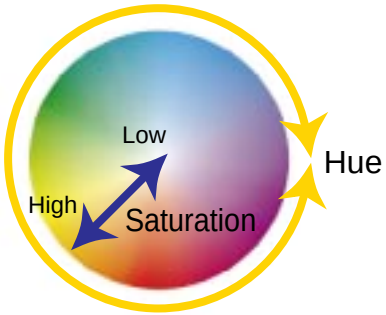
Color Pickup Mode

In color pickup mode, color image will be converted into binary image by three parameters - hue, saturation and value. Specifying picked up color, its corresponding part of the space in color cube will be converted into "1", and the other "0". Monotone color that cannot be treated by color gray filter, can be extracted in color pickup mode.



Colorgray filter in color filter mode

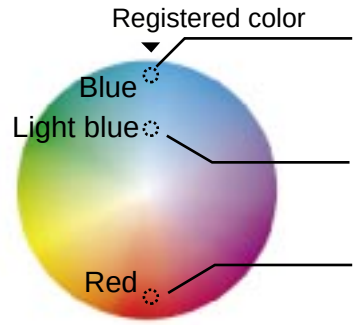
In colorgray filter, color image will be converted into gray image using hue and saturation, but lightness isn't considered during conversion.
The density of gray image after conversion depends on the point on hue/ saturation plane of color image.



Hue/saturation plane

Density of colorgray image
= Saturation of measured color - (Hue of registered color - Hue of measured color)

(Ex.) Registered color: blue



As measured color is as close as registered color and high chroma, it will be white in gray image.

Though hue is registered color, it will be gray in gray image because of low saturation.

As measured color is as far as registered color, it will be black in gray image though high saturation.

Select registered color out of 256 hues. Color bar displayed left side of a screen indicates hue.
Highest chroma colors in each hue are lined up on the color bar.
So blue must be selected on the color bar when light blue is to be registered.

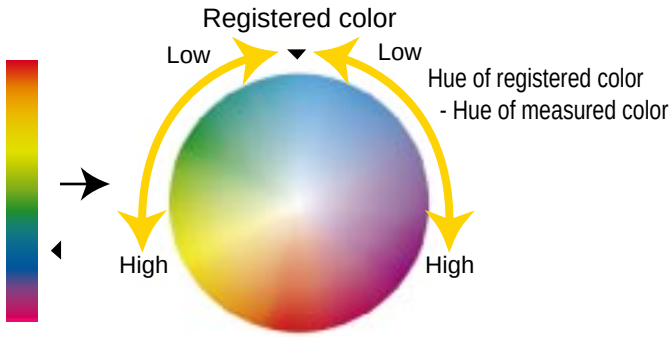
See next page for the setting of color gray filter. Next Page

How to set of colorgray filter
(Hue: STEP 1 to 2, Saturation: STEP 3)

Step1 Selecting the Registered Color

Select a color to be expressed brightly in gray image.
"Hue of registered color - Hue of measured color" will be converted to 256 levels in gray image.
Make output dark for hue of measured color as far as registered color.

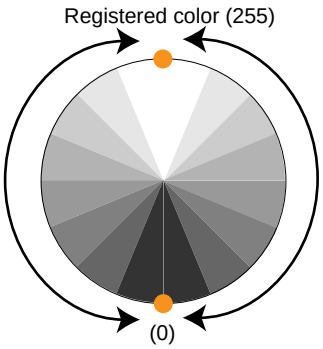
Converting the color bar into color circle will make it easy to understand.



Step2 Switching the Color Band

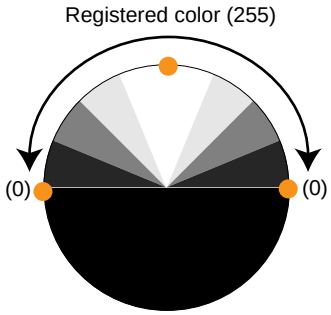
+/-180degrees

Centering the registered color, convert the colors of +/-180 degrees into gray image of 256 gradations.



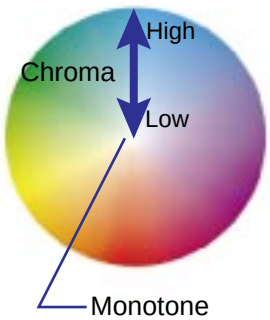
+/- 90 degrees

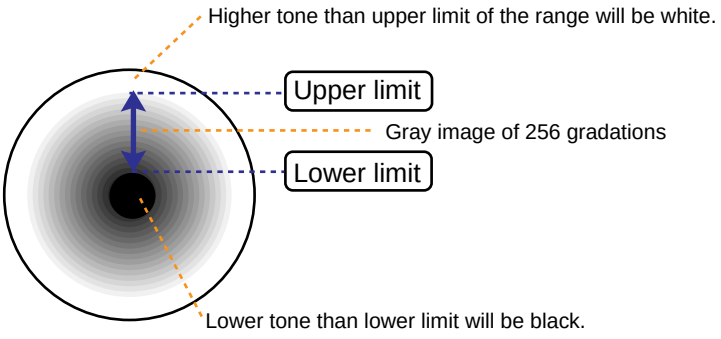
Centering the registered color, convert the colors of +/-90 degrees into gray image of 256 gradations.
Other colors will be converted into black.



Step3 Adjusting the Range of Chroma

Chroma means the vividness of color. Color of lower tone will be converted into darker.





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