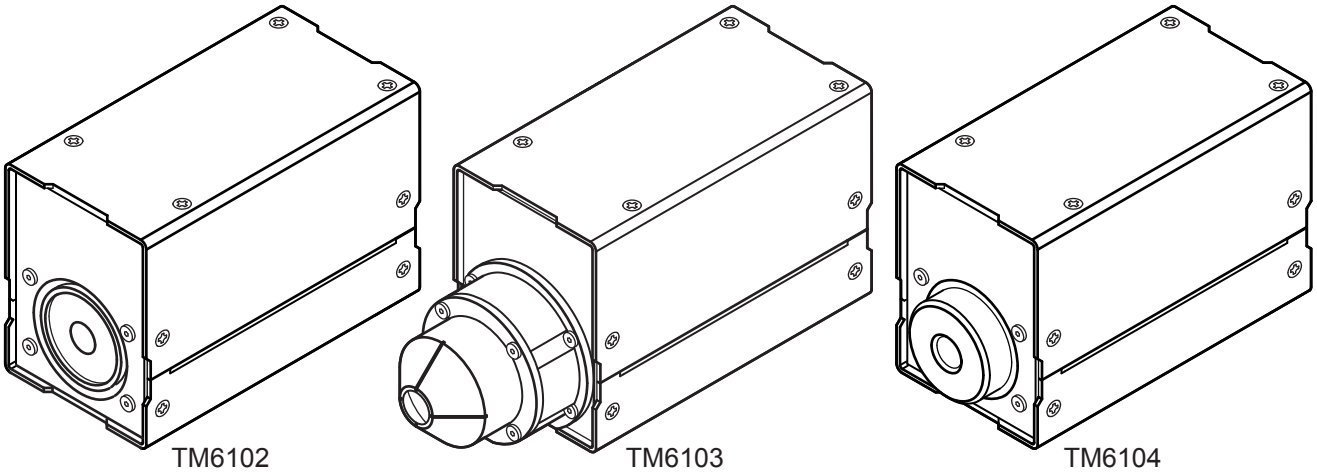
TM6102
RGB LASER METER

HIOKI

Instruction Manual

TM6103
RGB LASER LUMINANCE METER

TM6104
OPTICAL POWER METER



TM6102 TM6103 TM6104

Be sure to read this manual before using the instrument. Safety Notes ▶ p.4

When using the instrument for the first time

Troubleshooting

EN

Sept. 2018 Revised edition 1
TM6102A961-01 18-09H

* 6 0 0 4 8 4 4 5 1 *

Contents

Introduction

Thank you for purchasing the Hioki TM6102 RGB Laser Meter, TM6103 RGB Laser Luminance Meter, or TM6104 Optical Power Meter.
To obtain maximum performance from the instrument over the long term, be sure to read this manual carefully and keep it handy for future reference.

Trademarks

- Adobe and Adobe Reader are trademarks of Adobe Systems Incorporated.
- Microsoft and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and other countries.
- CORE i5 is a registered trademark of Intel Corporation.

License agreement

- The “RGBLaserUtility” application software is included with the instrument. This software requires a license agreement. Please use it only after reading and accepting the license agreement inside the CD.

Precautions during shipment

Store the packaging in which the instrument was delivered, as you will need it when transporting the instrument. (p.93)

Confirming Package Contents

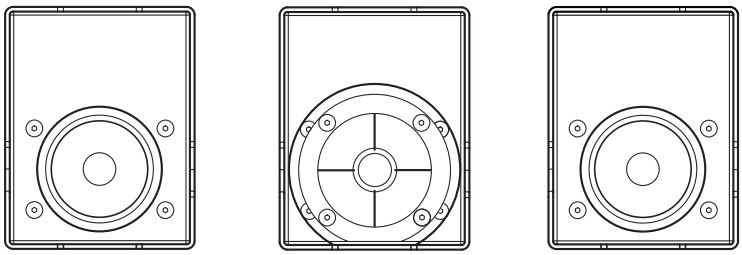
When you receive the instrument, inspect it carefully to ensure that no damage occurred during shipping. In particular, check the accessories and connectors. If damage is evident, or if it fails to operate according to the specifications, contact your authorized Hioki distributor or reseller.

Main unit and accessories

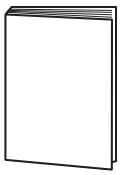
Confirm that these contents are provided.

☐ Model TM6102 RGB Laser Meter
Model TM6103 RGB Laser Luminance Meter
Model TM6104 Optical Power Meter

TM6102 TM6103 TM6104



☐ Instruction Manual (this document)

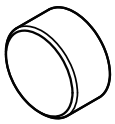


☐ Light shielding cap (Expressed as “cap” in this document)

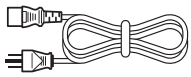
Instrument is shipped with the cap attached.
Be sure to attach the cap when the instrument is not in use.

For the TM6102 and the TM6104

For the TM6103



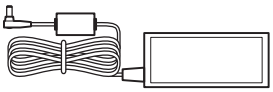
☐ Power cord



☐ LAN cable

Category 6A (CAT 6A)
Straight cable 3 m

☐ Model Z1008 AC Adapter



☐ Application disc (CD)

- Application software
  RGBLaserUtility
- Communication Command Instruction Manual (PDF version)
  (This manual describes the communication commands.)
- Sample program
- Software license agreement
- The latest version can be downloaded from our website.

Option

The following options are available for the instrument. Contact your authorized Hioki istributor or reseller when ordering.

☐ Model Z1008 AC Adapter

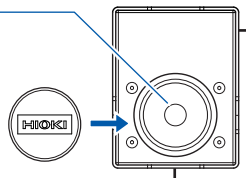
Measurement Flowchart

Installation

Illuminance measurement (p.12), Luminance measurement (p.16), Optical power measurement (p.20)

1 Check that no contaminant or dust is adhered to the detector window of the instrument.

2 Attach the cap.



3 Connect the LAN cable. (p.30)

5 Set the communication setting mode. (p.26)

6 Turn on the instrument. (p.27) Warm up for 30 minutes or longer.

7 Turn on the computer.

4 Connect the AC adapter. (p.26)

To a commercial power supply

Before communicating with the computer

- Installing the application software (p.28)
- External control settings (p.51)

Communication startup

Measurement condition settings (p.35)

Dark measurement (p.42)

Normal measurement (p.45)

White balance adjustment (p.46)

End of measurement

Attach the cap.

Safety Notes

This instrument is designed to conform to IEC 61010 Safety Standards, and has been thoroughly tested for safety prior to shipment. However, using the instrument in a way not described in this manual may negate the provided safety features.
Before using the instrument, be certain to carefully read the following safety notes.

⚠WARNING

- **Protective gears**
  Wear appropriate protective gear before measuring a strong laser light.
- **With regard to the electricity supply, there are risks of an electric shock, a heat generation, a fire, and an arc flash due to a short-circuit. Individuals using an electrical measuring instrument for the first time should be supervised by a technician who has experience in electrical measurement.**

⚠CAUTION

Mishandling during use could damage to the instrument. Be certain that you understand the instructions and precautions in the manual before use.

Notations

In this document, the risk seriousness and the hazard levels are classified as follows.

⚠**DANGER**	Indicates an imminently hazardous situation that will result in death or serious injury to the operator.
⚠**WARNING**	Indicates a potentially hazardous situation that may result in death or serious injury to the operator.
⚠**CAUTION**	Indicates a potentially hazardous situation that may result in minor or moderate injury to the operator or damage to the instrument or malfunction.
IMPORTANT	Indicates information related to the operation of the instrument or maintenance tasks with which the operators must be fully familiar.
	Indicates prohibited actions.
	Indicates the action which must be performed.
*	Additional information is presented below.
p.	Reference
[ ]	Menus, dialogs, buttons in a dialog, and other names on the screen and the keys are indicated in brackets.

• Unless otherwise specified, “Windows” represents Windows 7, Windows 8, or Windows 10.

Symbols affixed to the instrument

	Indicates cautions and hazards. When the symbol is printed on the instrument, refer to a corresponding topic in the Instruction Manual.
	Indicates DC (Direct Current).

Symbols for various standards

	Indicates the Waste Electrical and Electronic Equipment Directive (WEEE Directive) in EU member states.
	Indicates that the product conforms to regulations set out by the EU Directive.

Accuracy

We define measurement tolerances in terms of f.s. (full scale) and rdg. (reading) values, with the following meanings:

f.s.	f.s. (Maximum display value) The maximum display value. Generally, this value indicates the range currently being used.
rdg.	(Reading or displayed value) The value currently being measured and displayed on the measuring instrument.

Usage Notes

- Follow these precautions to ensure safe operation and to obtain the full benefits of the various functions.
- Ensure that your use of the product falls within the specifications not only of the instrument itself, but also of any accessories, options and other equipment being used.
- Before using the instrument, verify that it operates normally to ensure that no damage occurred during storage or shipping. If you find any damage, contact your authorized Hioki distributor or reseller.
- This instrument may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.

⚠WARNING

- **The instrument itself does not radiate any laser light. However, when a strong laser light is irradiated to the detector window of the sensor, a strong reflected light is generated. In this case, do not look into the detector window directly. Doing so may adversely affect your eyes or cause visual disturbance.**
  The instrument can measure lasers classified into classes I to IIIB. As required, refer to the risks during measurement of the relevant class laser and cautions on use stated in IEC60825-1 and FDA21CFR1040.10. When handling a laser product, always follow the caution and warning labels adhered to the laser product, and the contents described in the instruction manual.
- **Refer to the description of safe use of the laser and laser system stated in ANSI Z136.1. Only authorized operators who have trained in operation of the laser and laser system are allowed to perform the measurement.**
- **Do not input a light exceeding the maximum input level. Otherwise, accurate measurements cannot be performed or the sensor may be damaged by excessive energy.**
- **When an extremely focused beam is measured, the energy density on the sensor is excessive, causing inaccurate measurements. In addition, the sensor may deteriorate.**
- **To avoid the risk of fire, do not irradiate a strong laser light to the instrument or cap, nor focus a strong laser light on the instrument or cap. In particular, do not place any combustible materials near the instrument in the unmanned state such as automatic measurement.**
- **Use only the supplied Model Z1008 AC Adapter. The AC adapter input voltage range is 100 V to 240 V AC at a frequency of 50 Hz/60 Hz. To avoid electrical hazards and damage to the instrument, do not apply voltage outside of this range.**
- **To prevent an electrical shock and to maintain the safety specifications of this instrument, connect only the power cord provided to an outlet.**

⚠ CAUTION

- Avoid using an uninterruptible power supply (UPS) or DC/AC inverter with rectangular wave or pseudo-sine-wave output to power the supplied AC adapter. Doing so may damage the instrument.

- The instrument consists of precision optical components. Dropping the instrument or subjecting it to mechanical shock may damage it. Optical components inside the instrument may fall out of alignment if the instrument is dropped or subjected to mechanical shock, affecting measured values.
- To avoid damage to the instrument, protect it from physical shock when transporting and handling it. Be especially careful to avoid physical shock due to dropping it.
- Do not connect the power supply improperly. Doing so may damage the instrument's internal circuitry.
- If a light outside the measurement wavelength range enters, this may cause the sensor to deteriorate. Attach the cap when the instrument is not in use.
- Attach the cap when the instrument is not used for a long time.

Installing the instrument

Installing the instrument in inappropriate locations may cause a malfunction of instrument or may give rise to an accident. Avoid the following locations.

⚠ WARNING

- **Exposed to direct sunlight or high temperature**
- **Exposed to corrosive or combustible gases**
- **Exposed to water, oil, chemicals, or solvents**
- **Exposed to high humidity or condensation**
- **Exposed to a strong electromagnetic field or electrostatic charge**
- **Exposed to high quantities of dust particles**
- **Near induction heating systems (such as high-frequency induction heating systems and IH cooking equipment)**
- **Susceptible to vibration**

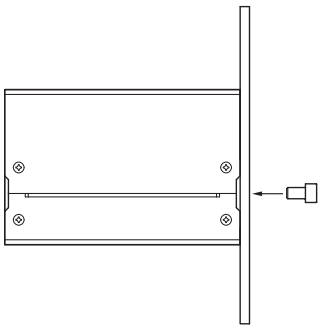
⚠ CAUTION

- Do not place the instrument on an unstable table or an inclined place. Dropping or knocking down the instrument can cause injury or damage to the instrument.
- The instrument consists of precision optical components. The instrument should be securely mounted on a jig using the screw hole in its base. Dropping the instrument or applying an impact to it can cause the accuracy to deviate from its specification. If an impact is applied to the instrument, it needs to be inspected.
- When orienting the instrument so that a part other than its base is facing down, fix it in place so that it cannot fall. Failure to do so may cause a fire or other malfunction in the instrument.
- The instrument is housed in a metal case and emits heat. Be sure to leave adequate space around the instrument. Failure to do so may cause the ambient temperature to rise, affecting measured values and potentially damaging the instrument.
- Install the instrument so that no load is applied to the detector window.

In an emergency, unplug the power cord to kill power to the instrument. Be sure to provide enough unobstructed space to unplug the power cord immediately.

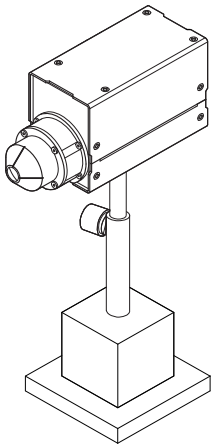
Securing the instrument

Securing the instrument using the tripod mounting screw holes in the rear



- Install the instrument using the tripod mounting screw holes in the rear.
- Sufficiently strengthen the surface on which the instrument is installed so that the instrument is not unstable.
- For the TM6103, securing only the rear may cause an unstable installation of the instrument. Therefore, be sure to secure the instrument using the tripod mounting screws on the bottom.
  Usable screw: 1/4-20UNC, hole depth 7.5 mm

Securing the instrument using the tripod mounting screw holes in the bottom



- Install the instrument using the tripod mounting screw holes in the bottom.
  Usable screw: 1/4-20UNC hole depth 7.5 mm
- A stand and others necessary for the installation work should be prepared by the customer.

Detector window (face detecting the light)

⚠ CAUTION

- Do not touch the detector window. The instrument may fail to operate to its full level of performance if the detector window is dirty.
- Avoid contacting the detector window with sharp objects (the tip of a pair of tweezers, etc.) or hard surfaces. The instrument may fail to operate to its full level of performance if the detector window is damaged.
- Never use solvents that contain benzene, alcohol, acetone, ether, ketones, thinners or gasoline. They can deform and discolor the detector window. (p.93)

Light shielding cylinder (TM6103)

⚠ CAUTION

When handling the TM6103, observe the following cautions to perform correct measurement.

- Do not put any foreign object in the light shielding cylinder.
- Do not apply a large load to the light shielding cylinder.
- Do not touch the inside of the light shielding cylinder with bare hands.
- Do not damage the inside of the light shielding cylinder using a sharp object.
- Do not apply an impact to the light shielding cylinder.
- Never attempt to modify, disassemble, or repair the light shielding cylinder.

AC Adapter

⚠ WARNING

- **Turn the instrument off before connecting the AC adapter to the instrument and to AC power.**
- **Use only the supplied Model Z1008 AC Adapter.**

Before starting the external control

⚠ DANGER

To avoid damage to the instrument, do not apply a voltage exceeding the rated maximum to the external input terminals.

⚠ WARNING

- **Always turn both devices OFF when connecting and disconnecting an interface connector. Otherwise, an electric shock may occur.**
- **To avoid an electric shock or damage to the equipment, always observe the following precautions when connecting to the external input terminals:**
  - **Always turn off the power to the instrument and to any devices to be connected before making connections.**
  - **Be careful to avoid exceeding the ratings of the external input terminals.**
  - **Connect cables securely to the external connector. During operation, a wire becoming dislocated and contacting another conductive object can be serious hazard.**

⚠ CAUTION

- Use a common ground for both the instrument and the computer. Using different ground circuits will result in a potential difference between the instrument's ground and the computer's ground. If the communications cable is connected while such a potential difference exists, it may result in equipment malfunction or failure.
- Before connecting or disconnecting any communications cables, always turn off the instrument and the computer. Failure to do so could result in equipment malfunction or damage.
- To prevent equipment failure, use the recommended wire type to connect to the external input terminals.

  Recommended wire
  Single strand: ϕ0.65 mm (AWG #22)
  Multi-strand: 0.32 mm^2 (AWG #22)

  Acceptable limits
  Single strand: ϕ0.32 mm to ϕ0.65 mm (AWG #28 to #22)
  Multi-strand: 0.08 mm^2 to 0.32 mm^2 (AWG #28 to #22)
  Strand diameter: minimum ϕ0.12 mm (per strand)
  Standard insulation stripping length: 9 mm to 10 mm
  Button pressing tool: Blade screwdriver (shaft diameter: 3 mm, tip width 2.6 mm)

CD precautions

- Exercise care to keep the recorded side of discs free of dirt and scratches. When writing text on a disc's label, use a pen or marker with a soft tip.
- Keep discs inside a protective case and do not expose to direct sunlight, high temperature, or high humidity.
- Hioki is not liable for any issues your computer system experiences in the course of using this disc.

1 Overview

1.1 Overview and Features

The instrument measures the centroid wavelength and radiometric quantity of laser light sources and calculates the chromaticity and photometric quantity.
In addition, the target value of the radiometric quantity (each of the red, green, and blue radiometric quantities) and the tolerance of the radiometric quantity necessary to adjust the chromaticity and photometric quantity to specified values are presented.
All of the control and display of the measurement are performed on the computer.

Highly accurate measurement dedicated for RGB lasers

The centroid wavelengths and radiometric quantities of the red, green, and blue lasers are measured simultaneously by means of the discrete centroid wavelength method*.
Additionally, the highly accurate photometry and colorimetry are achieved.
*: A method to measure the red, green, and blue centroid wavelengths and radiometric quantities of the RGB laser and calculate the chromaticity and photometric quantity from the color-matching function.

The industry's first traceability to national standards in laser illuminance

The industry's first traceability to national standards in laser illuminance was achieved using a monochromatic laser source. (As of May, 2017)
It is Hioki's original compliant, which renovates the conventional traceability to the standard lamp.

Shortening of adjustment process

When the white balance is adjusted, the target value of the radiometric quantity and the tolerance of the radiometric quantity are calculated from the measured result to contribute to shortening of the adjustment process.

Stable high-speed measurement

Various modulation frequencies (screen refresh rates) are supported to ensure stable measurement.

Measurement of centroid wavelength

In addition to the chromaticity and photometric quantity, the centroid wavelength, which is used to control the RGB laser module product itself, can be measured.
In addition, the measured centroid wavelength is utilized for the quality control or production control of the RGB laser module.

Sensors suitable for the measuring object

Three types of sensors, illuminance (TM6102), luminance (TM6103), and optical power (TM6104), suitable for various measuring objects such as HMD, HUD, and projector or various measurement scenes in the production process, are prepared.

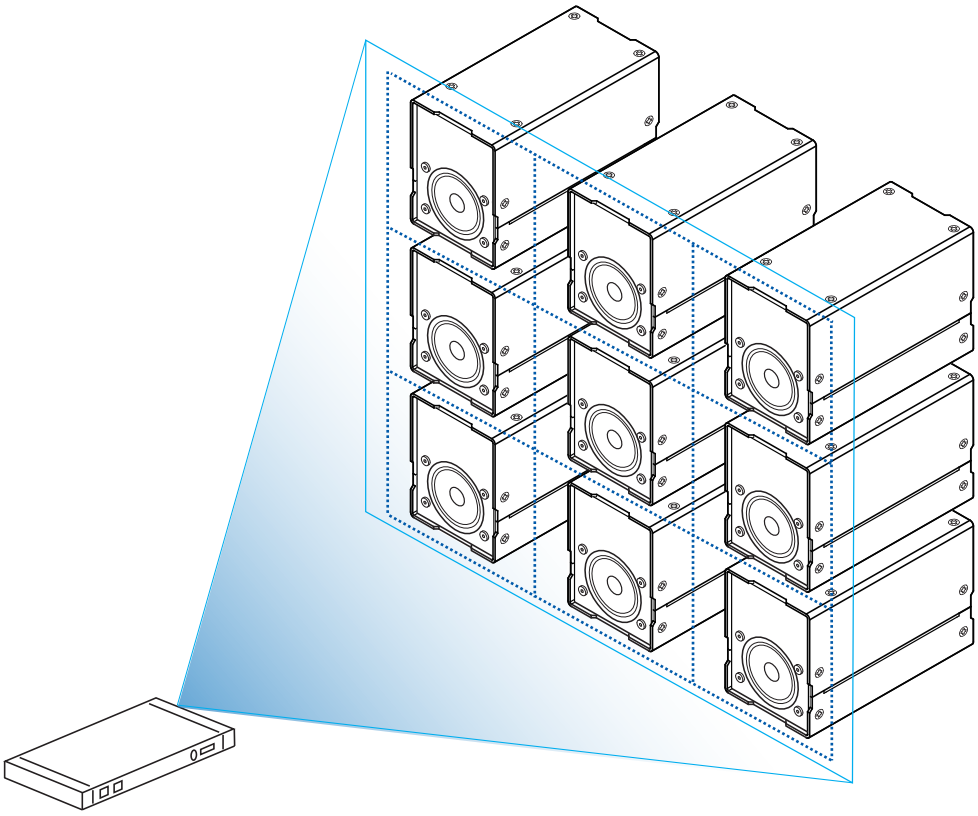
1.2 Model TM6102 RGB Laser Meter

The TM6102 RGB Laser Meter measures the light that is irradiated uniformly to the entire detector window from the RGB laser module of the projector or HUD (head up display).
The reference surface of the illuminance measurement is REF.LEVEL shown in the drawings of the dimensions. (p.15)

The measurement settings and measurement items except for the following points are the same as the TM6103 and TM6104.

- Radiometric quantity → Irradiance
- Photometric quantity → Illuminance

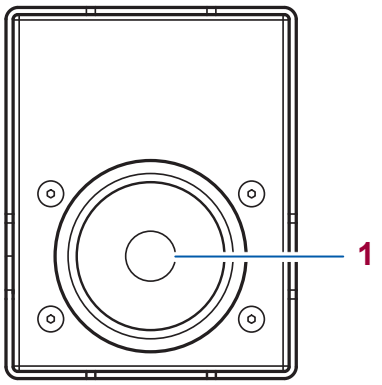
Measurement example



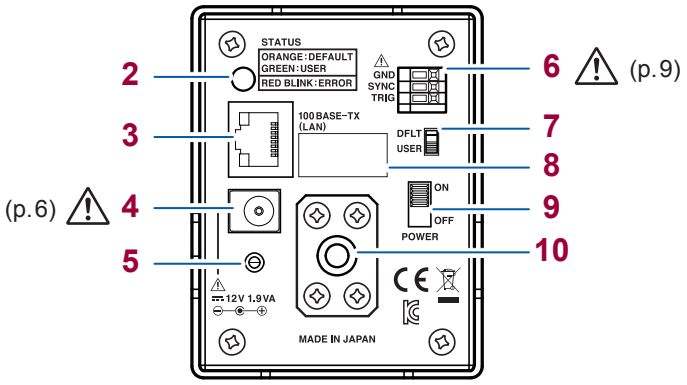
Example: Laser projector

Parts Names and Functions

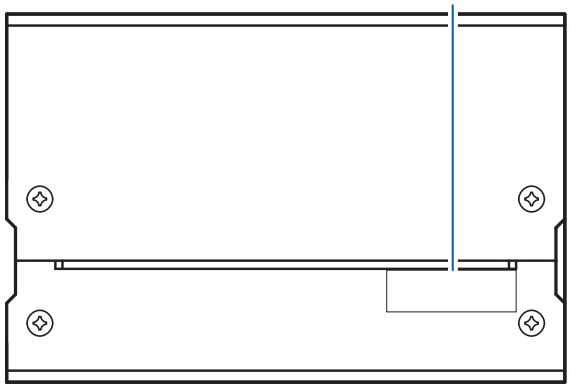
Front



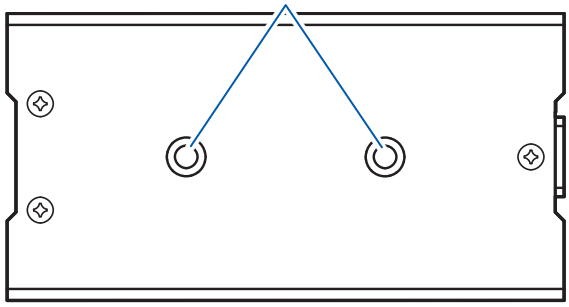
Rear



Right side

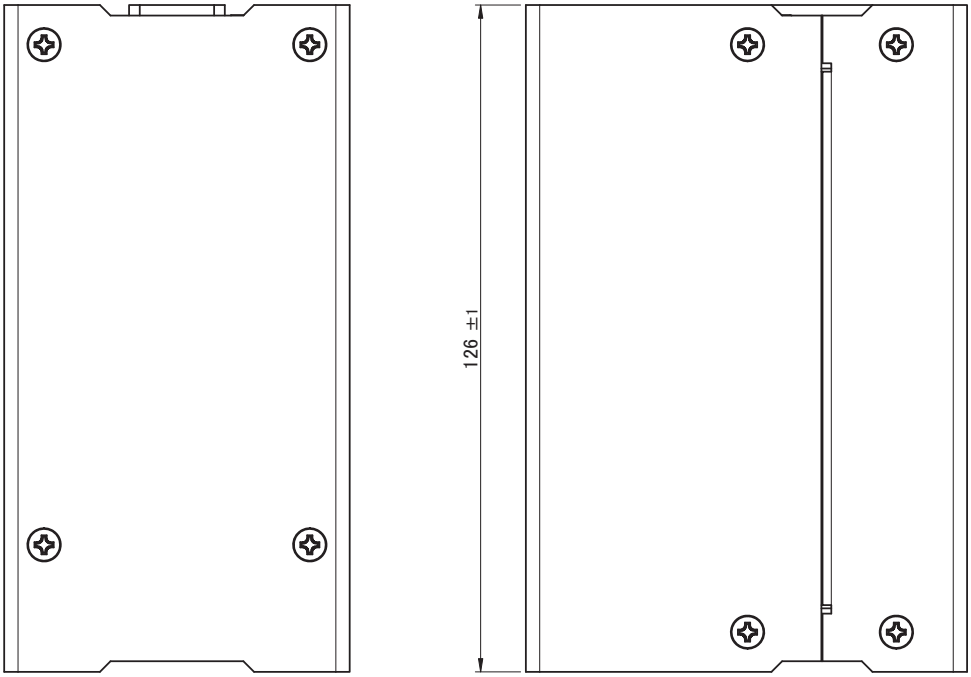


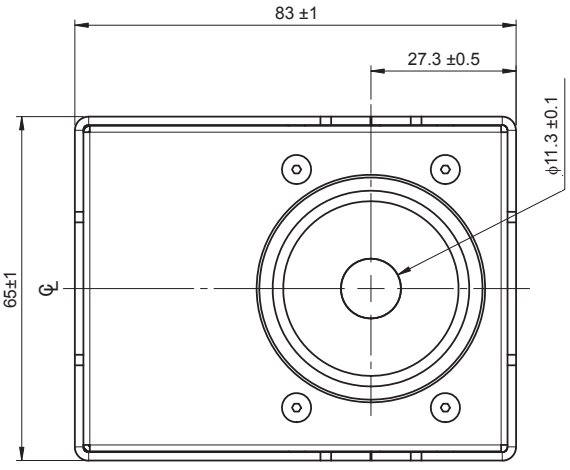
Bottom



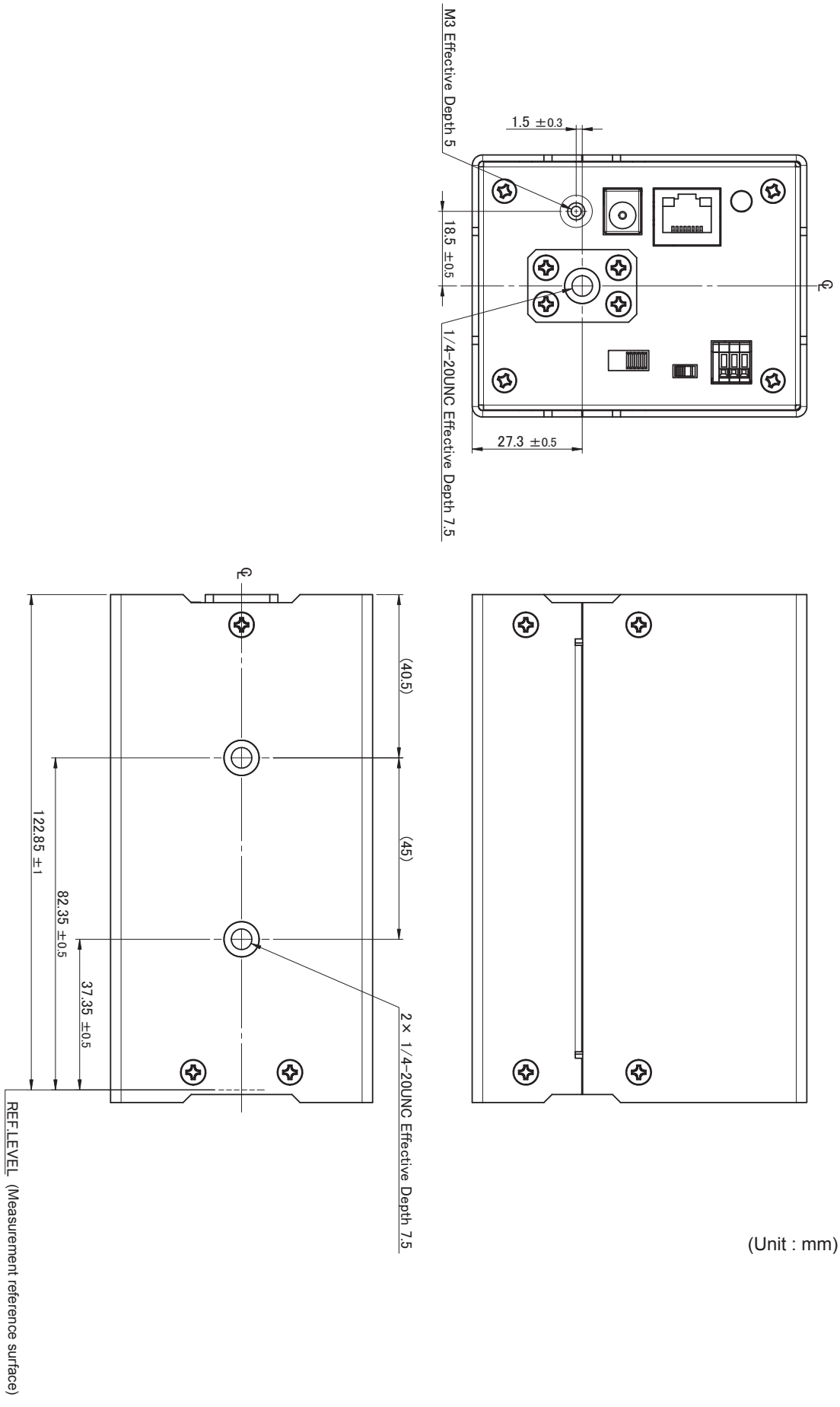
No.	Description	Reference
1	**Detector window** (ϕ11.3 mm ±0.1 mm)	p.8
2	**Power LED**	p.27
3	**LAN connector**	p.29
4	**AC adapter connector**	p.26
5	**General purpose screw hole** (Used to secure the power cord.)	–
6	**External input terminals**	p.51
7	**Communication mode switch**	p.26
8	**MAC address**	–
9	**Power switch**	p.27
10	**Tripod mounting screw holes**	p.8
11	**Serial No.** (Do not peel off the label because it is necessary for production control.)	–

Dimensions





(Unit : mm)


M3 Effective Depth 5
1.5 ±0.3
18.5 ±0.5
1/4-20UNC Effective Depth 7.5
27.3 ±0.5
(40.5)
(45)
122.85 ±1
82.35 ±0.5
37.35 ±0.5
2× 1/4-20UNC Effective Depth 7.5
REF.LEVEL (Measurement reference surface)

(Unit : mm)

1.3 TM6103 RGB Laser Luminance Meter

The TM6103 RGB Laser Luminance Meter is a light shielding cylinder type luminance meter.
The TM6103 measures the luminance at a close range of the display (example: the distance from the top end of the light shielding cylinder to the display is 10 mm).
Before starting the measurement, install the TM6103 so that it is perpendicular to the display. (To measure the luminance more accurately, align the light axis of the light emitted from the display and the light axis of the TM6103.)
The light source that becomes the measuring object needs to be larger than the measurement field diameter of the TM6103.
To perform accurate measurements, it is recommended to measure the light source that is sufficiently larger than the measurement field diameter.

The TM6103 measures the average luminance within the measurement field diameter in the same way as the conventional luminance meter.
When a directional light source (light source with an inconstant luminance) is measured using luminance meters with different angle-of-visibilities, the measured value that differs among them. This phenomenon occurs because the calibration light source of the luminance meter has a constant luminance area, but the measuring object does not have one.

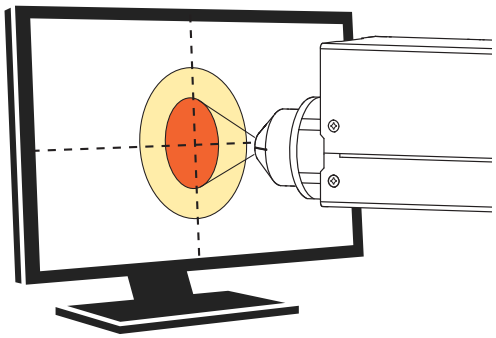
- When the light source of the measuring object has a constant luminance area, differences in the angle-of-visibility do not affect the measured luminance value.
- The measured luminance is a value for which the angle dependency of the light source luminance is averaged by the angle-of-visibility. Therefore, when the light source of the measuring object does not have a constant luminance area, the angle-of-visibility of the luminance meter affects the measured luminance value, in principle.

To perform the measurement with excellent reproducibility, it is necessary to align the light axis of the light emitted from the display and the light axis of the luminance meter. In this case, it is recommended to use an optical bench.

The measurement settings and measurement items except for the following points are the same as the TM6102 and TM6104. (p. 12)
- Radiometric quantity → Radiance
- Photometric quantity → Luminance

CAUTION
Removing or disassembling the light shielding cylinder may cause inaccurate measurements. (p. 8)
Never attempt to remove or disassemble the light shielding cylinder.

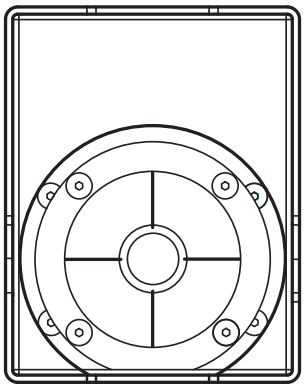
Measurement example



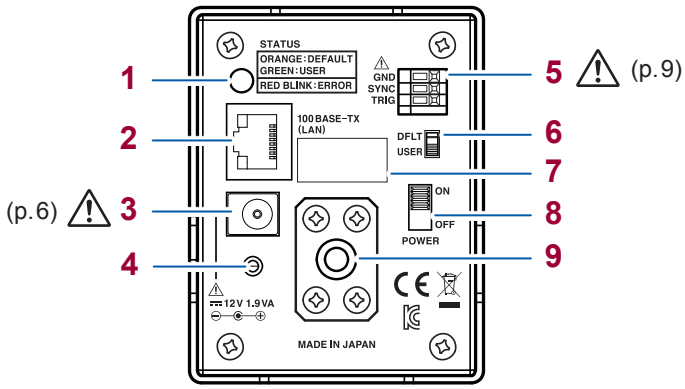
Light source (Target)

Parts Names and Functions

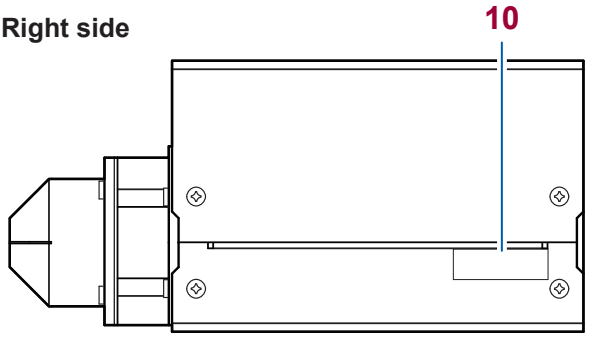
Front



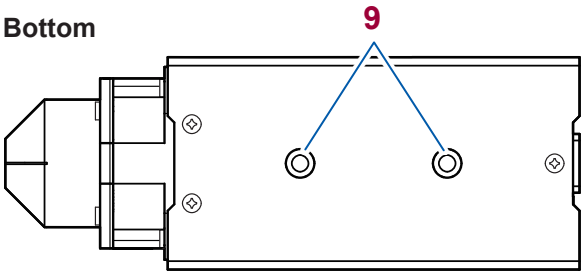
Rear



Right side

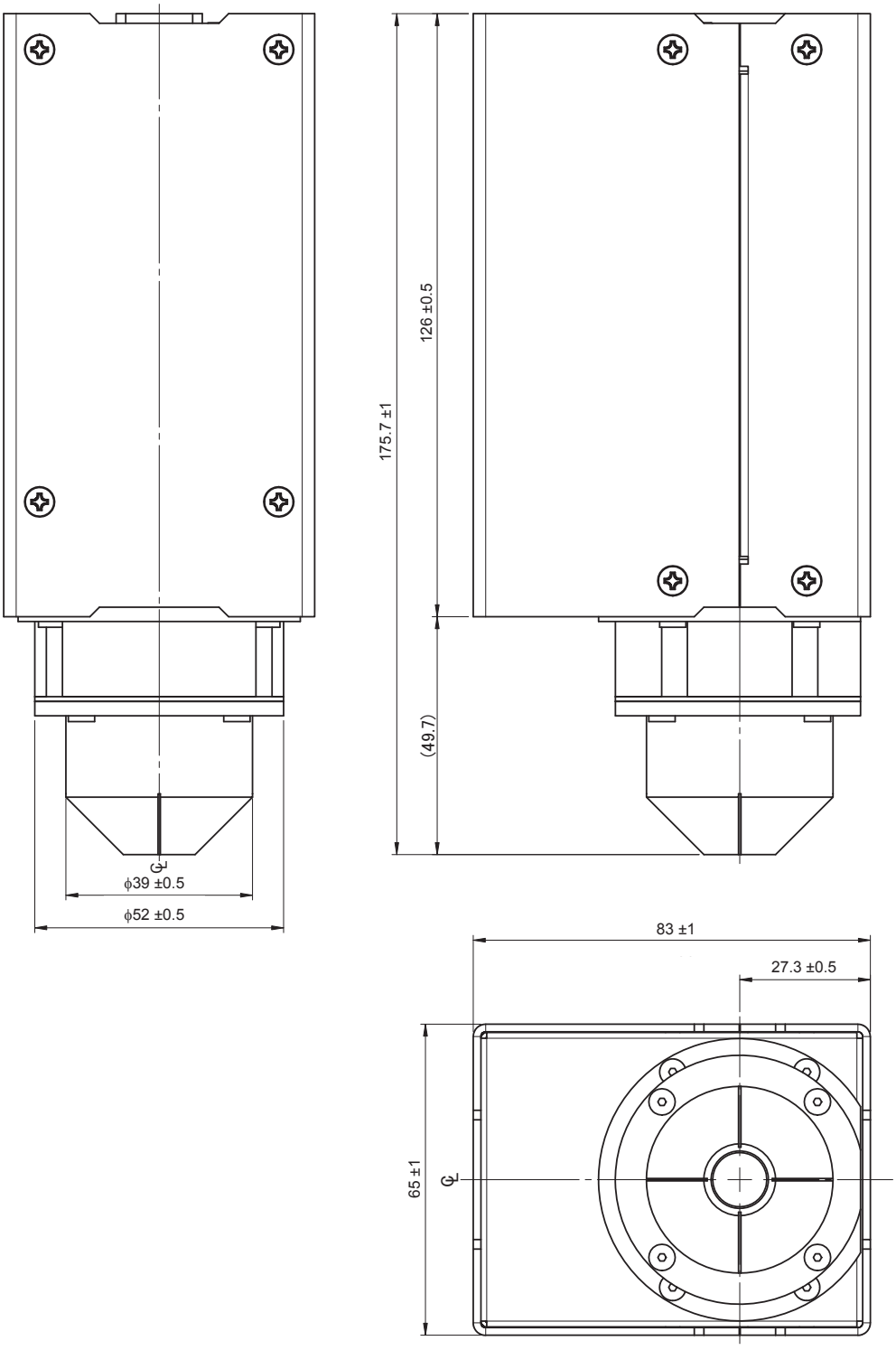


Bottom

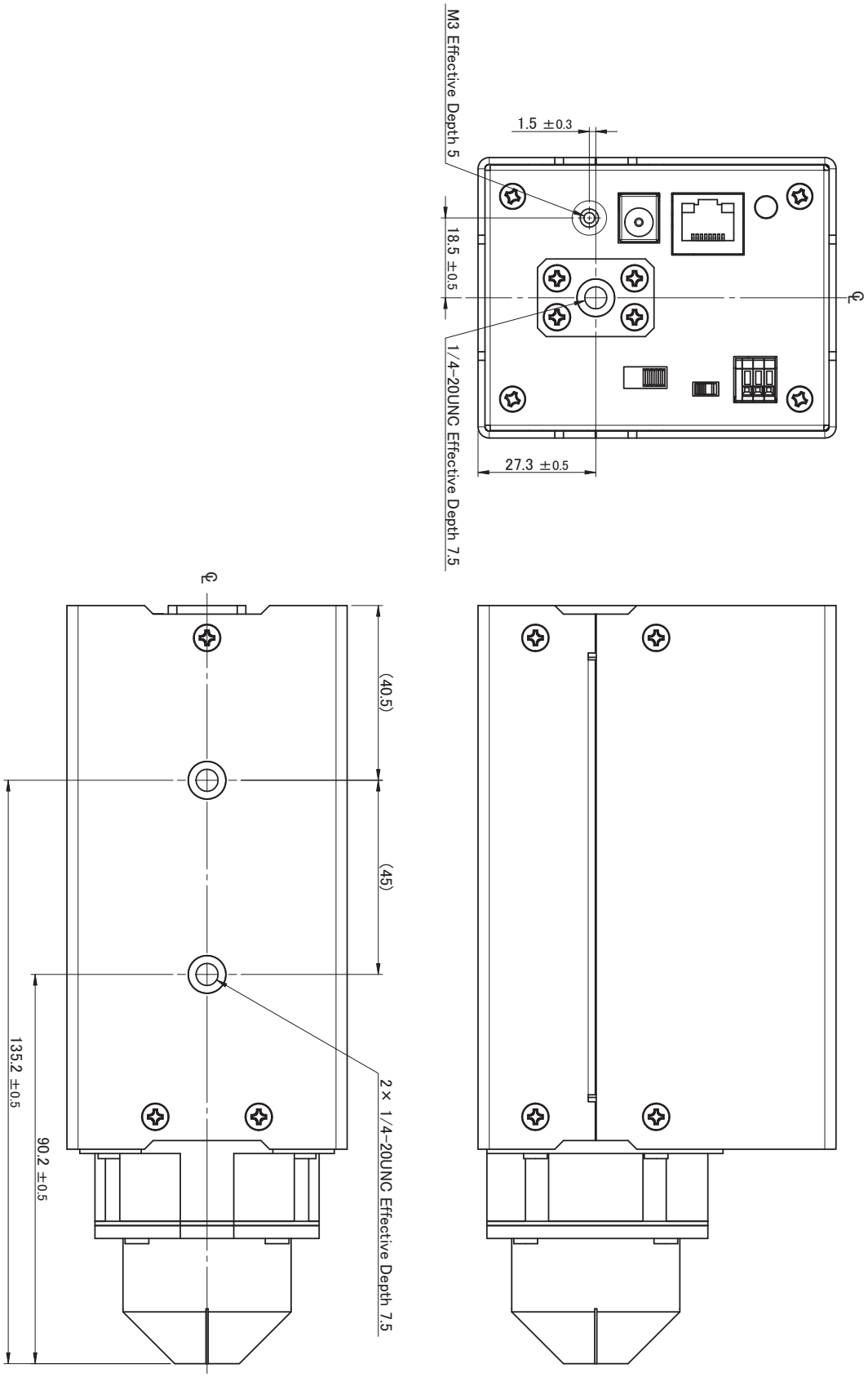


No.	Description	Reference
1	**Power LED**	p.27
2	**LAN connector**	p.29
3	**AC adapter connector**	p.26
4	**General purpose screw hole** (Used to secure the power cord.)	–
5	**External input terminals**	p.51
6	**Communication mode switch**	p.26
7	**MAC address**	–
8	**Power switch**	p.27
9	**Tripod mounting screw holes**	p.8
10	**Serial No.** (Do not peel off the label because it is necessary for production control.)	–

Dimensions



(Unit : mm)


M3 Effective Depth 5
1.5 ±0.3
18.5 ±0.5
1/4-20UNC Effective Depth 7.5
27.3 ±0.5
(40.5)
(45)
135.2 ±0.5
90.2 ±0.5
2× 1/4-20UNC Effective Depth 7.5

(Unit : mm)

1.4 Model TM6104 Optical Power Meter

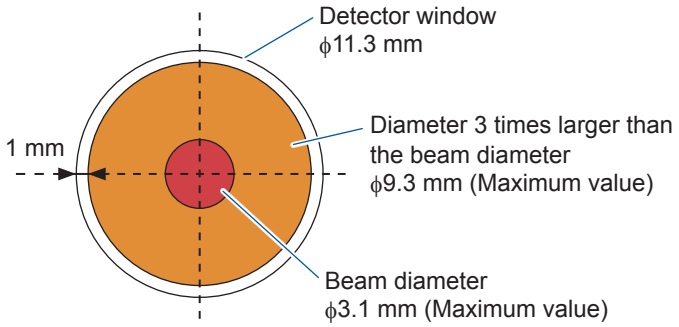
The TM6104 Optical Power Meter measures the power and centroid wavelength of the laser beam irradiated at the center of the detector window.
When performing the measurement, you have to consider the beam diameter.
The beam diameter is defined as a maximum distance between the points in the cross section of the beam where the optical power density is e^{-2} (=0.1353) to the maximum value in the beam (JIS C6182).
Although IEC1040 adopts e^{-1} as the definition of a beam diameter instead of e^{-2}, this instrument uses the definition of JIS C6182.
To perform accurate measurements, it is necessary to make all powers of the beam enter the detector window.

In addition, it is recommended to use a laser with a beam diameter of 3.1 mm or less so as to perform accurate measurements.
This makes the diameter that is 3 times larger than the beam diameter smaller than the diameter of the detector window (=ϕ11.3 mm) as a guide since the beam usually has a spread.

Example: When the beam diameter is 1 mm, make the beam enter an area within 6 mm dia. from the center of the detector window.

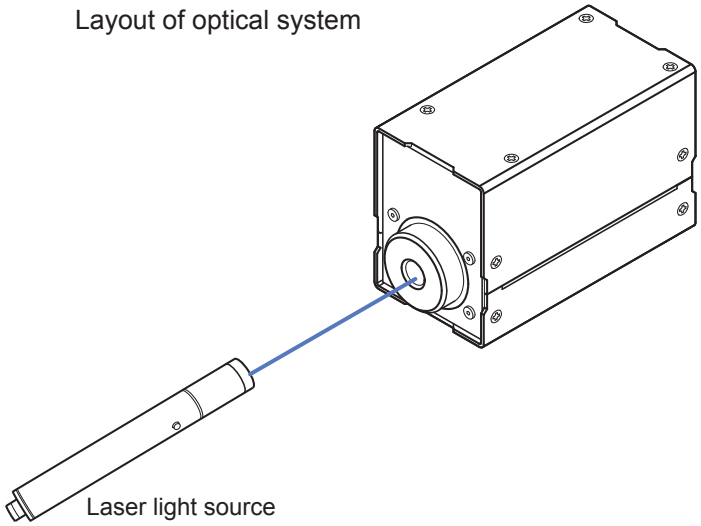
However, this does not apply when the beam has no spread.

The measurement settings and measurement items except for the following points are the same as the TM6102 and TM6103. (p. 12)
- Radiometric quantity → Radiant flux (Optical power)
- Photometric quantity → Luminous flux



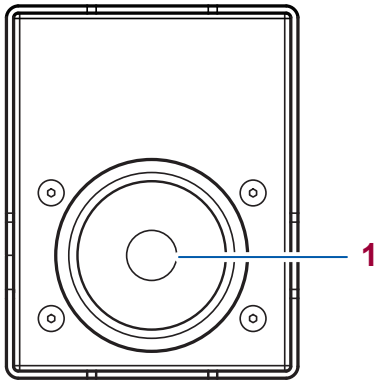
Measurement example

Layout of optical system

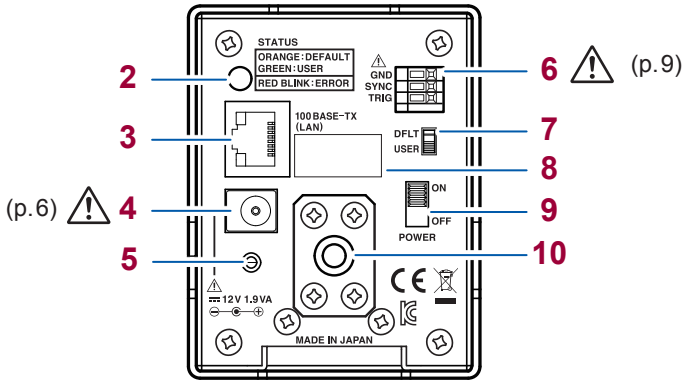


Parts Names and Functions

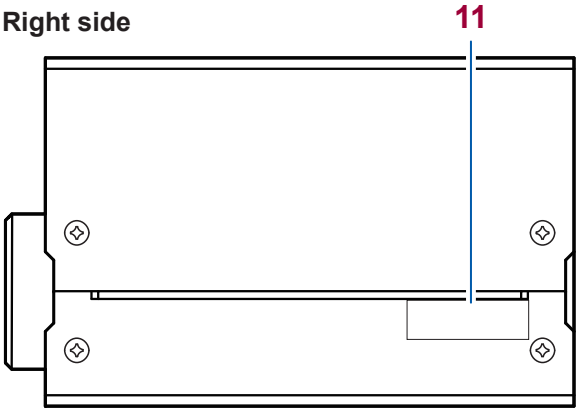
Front



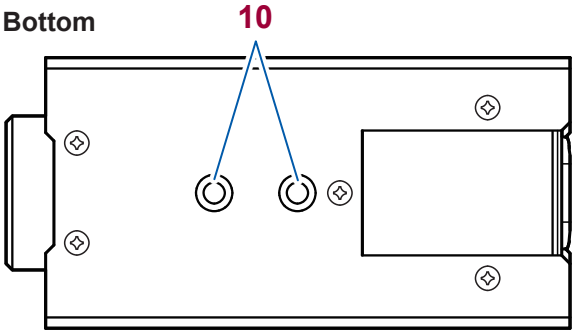
Rear



Right side

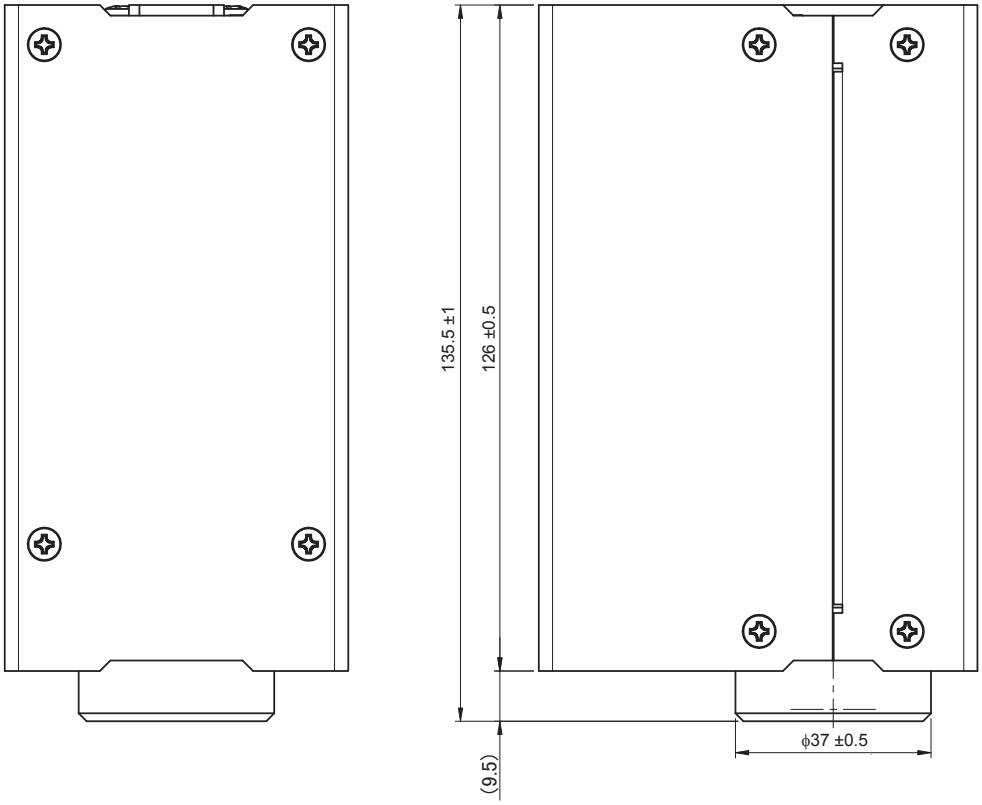


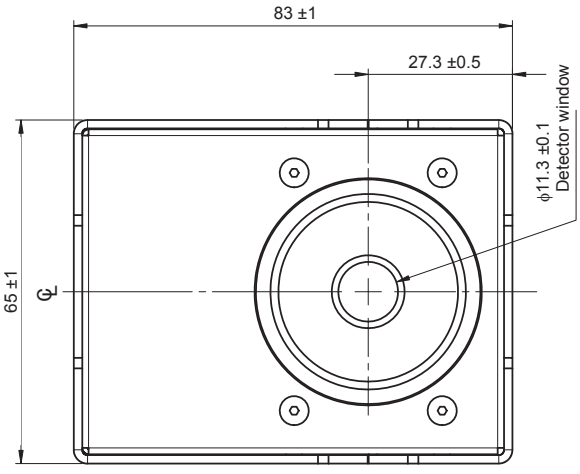
Bottom



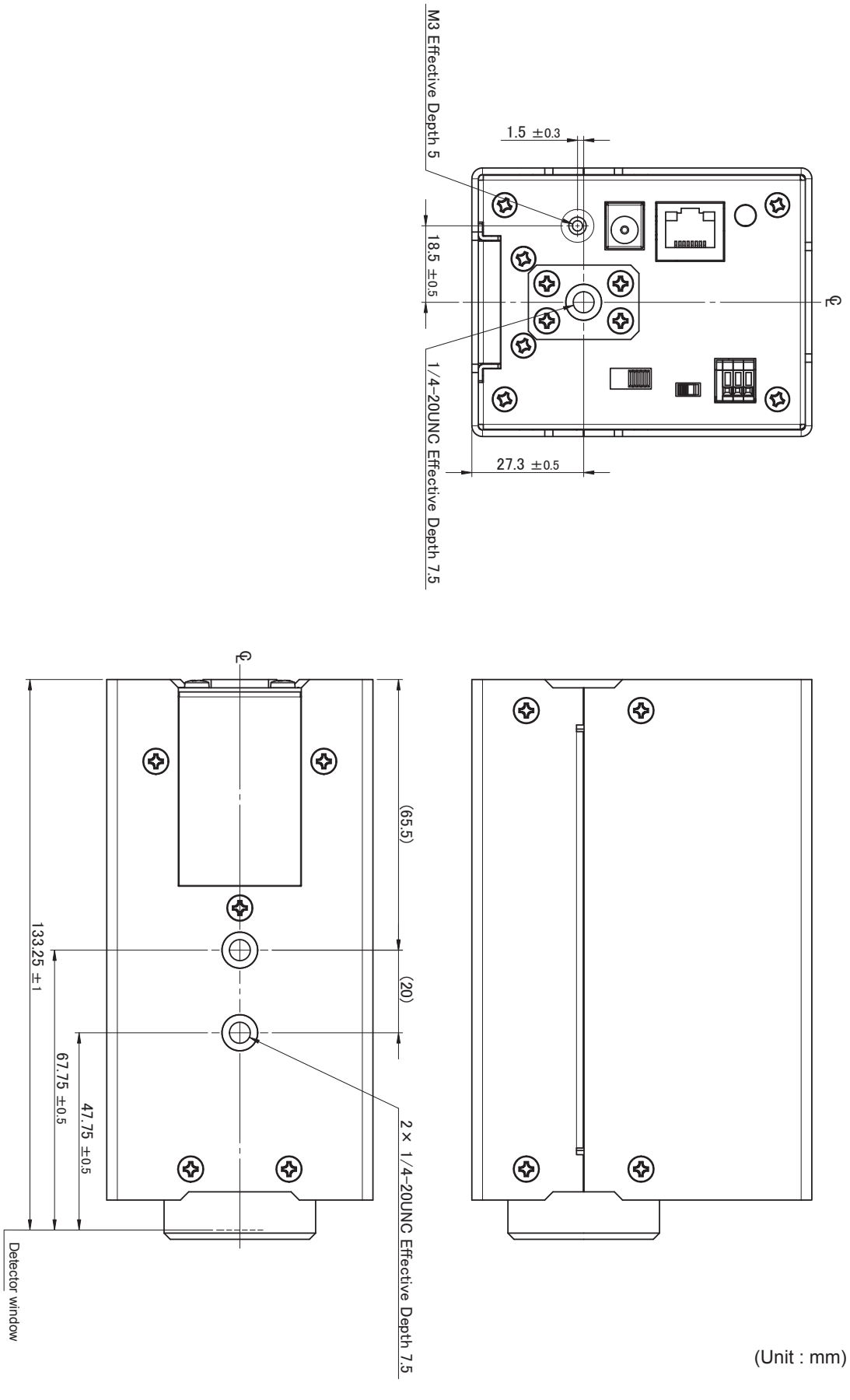
No.	Description	Reference
1	**Detector window** (ϕ11.3 mm ±0.1 mm)	p.8
2	**Power LED**	p.27
3	**LAN connector**	p.29
4	**AC adapter connector**	p.26
5	**General purpose screw hole** (Used to secure the power cord.)	–
6	**External input terminals**	p.51
7	**Communication mode switch**	p.26
8	**MAC address**	–
9	**Power switch**	p.27
10	**Tripod mounting screw holes**	p.8
11	**Serial No.** (Do not peel off the label because it is necessary for production control.)	–

Dimensions





(Unit : mm)


M3 Effective Depth 5
1.5 ±0.3
18.5 ±0.5
1/4-20UNC Effective Depth 7.5
27.3 ±0.5
(65.5)
(20)
133.25 ±1
67.75 ±0.5
47.75 ±0.5
2× 1/4-20UNC Effective Depth 7.5
Detector window

(Unit : mm)

2 Preparations

2.1 Inspection Before Measurement

Check before use

Before using the instrument, verify that it operates normally to ensure that no damage occurred during storage or shipping. If you find any damage, contact your authorized Hioki distributor or reseller.

Inspecting peripheral devices

Check item	Action
Is the sheath of any connection cable damaged or any metal part exposed?	Using a damaged connection cable may cause an electrical shock or a short circuit accident. Do not use any damaged connection cable. Replace the damaged connection cable with a new one.

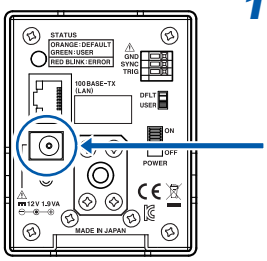
Inspecting the instrument

Check item	Action
Is the instrument damaged?	If the instrument is damaged, send the instrument for repair.
Is any dust or contaminant adhered to the detector window?	If the detector window is contaminated, clean it. (p.93)
Does the power LED light up?	• If the power LED does not light up, the power cord contains a broken wire or the inside of the instrument malfunctions. If the instrument malfunctions, send it for repair. (p.27) • If the power LED blinks in red, an error occurred inside the instrument. After connecting the instrument via TCP/IP, use the `*ESR?,:SYSTem:ERRor?` command to check the details of the error, and then take appropriate corrective actions corresponding to the error. Details of error: Communication Command Instruction Manual (CD)
Execute the self-test to check if an error occurs. (Use the `*TST?` command to execute the self-test. When no error occurs, `PASS` is returned. When an error occurs, `FAIL` is returned.)	• When an error occurs, use the `:SYSTem:ERRor?` command to check the details of the error, and then take appropriate corrective actions corresponding to the error. • For details about the error, see the Communication Command Instruction Manual (CD). • When executing the self-test using the application software, see “Self-test” (p.79).
Input the modulation frequency signal to the SYNC terminal and execute the modulation frequency measurement. Is the measured result of the modulation frequency within the assumed range?	If the measured result of the modulation frequency is not within the assumed range, the inside of the instrument may malfunction. Send the instrument for repair.
Is the measured value of the photometric quantity changed by changing the brightness of the irradiation light?	If the measured value of the photometric quantity is not changed, the inside of the instrument may malfunction. Send the instrument for repair.
Is the measured result of the centroid wavelength within the assumed range when the laser light source with the known wavelength is measured?	If the measured result of the centroid wavelength is not within the assumed range, the inside of the instrument may malfunction. Send the instrument for repair.

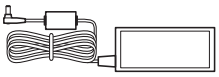
2.2 Connecting the AC Adapter and Power Cord

Check the following points before starting the connection work.
- Check that the cap is attached to the detector window.
- Thoroughly read “AC Adapter” (p.9).

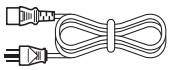
Rear



1 **Connect the AC adapter to the AC adapter connection terminal of the instrument.**



2 **Connect the power cord to the AC adapter.**

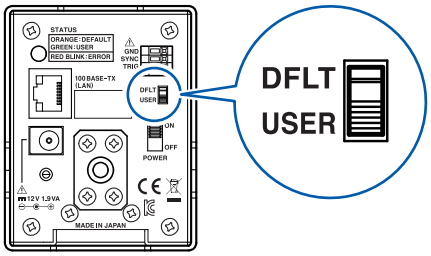


3 **Connect the power cord to a commercial power supply.**

2.3 Setting the Communication Setting Mode

Change the LAN communication setting mode using the communication setting mode switch. (p.31)
The LAN communication setting mode cannot be changed when the power is **ON**.

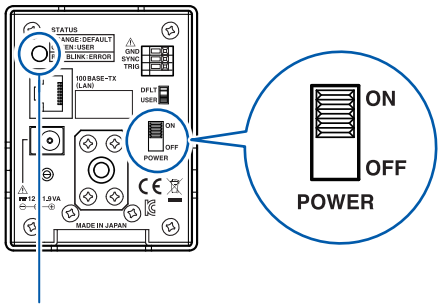
Rear



Switch	Communication setting mode	Settings
DFLT	Fixed setting mode	• The LAN settings are as follows. IP address: 192.168.0.254 Subnet mask: 255.255.255.0 Default gateway: 0.0.0.0 (None) Communication command port: 1024 • The fixed setting mode is used to make the LAN settings. • The fixed setting mode can also be used when one-to-one communication with the computer is performed.
USER	User setting mode	Use the LAN settings that are set using the following communication commands. **:SYSTem:COMMunicate:LAN:IPADdress** <IP address> **:SYSTem:COMMunicate:LAN:SMASk** <Subnet mask> **:SYSTem:COMMunicate:LAN:GATeway** <Address> **:SYSTem:COMMunicate:LAN:CONTrol** <Port No.> **:SYSTem:COMMunicate:LAN:UPDate**

2.4 Turning ON/OFF the Power

Rear



Power LED

Color	Status	Description
Green	Lit	Running when the communication setting mode is set to the user setting mode.
Orange	Lit	Running when the communication setting mode is set to the fixed setting mode.
Red	Blink	An internal error is occuring. Use the communication command (`*ESR?`, `:SYSTem:ERRor?`) to check the details. See: Communication Command Instruction Manual (CD)
Orange	Blink	Running in the version up mode (boot mode). The communication setting mode becomes the fixed setting mode regardless of the communication setting mode switch state.
–	Off	The power is off.

2.5 Installing the Application Software

Recommended computer operating environment

CPU	Core i5, 2.7 GHz or faster
OS	Windows 7/ Windows 8/ Windows 10
Memory	8 GB or more
Screen display	Resolution 1024 × 768 dots, 64,000 colors or more
Hard disk	Free capacity 100 MB or more
Interface	LAN 100BASE-TX (TCP/IPv4 connection)
CD-ROM drive	For software installation

The application software supplied with the instrument may run slowly depending on the computer operating environment and the type of other application software that is used at the same time. It is recommended to run the application software in the recommended operating environment.

Installation

Before starting the installation, exit all applications running on the computer.

1 **Log into the computer using an account with administrative privileges such as "administrator".**

2 **Execute X:\RGBLaserUtility\Setup.msi contained in the TM6102/TM6103/TM6104 Application Disc (CD).**

(X: is a CD-ROM drive.)

After executing **setup.msi**, follow the instructions that appear on the screen to proceed the installation.

3 **After the installation has been completed and all connections have been performed, start the program in one of the following ways.**

- Double-click the **[RGBLaserUtility]** icon on the desktop.
- From the **[Start]** menu of Windows, click **[All Programs]** > **[HIOKI]** > **[RGBLaserUtility]**.

Uninstallation

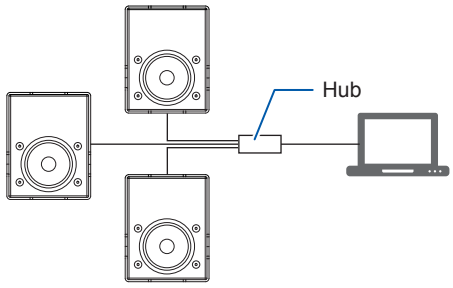
When the application software is no longer needed, delete it in one of the following ways.

- Click **[Control Panel]** > **[Uninstall a program]**, and then delete **[HIOKI RGBLaserUtility]**.
- Click **[Control Panel]** > **[Programs and Features]**, and then delete **[HIOKI RGBLaserUtility]**.

2.6 Using a LAN

The instrument is equipped with an Ethernet 100BASE-TX interface as a standard.
The instrument is connected to the network using the recommended LAN cable (p.30), and then the instrument can be controlled using the computer.
When a program is created and the instrument is connected to the communication command port via TCP/IP, the instrument can be controlled using communication commands. (For details, see the Communication Command Instruction Manual (CD).)

Network multiple instruments and computer.



Perform one-to-one connection between the instrument and computer.

Flow of preparations

1 **Connect the LAN cable (p.30).**

2 **Set the communication conditions of the instrument (p.31).**

Constructing the network environment

For LAN settings on the computer, see “LAN Settings on the Computer” (p.101).

⚠CAUTION

- Do not connect the instrument to the existing network.
  When the instrument is started in the fixed setting mode or version up mode, it uses the fixed IP address (192.168.0.254). Therefore, when there is the same IP address in the existing network, the IP addresses are overlapped.
- Do not send more commands than necessary. Doing so may lower the communication speed when multiple instruments are controlled.
- Accessing using a wireless LAN or router is not recommended.

Description of setting items

IP address	An address to identify individual instruments that are connected on the network. Set a unique IP address that does not overlap with other instrument. The instrument uses IP version 4. The IP address is expressed by four decimal numbers separated by a dot (.) like “192.168.0.1”.
Subnet mask	This setting separates the IP address into the address part showing the network and the address part showing the instrument. Normally, the subnet mask is expressed by four decimal numbers separated by a dot (.) like “255.255.255.0”.
Default gateway	When the communicating computer and the instrument are in different networks, specify the IP address of the device that becomes a gateway. When performing one-to-one connection or when using no gateway, set “0.0.0.0” for the instrument.
Communication command port number	Specify the connected TCP/IP port number for communication commands.

Example of network environment construction

Example 1: Connect one computer and multiple instruments using a hub.

When a local network that is not connected externally is constructed, it is recommended to use a private IP address shown in an example for the IP address.

IP address	Computer: 192.168.0.1 Instrument: Specify 192.168.0.2, 192.168.0.3, 192.168.0.4, ...in order.
Subnet mask	255.255.255.0
Default gateway	Computer: No entry Instrument: 0.0.0.0

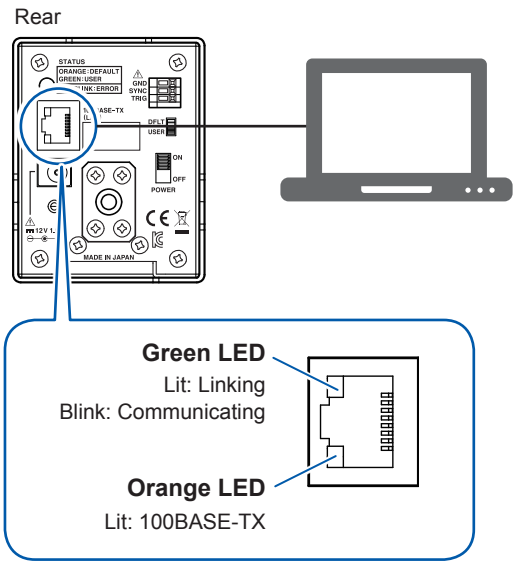
Example 2: Perform one-to-one connection between the computer and instrument using the LAN cable.

When performing one-to-one connection between the computer and instrument, you can set a desired IP address. However, it is recommended to use a private IP address.

IP address	Computer: 192.168.0.1 Instrument: 192.168.0.2 (Set an IP address different from the computer setting.)
Subnet mask	255.255.255.0
Default gateway	Computer: No entry Instrument: 0.0.0.0

Connecting the LAN cable

Connect the instrument and computer using the LAN cable.
If the green LED on the LAN connector is not lit even after the instrument has been connected to the LAN, the instrument or connection device may malfunction or the LAN cable may have a broken wire.



Recommended cable

Category 6A (CAT 6A) cable (Maximum 100 m)

- Since the instrument supports only 100BASE-TX, the communication can be performed using at least category 5 (CAT 5) cable. However, to ensure the high quality communication, it is recommended to use the category 6A cable.
- The instrument incorporates a cable automatic recognition function. Either the straight cable or cross cable can be used.

Setting the LAN

To set the LAN of the instrument, follow the settings and steps below.
- Be sure to perform one-to-one connection with the computer.
- Set the communication setting mode to the fixed setting mode.

Perform one-to-one connection between the instrument and computer.

Instrument settings (fixed setting mode)

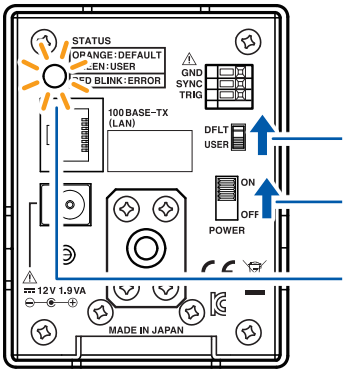
IP address: 192.168.0.254
Subnet mask: 255.255.255.0
Default gateway: None
Port: 1024

1 **Turn OFF the instrument.**

2 **Disconnect the LAN cable from the instrument and computer.**

3 **Start the instrument in the fixed setting mode.**

Rear



1 Set the communication mode switch to the fixed setting mode (**DFLT**).

2 Turn **ON** the power switch.

3 When the power is **ON**, check that the power LED is lit in orange.

If the power LED is not lit in orange, the setting of the communication mode switch may be incorrect or the instrument may malfunction. If the instrument malfunctions, stop the setting and send the instrument for repair.

4 **Turn OFF the instrument.**

5 **Make the network settings of the computer.**

Make the TCP/IPv4 settings of the computer to be connected to the instrument as follows.

IP address: 192.168.0.1
Subnet mask: 255.255.255.0
Default gateway: None

6 **Connect the instrument and computer using the LAN cable in the power OFF state.**

7 **Check again that the communication mode switch of the instrument is set to the fixed setting mode (DFLT), and then turn ON the instrument.**

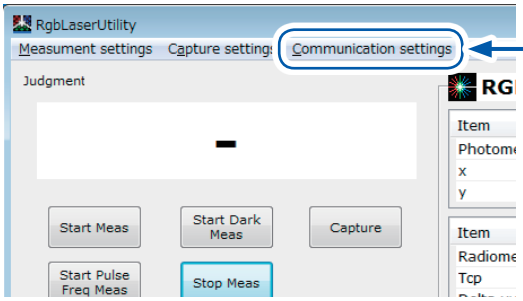
Check again that the power LED is lit in orange.

8 Make the settings of the LAN you want to use.

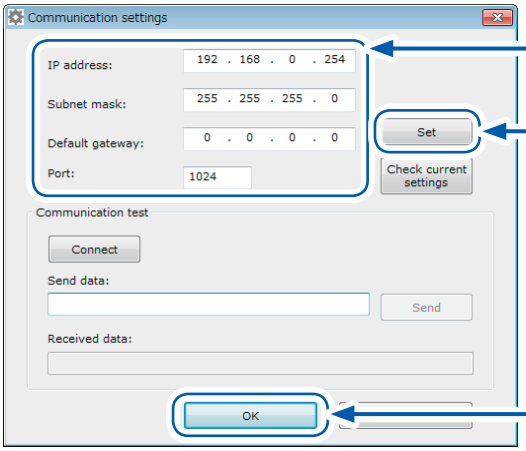
Using the application software (RGBLaserUtility.exe) supplied with the instrument

Installation procedure: Communication Command Instruction Manual (CD)

1 From the **[Start]** menu of Windows, click **[All Programs]** > **[HIOKI]** > **[RGBLaserUtility]** to start the program.



2 Click this tab to start the Communication settings screen.



3 Enter the parameters to be set for the instrument.

4 Click.
(Dialog **[Cancel]** will be invalid.)

5 Click this button to exit the Communication settings screen.

Using communication commands (The customer creates a program.)

1 Connect the instrument to the following port via TCP/IP.
IP address: 192.168.0.254
Port: 1024

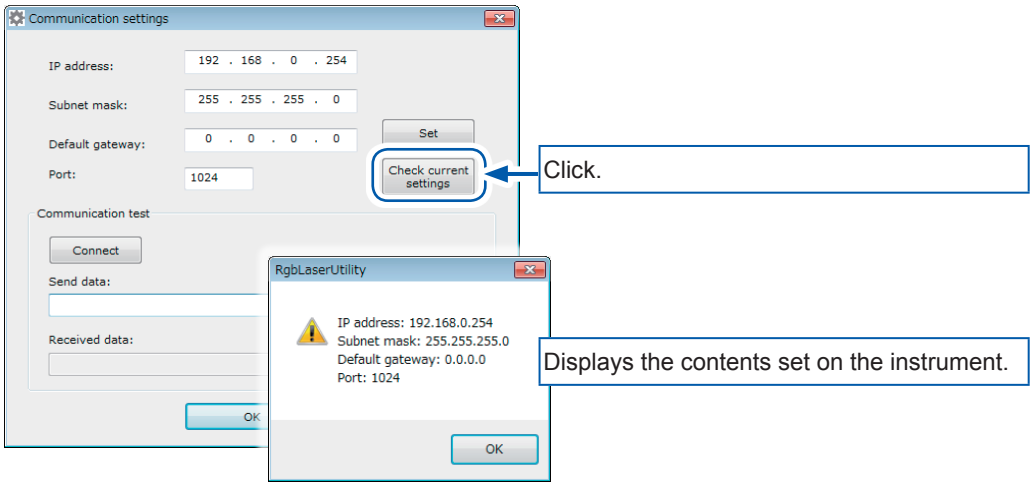
2 Set the commands shown below.
See: Communication Command Instruction Manual (CD)

```
:SYSTem:COMMunicate:LAN:IPADdress <IP address>
:SYSTem:COMMunicate:LAN:SMASk <Subnet mask>
:SYSTem:COMMunicate:LAN:GATeway <Address>
:SYSTem:COMMunicate:LAN:CONTrol <Port No.>
:SYSTem:COMMunicate:LAN:UPDate
```

3 Cancel the connection.

Acquiring the communication settings you have set

Acquiring the communication settings using RGBLaserUtility



Acquiring the communication settings using communication commands

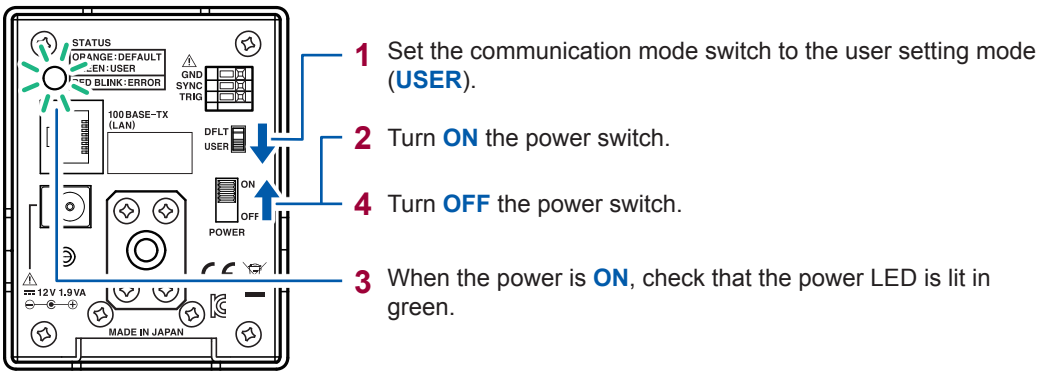
- IP address
  `:SYSTem:COMMunicate:LAN:IPADdress?`
- Subnet mask
  `:SYSTem:COMMunicate:LAN:SMASk?`
- Default gateway
  `:SYSTem:COMMunicate:LAN:GATeway?`
- Port
  `:SYSTem:COMMunicate:LAN:CONTrol?`

9 **Turn OFF the instrument.**

10 **Disconnect the LAN cable from the instrument.**

11 **Change the communication mode switch to the user setting mode, and then start the instrument.**

Rear



If the power LED is not lit in green, the setting of the communication mode switch may be incorrect or the instrument may malfunction. If the instrument malfunctions, stop the settings and send the instrument for repair.

12 **Connect the instrument to the network to be used using the LAN cable.**

13 **Check that the communication mode switch is set to the user setting mode (USER), and then turn the instrument power ON.**

Check again that the power LED is lit in green.

14 **Perform the TCP/IP connection using the IP address and port settings you have set.**

CAUTION

When the connection to the instrument is performed multiple times, the existing connection is canceled and the last connection is enabled.

3 Measurement Condition Settings

You can set the measurement conditions in one of the following ways.

Setting using the application software supplied with the instrument.	See: “6 Application Software (RGBLaserUtility)” (p.55), “6.4 Measurement Settings” (p.60)
Setting using communication commands.	An example of communication commands is described in the following document. For details about the communication commands, see the Communication Command Instruction Manual (CD).

3.1 Various Settings

Precaution

- If you turn **OFF** the power during measurement or setting change, the settings might not be saved. In this case, the backup error occurs when the instrument is started next time, and then the settings are reset.
  Before turning **OFF** the power, execute the following items.
  1. **Check that the response of `*OPC?` is 1.**
  2. **After checking, turn OFF the power without triggering or changing the settings.**
- When using the application software supplied with the instrument, exit the application software, and then turn **OFF** the instrument. If you turn **OFF** the power during measurement or setting change, the backup error may occur when the instrument is started next time.

Settings related to trigger

Trigger source (p.60)

Bus trigger: Triggering is enabled by the communication command (`*TRG`).
External trigger: Triggering is enabled from the TRIG terminal.

Communication command

```
:TRIGger:SOURce <BUS/EXTernal>
```

Trigger edge (p.60)

Set to detect the rising edge of the external trigger signal, or to detect the falling edge of the external trigger signal.

Communication command

```
:TRIGger:EDGE <RISE/FALL>
```

Trigger delay (p.60)

Set the delay time from the trigger signal to the measurement start.
The trigger delay function does not apply to the modulation frequency measurement.

Communication command

```
:TRIGger:DELay <Delay time [sec]>
```

Measurement mode settings

Normal measurement mode (p.68) to (p.78)

The RGB laser light is measured in this mode.

Dark measurement mode (p.69)

The dark is measured in this mode.

Modulation frequency measurement mode (p.68)

The modulation frequency is measured in this mode.
Input the modulation frequency signal to the external input terminal (SYNC terminal) to measure its period.
Set the result of the modulation frequency measurement to the modulation frequency.

Communication command

```
:MODE <NORMal/DARK/PULSe>
```

Settings common to normal measurement and dark measurement

Modulation frequency settings (p.61)

⚠ CAUTION

If the modulation frequency is set incorrectly, accurate measurements cannot be performed. Set the modulation frequency that matches the blinking period of the measuring object.

For the light source that is lit continuously, set the modulated light function to OFF.
The set value of the modulation frequency is not reflected in the parameter settings inside the instrument while the modulated light function is OFF.
When setting the modulation frequency, set the modulated light function to ON, and then set the modulation frequency result or known modulation frequency.
The parameters such as the measurement time based on the set modulation frequency are set inside the instrument.

Communication command

```
:PULSe <1/0/ON/OFF>
:PULSe:FREQuency <Frequency [Hz]>
```

Auto range settings (p.71)

Set the auto range to ON or OFF for each of three sensors that are the R, G, and B sensors.
The auto range may not operate properly depending on input light conditions.
In that case, turn off the auto range and set the range properly.

Communication command

```
:RANGe:AUTO:R <1/0/ON/OFF>
:RANGe:AUTO:G <1/0/ON/OFF>
:RANGe:AUTO:B <1/0/ON/OFF>
```

Range settings (p.61)

Set an arbitrary range (1 to 16) for each of three sensors that are the R, G, and B sensors.
When the range is set in the auto range ON state, the auto range setting is OFF.
A larger range number increases the measurement sensitivity and a weaker light can be measured.

Communication command

```
:RANGe:R <Range number (1 to 16)>
:RANGe:G <Range number (1 to 16)>
:RANGe:B <Range number (1 to 16)>
```

Normal measurement settings

Color-matching function (p.61)

Select the color-matching function from 2° or 10°.
The chromaticity is calculated using the set color-matching function.
However, the photometric quantity is always calculated using the color-matching function with a field-of-view of 2° regardless of the color-matching function settings.
In addition, when a field-of-view of 10° is set, the following measurement items are not measured.

- Correlated color temperature
- Delta uv
- NTSC ratio

Communication command

```
:ANGLe <2/10>
```

Averaging (p.63)

The averaging is performed the specified number of times.
When the number of averaging is increased, the measurement may take some time.

Number of averaging = 1 to 100 times

Communication command

```
:AVERaging <1 to 100>
```

3.2 Correction Functions

Centroid wavelength input mode (p.39)	The photometry is performed using the centroid wavelength set for each of R, G, and B.
Centroid wavelength offset correction (p.39)	The centroid wavelength is corrected using the centroid wavelength offset value set for each of R, G, and B.
Radiometric quantity gain correction (p.40)	The radiometric quantity is corrected using the radiometric quantity gain value set for each of R, G, and B.
Chromaticity xy offset correction (p.40)	xy of the RGB mixed light (lights with R, G, and B wavelengths are mixed) are corrected.
Photometric quantity gain correction (p.40)	The photometric quantity of the RGB mixed light (lights with R, G, and B wavelengths are mixed) is corrected.

The corrections of the centroid wavelength and radiometric quantity may affect the calculations of the chromaticity and photometric quantity.
Therefore, when the chromaticity or photometric quantity is corrected in the state where the centroid wavelength or radiometric quantity is corrected, this is double-correction.
It is recommended to apply the correction in accordance with the combinations shown in the table below.

✓: Recommended. –: Not recommended.

	Centroid wavelength input mode	Centroid wavelength offset correction	Radiometric quantity gain correction	Chromaticity xy offset correction	Photometric quantity gain correction
Centroid wavelength input mode	–	– *	✓	–	–
Centroid wavelength offset correction	– *	–	✓	–	–
Radiometric quantity gain correction	✓	✓	–	–	–
Chromaticity xy offset correction	–	–	–	–	✓
Photometric quantity gain correction	–	–	–	✓	–

*:When the double-correction of the centroid wavelength input mode and centroid wavelength offset is set, the centroid wavelength offset correction is disabled.

Centroid wavelength input mode

See: “Centroid wavelength input mode settings” (p.63)

When the detection level is less than 10%, the measurement accuracy of the centroid wavelength becomes worse. This affects the measured value of the radiometric quantity. In this case, set the centroid wavelength beforehand when a strong laser light is measured, and then measure the radiometric quantity.

- The settable centroid wavelength value must be only in the measurable wavelength range.
- When the centroid wavelength input mode is used, the centroid wavelength offset correction does not reflect to the measurement result.
- When the centroid wavelength input mode is set to ON, the auto range operation is not performed. After setting the range, execute the measurement.
- Be sure to specify an appropriate range, and then perform the measurement.

Measured value

Measured value of centroid wavelength = Set centroid wavelength value

Communication command

```
:SCALe:WAVelength:R <1/0/ON/OFF>
:SCALe:WAVelength:DATA:R <Centroid Wavelength (615.00 to 665.00) [nm]>
:SCALe:WAVelength:G <1/0/ON/OFF>
:SCALe:WAVelength:DATA:G <Centroid Wavelength (505.00 to 550.00) [nm]>
:SCALe:WAVelength:B <1/0/ON/OFF>
:SCALe:WAVelength:DATA:B <Centroid Wavelength (435.00 to 477.00) [nm]>
```

Centroid wavelength offset correction

See: “Centroid wavelength offset correction settings” (p.63)

Set the centroid wavelength offset correction when you want to correct the measured value of the centroid wavelength.
When the centroid wavelength offset correction is enabled, the measurement may not be performed near the upper and lower limits of the centroid wavelength measurement range.
In this case, the centroid wavelength measurement is treated as an underflow, and other measured values are also treated as underflows.
When the centroid wavelength input mode is used, the centroid wavelength offset correction does not reflect to the measurement result.

Measured value

Measured value of centroid wavelength = Centroid wavelength obtained from measurement + Offset value

Communication command

```
:SCALe:WAVelength:OFFSet <1/0/ON/OFF>
:SCALe:WAVelength:OFFSet:DATA:R <Offset (-2.00 to 2.00) [nm]>
:SCALe:WAVelength:OFFSet:DATA:G <Offset (-2.00 to 2.00) [nm]>
:SCALe:WAVelength:OFFSet:DATA:B <Offset (-2.00 to 2.00) [nm]>
```

Radiometric quantity gain correction

See: “Radiometric quantity gain correction settings” (p.63)

Set the radiometric quantity gain correction when you want to correct the measured value of the radiometric quantity.

Measured value

Measured value of radiometric quantity = Gain value × Radiometric quantity obtained from measurement

Communication command

```
:SCALe:RADiometry:GAIN <1/0/ON/OFF>
:SCALe:RADiometry:GAIN:DATA:R <Gain value (1.00000E-3 to 1.00000E+3)>
:SCALe:RADiometry:GAIN:DATA:G <Gain value (1.00000E-3 to 1.00000E+3)>
:SCALe:RADiometry:GAIN:DATA:B <Gain value (1.00000E-3 to 1.00000E+3)>
```

Chromaticity xy offset correction

See: “Chromaticity xy offset correction settings” (p.63)

Set the chromaticity xy offset correction when you want to correct the measured values of the chromaticity xy of the RGB mixed light (lights with R, G, and B wavelengths are mixed).
The measured value may become a non-existent value depending on the offset correction value.

Measured value

Measured value of chromaticity x = Chromaticity x obtained from measurement + Chromaticity x offset value
Measured value of chromaticity y = Chromaticity y obtained from measurement + Chromaticity y offset value

Communication command

```
:SCALe:XY:OFFSet <1/0/ON/OFF>
:SCALe:XY:OFFSet:DATA:X <Chromaticity x Offset value (-1.0000E+00 to 1.0000E+00)>
:SCALe:XY:OFFSet:DATA:Y <Chromaticity y Offset value (-1.0000E+00 to 1.0000E+00)>
```

Photometric quantity gain correction

See: “Photometric quantity gain correction” (p.63)

Set the photometric quantity gain correction when you want to correct the measured values of the photometric quantity of the RGB mixed light (lights with R, G, and B wavelengths are mixed). The gain correction is applied to the photometric quantity of the RGB mixed light and the tristimulus values XYZ of the RGB mixed light.

Measured value

Measured value of photometric quantity = Gain value × Photometric quantity obtained from measurement
Measured value of tristimulus value = Gain value × Tristimulus value obtained from measurement

Communication command

```
:SCALe:PHOTometry:GAIN <1/0/ON/OFF>
:SCALe:PHOTometry:GAIN:DATA < Gain value (1.00000E-3 to 1.00000E+3)>
```

3.3 Modulation Frequency Measurement

Input the modulation frequency signal to the external input terminal (SYNC terminal) to measure its period.
Set the result of the modulation frequency measurement to the modulation frequency.

Modulation frequency measurement settings

Averaging (p.64)

The averaging is performed the specified number of times.

Number of averaging = 1 to 10 times

Communication command

```
:PULSe:AVERaging <1 to 10>
```

Measurement edge (p.64)

Set to count the rising edge of the modulation frequency, or to detect the falling edge of the modulation frequency.

Communication command

```
:PULSe:EDGE <RISE/FALL>
```

Modulation frequency measurement execution and modulation frequency settings

See: “Modulation Frequency Measurement” (p.68)

1 **Set the measurement mode to the modulation frequency measurement.**

```
:MODE PULSe
```

2 **Make the modulation frequency measurement settings.**

```
:PULSe:AVERaging <1 to 10>
:PULSe:EDGE <RISE/FALL>
```

3 **Input the modulation frequency signal between the SYNC terminal and the ground terminal.**

4 **Execute the modulation frequency measurement (apply triggering).**

```
:READ?
*TRG
```

5 **Set the dark estimation.**

```
:DARK:ESTimate <ON/OFF>
```

6 **Set the modulation frequency.**

```
:PULSe <ON/OFF>
:PULSe:FREQuency <Modulation frequency [Hz]>
```

7 **When the dark estimation is ON, acquire the estimation result.**

```
:DARK:ESTimate:RESult?
```

8 **Set the measurement mode to the dark measurement mode or normal measurement mode.**

```
:MODE <NORMal/DARK>
```

3.4 Dark Measurement

Before starting the measurement (after warming up for 30 minutes or longer), attach the cap, and then be sure to execute the dark measurement.
When the dark measurement is performed, the sensor offset can be canceled and the correct measured value can be acquired.
Additionally, it is recommended to perform the dark measurement every time the set value of the modulation frequency is changed.

- After the dark measurement has been executed, the value that is corrected using the acquired dark value is reflected in the measured result. This dark value is valid until the power is turned off.
- To perform more highly accurate measurements, if the atmospheric temperature changes after the dark measurement has been executed, execute the dark measurement again.
- When the dark measurement is not performed after the power has been turned on, the dark measurement value at shipment (default dark value) is reflected in the measurement result.

To measure a weak light, the following dark measurements are recommended.

- Increase the number of averaging of the dark measurement.
- Execute the dark measurement frequently.

Dark measurement settings

Range in which the dark measurement is performed (p.64)

Set the measurement to be performed in all ranges or only in the fixed range.
When all ranges are selected, the dark measurement is performed in all ranges.
When the fixed range is selected, the dark measurement is performed only in the range selected at this time.
However, when the auto range setting is ON, the dark measurement is performed forcibly in all ranges regardless of the settings.

Communication command

```
:DARK:TYPE <ALL/FIX>
```

Averaging (p.64)

The averaging is performed the specified number of times.
To measure a weak light, it is recommended to increase the number of averaging.
When the number of averaging is increased, the measurement may take some time.

Number of averaging = 1 to 100 times

Communication command

```
:DARK:AVERaging <1 to 100>
```

Dark measurement result judgment (p.64)

Whether the dark value is correct can be judged.
When the dark measurement is performed with the judgment set to OFF, the dark measurement succeeds in any dark measurement state. However, when the dark measurement is executed in the light incidence state, subsequent normal measurement may not be performed correctly.
Therefore, it is recommended to set the dark measurement judgment to ON and check the judgment after the dark measurement has been executed.

Communication command

```
:DARK:JUDGment <1/0/ON/OFF>
```

Dark estimation

The dark estimation is used when the modulation frequency setting is changed.
When the modulation frequency setting is changed in the dark estimation ON state, the dark value at the new modulation frequency is calculated.

- When the modulation frequency is changed in the dark estimation ON state, be sure to check that the dark estimation is performed correctly.
- To execute the dark estimation correctly, set the modulated light function to ON beforehand. After that, perform the dark measurement in all ranges of all colors. (p.64)
  It is recommended to set the number of averaging of the dark measurement to 10 or more.
- The dark estimation is performed in all ranges regardless of the setting of the range in which the dark measurement is performed.
- When the modulation frequency is changed in the modulated light function OFF state, the dark estimation is not executed.
- The dark estimation is used only in a range of the modulation frequency ±5 Hz or less after the dark measurement has been performed. The dark value obtained by the dark estimation is an estimate value. Basically, it is recommended to execute the dark measurement when the modulation frequency setting is changed.

Communication command

```
:DARK:ESTimate <1/0/ON/OFF>
:DARK:ESTimate:RESult?
```

Executing the dark measurement

See: “Dark Measurement” (p.69)

1 **Attach the cap.**

2 **Set the modulation frequency.**

Communication command

```
:PULSe:FREQuency <10.0000 to 300.0000>
```

3 **Set the measurement mode to the dark measurement.**

Communication command

```
:MODE DARK
```

4 **Make the dark measurement settings.**

Set the range in which the dark measurement is performed, the number of averaging, and the measurement result judgment.

Communication command

```
:DARK:TYPE <ALL/FIX>
:DARK:AVERaging <1 to 100>
:DARK:JUDGment <ON/OFF>
```

5 **Execute the dark measurement (apply triggering).**

Communication command

```
:READ?
*TRG
```

6 **Acquire the measurement result of the dark measurement, and then check that the dark value is appropriate.**

7 **Set the measurement mode to the normal measurement mode.**

4 Normal Measurement

The centroid wavelength, radiometric quantity, tristimulus value, chromaticity, photometric quantity, correlated color temperature, NTSC ratio, and dominant wavelength of the laser light source that is a measuring object are measured.
The measurement can be performed in two ways shown below.

Measurement using the application software supplied with the instrument.

1. Make preparations for measurement.
   See: “2 Preparations” (p.25)
2. Execute the measurement in accordance with the application software RGBLaserUtility.
   See: “6 Application Software (RGBLaserUtility)” (p.55)

Measurement using communication commands.

The instrument can be controlled using commands.
An example of communication commands is described in the following.
For details about the communication commands, see the Communication Command Instruction Manual (CD).

Measurement item	Command

Centroid Wavelength	`:FETCh:WAVelength:CENTroid:R?`
	`:FETCh:WAVelength:CENTroid:G?`
	`:FETCh:WAVelength:CENTroid:B?`

Radiometric Quantity	`:FETCh:RADiometry:R?`
	`:FETCh:RADiometry:G?`
	`:FETCh:RADiometry:B?`
	`:FETCh:RADiometry:RGB?`

Tristimulus Values XYZ	`:FETCh:XYZ:R?`
	`:FETCh:XYZ:G?`
	`:FETCh:XYZ:B?`
	`:FETCh:XYZ:RGB?`

Chromaticity xy	`:FETCh:XY:R?`
	`:FETCh:XY:G?`
	`:FETCh:XY:B?`
	`:FETCh:XY:RGB?`

Chromaticity u’v’	`:FETCh:UDVD:R?`
	`:FETCh:UDVD:G?`
	`:FETCh:UDVD:B?`
	`:FETCh:UDVD:RGB?`

Photometric Quantity	`:FETCh:PHOTometry:R?`
	`:FETCh:PHOTometry:G?`
	`:FETCh:PHOTometry:B?`
	`:FETCh:PHOTometry:RGB?`

Correlated Color Temperature, Delta uv	`:FETCh:TCP?` `:FETCh:DELUv?`
NTSC Ratio	`:FETCh:NTSCratio?`

Dominant Wavelength	`:FETCh:WAVelength:DOMinant:R?`
	`:FETCh:WAVelength:DOMinant:G?`
	`:FETCh:WAVelength:DOMinant:B?`

4.1 Adjusting the White Balance of the Light Source (White Balance Adjustment Assistance Function)

The instrument provides a function that assists the work to adjust the white balance of the RGB laser light source, which is a measuring object, to the target chromaticity and photometric quantity.

Acquiring the target value of the radiometric quantity

When inputting the target chromaticity and photometric quantity for the white balance before starting the measurement, you can acquire not only the measured values, but also the target values of the R, G, and B radiometric quantities. (The target value of the radiometric quantity is expressed in the unit of the radiometric quantity.)

You can adjust the light source to the target chromaticity and photometric quantity for the white balance only by adjusting the radiometric quantity of the RGB laser to the target value of the radiometric quantity.

- The fine adjustment of the radiometric quantity of the RGB laser, which operated by sense while checking the measured values of the chromaticity and photometric quantity, is no longer needed.
- Since the target value of the radiometric quantity can be acquired in the RGB laser simultaneous incidence state, the processes such as turning on the light sources in order are not needed.

Acquiring the tolerance of the radiometric quantity

To make the white balance adjustment assistance function easier to use, the tolerance of the radiometric quantity can be acquired in accordance with the tolerances of the chromaticity and photometric quantity for the white balance you have input.
When inputting the tolerances of the chromaticity and photometric quantity for the white balance before starting the measurement, you can acquire the tolerances of the R, G, and B radiometric quantities. (The tolerance of the radiometric quantity is expressed in the unit of the radiometric quantity.)

You can adjust the chromaticity and radiometric quantity of the light source to their tolerances you have specified by adjusting the radiometric quantity of the RGB laser to the tolerance of the radiometric quantity you have acquired.
You can adjust the white balance more easily by acquiring not only the target value of the radiometric quantity, but also the tolerance of the radiometric quantity.

Execution example

1 **Set the measurement contents. (p.35)**

Set the measurement range and the number of averaging.

2 **Set the target values of the chromaticity and photometric quantity.**

3 **Set the tolerances of the values you have input in step 2.**

```
:TARGet <1/0/ON/OFF>
:TARGet:DEViation:X <Target Value of Chromaticity x>,<Tolerance of Chromaticity x>
:TARGet:DEViation:Y <Target Value of Chromaticity y>,<Tolerance of Chromaticity y>
:TARGet:DEViation:PHOTometry <Target Value of Photometric Quantity>,<Tolerance of
Photometric Quantity>
```

The instrument returns the PASS judgment when the measured value of the chromaticity x, chromaticity y, or photometric quantity satisfies the conditions shown below.
Target Value − Tolerance ≤ Measured Value ≤ Target Value + Tolerance

Setting example: Set the judgment condition for the chromaticity x to 0.333 ±0.01.

```
:TARGet:DEViation:X 0.333,0.01
```

4 **Execute the measurement.**

```
:READ?
*TRG
```

5 **Acquire the measurement results. (p.45)**

Centroid wavelength, radiometric quantity, chromaticity, and photometric quantity, etc.

6 **Acquire the tolerance of the radiometric quantity.**

```
:TARGet:RESult:R?
:TARGet:RESult:G?
:TARGet:RESult:B?
```

7 **Adjust the radiometric quantity of the RGB laser light source so that it enters the tolerance of the radiometric quantity.**

8 **Execute the measurement, and then check that the chromaticity xy and photometric quantity are in a range of the target value ± the tolerance.**

```
:READ?
*TRG
:TARGet:RESult:RGB?
```

Even when the radiometric quantity of the RGB laser light source is adjusted to the tolerance of the radiometric quantity, the chromaticity and photometric quantity of the light source may not enter their tolerances. In this case, adjust the radiometric quantity of the RGB laser light source so that it gets close to the target value of the radiometric quantity.

4.2 Precaution

Measurement status

Be sure to check the measurement status during measurement.

Measurement status	Measurement status No. of Command	Details	Corrective action
Error	10	An error occurred that affects the measured value.	The repair is required. Contact your authorized Hioki distributor or reseller.
Overflow	8	The light with an unmeasurable radiometric quantity was measured.	Change the measurement range to set an appropriate measurement range. (If an overflow occurs in the auto range, this light is out of the measurement range.)
Underflow	7	• The light whose centroid wavelength cannot be calculated was measured. • The light whose radiometric quantity cannot be calculated was measured.	Change the measurement range to set an appropriate measurement range. (If an underflow occurs in the auto range, this light is out of the measurement range.)
Excessive input	9	A radiometric quantity larger than the maximum input entered.	If the excessive input state continues for an extended period of time, this may cause a malfunction. Do not allow a light larger than the maximum input to enter.
Unbalance	6	There was a color whose measured radiometric quantity is less than 1/20 of the maximum radiometric quantity measured among three colors, R, G, and B. The measured value related to the color with less than 1/20 of the maximum radiometric quantity may not be accurate.	Do not use the measured value related to the color with less than 1/20 of the maximum radiometric quantity.
Low input	5	The detection level in the range used for the measurement was less than 10%. The measurement can be performed, but the measurement cannot be performed accurately.	Increase the measurement range of the target color to select a measurement range in which the detection level is 10% or more.
No dark	4	The following occurred in a range used for the normal measurement. • No dark measurement was performed. • The modulation frequency used for the dark measurement did not match the modulation frequency used for the normal measurement.	• Execute the dark measurement. • Set the modulation frequency in the dark estimation ON state.
Centroid wavelength input mode	3	The wavelength set by the user was calculated as the centroid wavelength.	–
Measurement stop status	2	The measurement was stopped during measurement.	–
Non-measurement	1	The measured value was acquired in the non-measurement state.	–
Normal	0	The measured value was acquired in the appropriate state.	–

Measured value showing abnormal value	Details
1.0E+99	Error status
1.0E+90	Non-measurement status
1.0E+80	Overflow status
1.0E+70	Underflow status

When a single color light enters or when a light with large radiometric quantity of only one color enters

When a weak light with less than 1/20 of the strongest radiometric quantity among three colors, R, G, and B, is measured, a weak light may not be measured properly due to the effect of the strong light color.
At this time, the measurement status shows unbalance.
When the measurement status shows unbalance, it is recommended not to use the measured value.

5 External Control

The following items can be executed using the external input terminals on the rear of the instrument.
After checking that external control devices are turned off, connect the instrument and external control devices.

- The modulation frequency is measured.
- The instrument is controlled by inputting the measurement trigger signal from the external device.

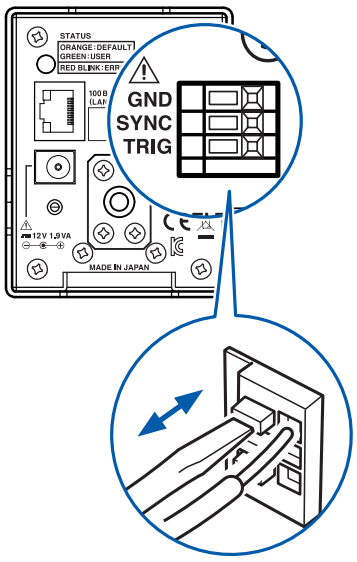
All signals are insulated by digital isolators.
Check the input rating and internal circuit configuration, and then understand the safety precautions. After that, connect the control system and use it in a correct manner.

5.1 External Input Terminals and Signals

Thoroughly read “Before starting the external control” (p.9”) beforehand.

Connectors used

Rear



Signal layout

Signal name	I/O	Function	Logic	
GND	–	GND	–	–
SYNC	IN	Modulation frequency signal	Rising edge	Falling edge
TRIG	IN	External trigger	Rising edge	Falling edge

1 **Push in the terminal button using a tool such as a slotted screwdriver.**

2 **With the button pushed in, insert an electric wire into the electric wire connection hole.**

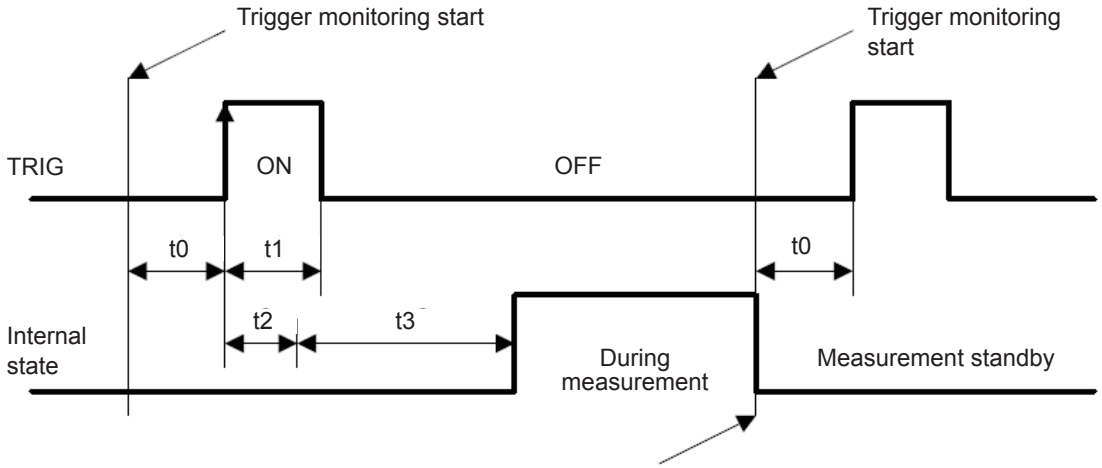
3 **Release the button.**
The electric wire is then locked.

Input signal

TRIG	When the trigger source is external, the measurement is performed once on the rising edge or falling edge of the TRIG signal. The trigger source can be set by the `:TRIGger:SOURce` command. (p.35) The direction of the detection edge can be set by the `:TRIGger:EDGE` command. (p.35) The delay from the trigger input to the measurement start can be set by the `:TRIGger:DELay` command. (p.35) When the trigger signal is input during measurement, it is ignored. When the trigger source is set to the communication bus, the trigger measurement is not performed.
SYNC	The period of the SYNC signal is measured during measurement of the modulation frequency. Input a signal synchronized with the modulation frequency of the laser light.

Timing chart

- The level of the TRIG signal shows the voltage level.
- The following figure shows the operation when the edge of the external trigger is set to the rising edge.
- Do not input any TRIG signal after the external trigger measurement has been started. (The input TRIG signal is disabled.)



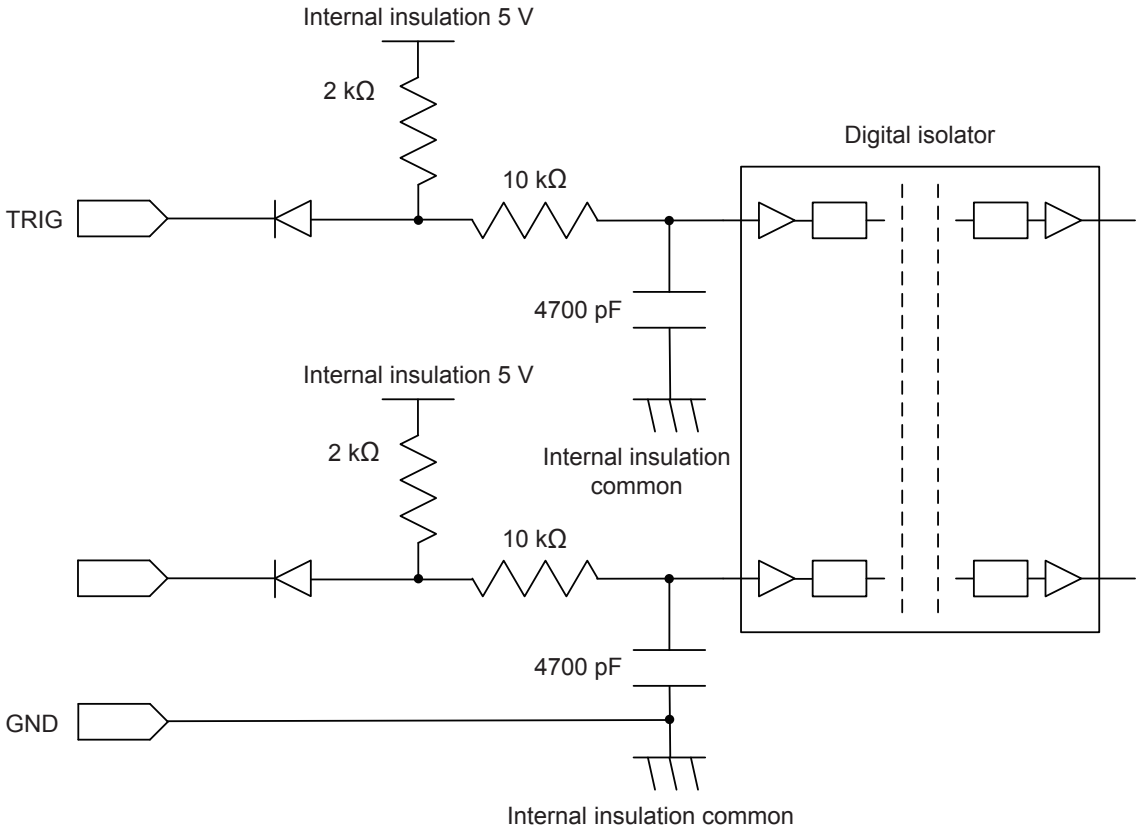
The measurement completion can be checked using communication commands.

Each time of timing chart

Item	Description	Time	Remarks
t0	Trigger pulse OFF time	0.3 ms or longer	
t1	Trigger pulse ON time	0.3 ms or longer	Rise or fall can be selected.
t2	Trigger judgment time + Measurement start wait time	0.3 ms to 0.9 ms	No command send/receive state
t3	Delay time	0 to 1000 ms	In accordance with the setting of the trigger delay. (p.35)

5.2 Internal Circuit Configuration

Input circuit



Electrical specifications

Input	Insulation	Digital isolator
	Input HI	2.4 V to 5 V
	Input LO	0 V to 0.4 V
	Response pulse width	300 µs or longer
	Maximum applied voltage	6 V

5.3 Frequently Asked Questions about External Input

Frequently asked question	Answer/Corrective action
What kind of connection method is used to input the trigger?	Input the HIGH level (2.4 V to 5.0 V) or LOW level (0 V to 0.4 V) pulse signal, or the rectangular wave signal between the TRIG terminal and the ground.
What kind of connection method is used to input the modulation frequency synchronizing signal?	Input the HIGH level (2.4 V to 5.0 V) or LOW level (0 V to 0.4 V) pulse signal, or the rectangular wave signal between the SYNC terminal and the ground.
How is the input (control) checked?	If the operation does not start even when the TRIG signal is input, short-circuit the TRIG signal and the ground terminal instead of the pulse signal. (Be careful not to short-circuit the power supply.)
Can the PLC be connected directly?	When the output is a relay or an open collector, the direct connection can be performed. (Before connecting, check that the voltage level or flowing current does not exceed the rating.)

6 Application Software (RGBLaserUtility)

RGBLaserUtility is application software dedicated for the TM6102 RGB Laser Meter, TM6103 RGB Laser Luminance Meter, and TM6104 Optical Power Meter.

RGBLaserUtility controls the TM6102, TM6103, and TM6104 to check the measurement results. When performing more advanced control or when creating an arbitrary program, perform the control using commands while referring to the Communication Command Instruction Manual (CD).

Notations

- Windows dialog box is expressed as a “dialog”.
- Names and keys on screens, such as menu names, dialog names, and buttons in dialogs are enclosed by square brackets (**[ ]**).

Mouse operations

Click:	Press and quickly release the left button of the mouse.
Right-click:	Press and quickly release the right button of the mouse.
Double click:	Quickly click the left button of the mouse twice.
Drag:	While holding down the left button of the mouse, move the mouse and then release the left button to deposit the chosen item in the desired position.

Font sizes on the screen

RGBLaserUtility does not support high DPI. Setting to high DPI may disturb the layout. Set the DPI as follows.

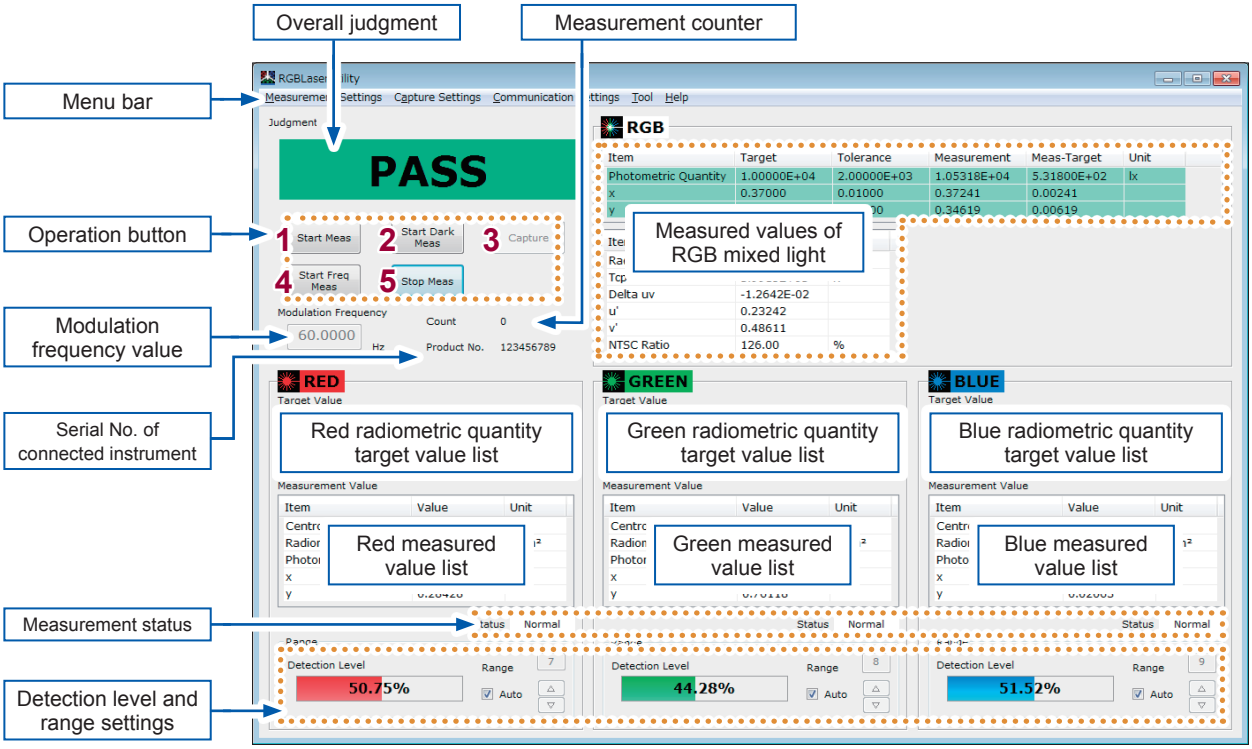
Windows version	Setting procedure
Windows 7, Windows 8, Windows 8.1	Select **[Control Panel]** > **[Appearance and Personalization]** > **[Display]** > **[Set custom text size (DPI)]**, and then change the setting to “Smaller - 100% (default)”.
Windows 10	Select **[Settings]** > **[System]** > **[Display]** > **[Change the size of text, apps, and other items]**, and then change the setting to “100%(Recommended)”.

6.1 Startup Procedure

Start up the application software in one of the following ways.
See: "Installing the Application Software" (p.28)

- Double-click the **[RGBLaserUtility]** icon on the desktop.
- From the **[Start]** menu of Windows, click **[All Programs]** > **[HIOKI]** > **[RGBLaserUtility]**.

Screen configuration (Main dialog)



Check boxes and radio buttons

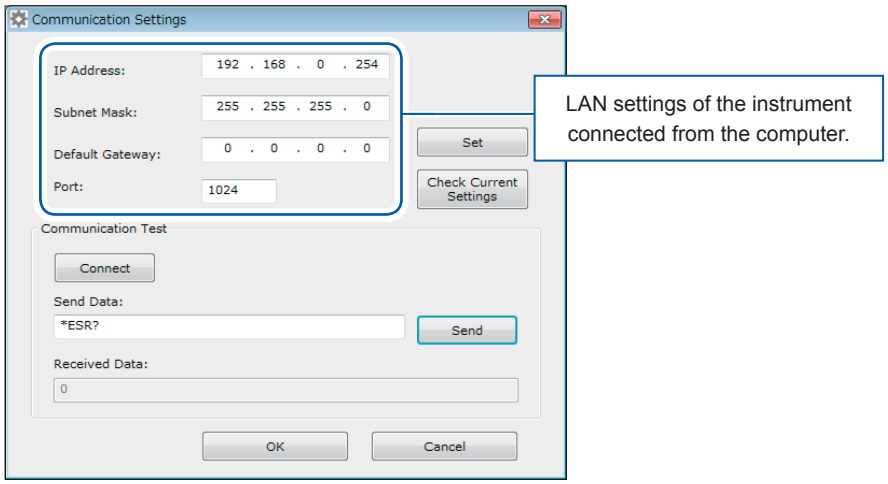
Settings	Status	Check box	Radio button
Set to ON (enabled).	Check on.	☑	◉
Set to OFF (disabled).	Check off.	☐	○

Operation buttons

1	Start Normal Measurement
2	Start Dark Measurement
3	Capture Measured Value
4	Start Modulation Frequency Measurement
5	Stop Measurement

6.2 Setting the LAN

[Communication Settings] on the menu bar > Communication Settings dialog



Making the LAN settings of the instrument connected from the computer

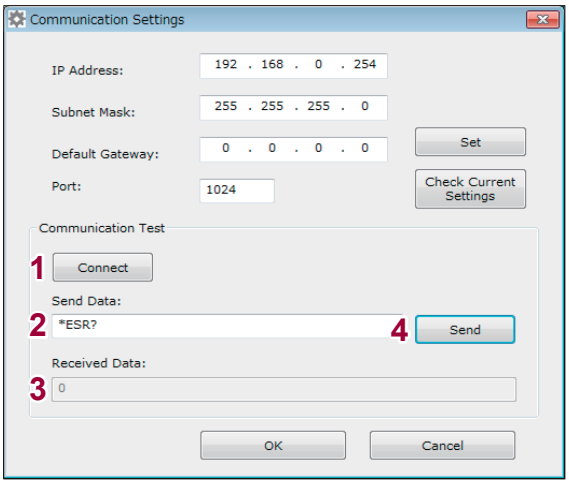
RGBLaserUtility uses “LAN settings of the instrument connected from the computer” to perform the TCP/IP connection to the instrument.

See: "Setting the LAN" (p.31)

Communication test

Enter a command in the Send Data field and click **[Send]**. This command is sent to the port number of the IP address you have set above.

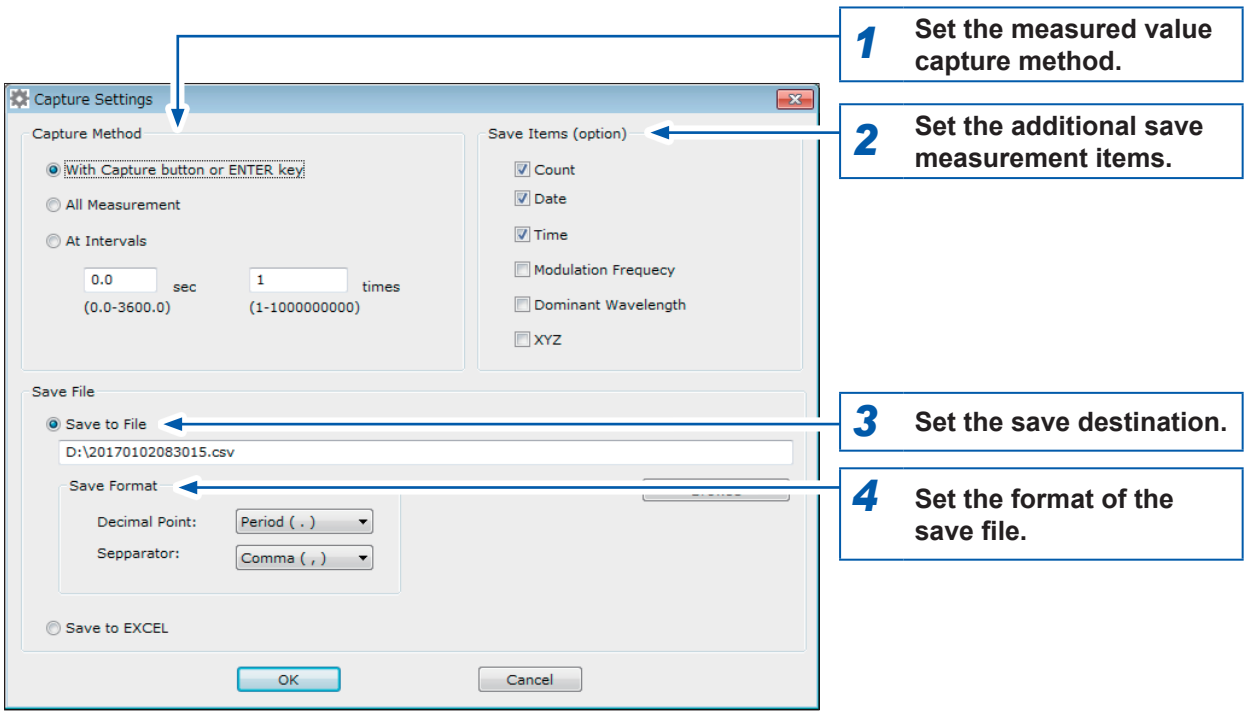
When a query command is sent, the received data is displayed in the Received Data field.



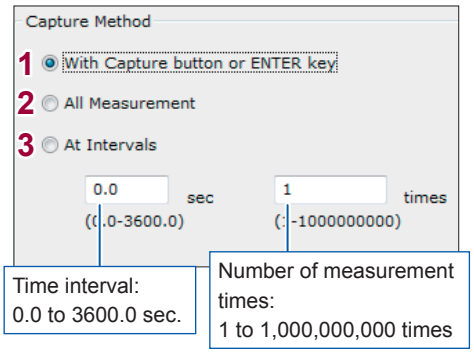
1	Connection start
2	Send command entry field
3	Received data display field
4	Send

6.3 Measured Value Capture Settings

[Capture Settings] on the menu bar > Capture Settings dialog



1 Set the measured value capture method.

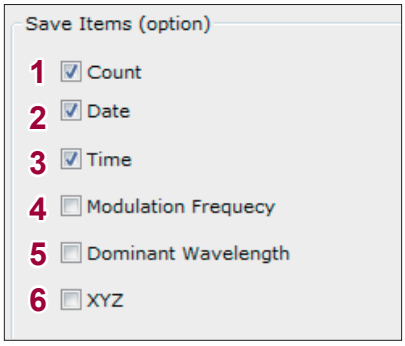


1	1. Click the **[Start Meas]** operation button to start the measurement. 2. Press **[Capture]** on the measurement screen or the Enter key on the keyboard. • The measured values that are displayed at this time can be captured to a text file or an Excel® file. • The trigger source is recommended to be set to BUS. For EXT trigger, measurement will not be executed until TRIG terminal is input to the trigger signal.
2	All measured values from the measurement start to the measurement stop are captured to a text file or an Excel® file.
3*	Click the **[Start Meas]** operation button to start the measurement. • The values that have been measured the specified number of times at specified time intervals are captured to a text file or an Excel® file. • The trigger source is recommended to be set to BUS. For EXT trigger, measurement will not be executed until TRIG terminal is input to the trigger signal. • The measurement counter on the main screen increments every time the measurement is performed until the measurement counter is reset. (p.75) To perform the interval measurement from count number 1 of the measurement counter, reset the measurement counter before starting the measurement.

*:
• The time intervals operate as follows.
“Measurement + Measured value acquisition” → “Interval time wait” → “Measurement + Measured value acquisition”・・・
• Even when the time interval is set to 2.0 sec., the measured value may not be captured to a file at intervals of 2.0 sec. This is because the time interval includes the period of time necessary for “Measurement + Measured value acquisition”.
Example:
For measurement settings for which “Measurement + Measured value acquisition” takes 1.0 sec., the measured value is captured to a file at intervals of 3.0 sec.

2 Set the additional save measurement items.

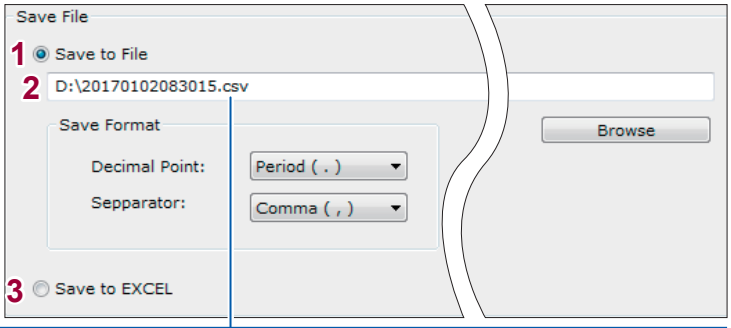
All measured data displayed on the measurement screen are captured to a text file or an Excel® file. When there are additional save items, check on the relevant check boxes (☑).



1	Measurement counter
2	Date when the measured value was saved.
3	Time when the measured value was saved.
4	Modulation frequency measurement settings when the measurement was performed.
5	Measured value of dominant wavelength When the dominant wavelength saving is enabled, the measured value acquisition time becomes longer than that when it is disabled. (Up to approximately 300 ms)
6	Measured values of tristimulus values XYZ

3 Set the save destination.

Create a save file in a desired place.



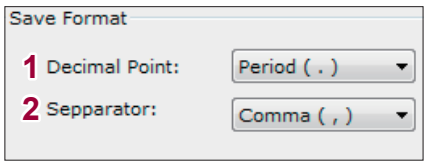
1	Save file. (Save to a text file.)
2	Specify a save file. (Clicking **[Browse]** allows you to select a desired file.)
3	Save to an Excel® file.

The file is initialized to a file name using the date and time when the software is started. However, the folder at the save destination is started in the previously set place.
Example:

Time when the software was started.	8:30 and 15 seconds on January 2, 2017
File name	20170102083015.csv

4 Set the format of the save file.

Set the types of the decimal point and separator when setting the save destination in **[Save to File]**.
However, note that this format setting does not affect the numerical value displayed on the software. The decimal point displayed on the software is fixed to a period (.) despite the locale setting.



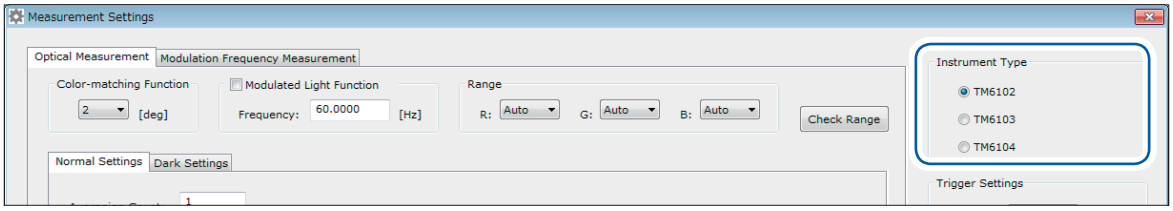
1	Decimal point: Period (.), comma (,)
2	Separator: Comma (,), semicolon (;), tab, space

6.4 Measurement Settings

[Measurement Settings] on the menu bar > Measurement Settings dialog

1 Make the basic settings.

(1) Select the model of the instrument to be connected.

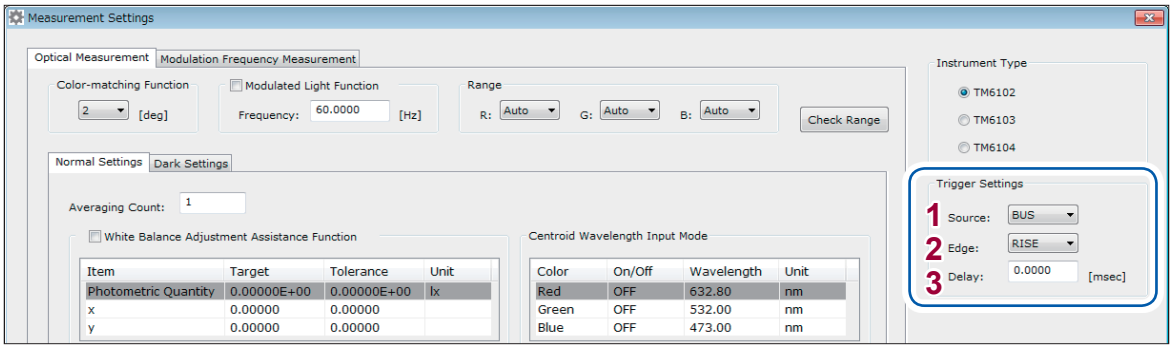


The units of the radiometric quantity and photometric quantity, and the unit of the save data are changed in accordance with the selected model.
It is necessary that the selected model matches the model of the instrument to be connected.
If the selected model does not match the model of the instrument to be connected, the measurement cannot be started.

Settings	Unit of RGBLaserUtility		Unit of the header (save item name) to be saved to a text file or an Excel® file	
	Radiometric Quantity	Photometric Quantity	Radiometric Quantity	Photometric Quantity
TM6102	W/m^2	lx	W/m2 *1	lx
TM6103	W/sr·m^2	cd/m^2	W/sr*m2 *1	cd/m2 *1
TM6104	W	lm	W	lm

*1: Shows the same unit as the display unit.

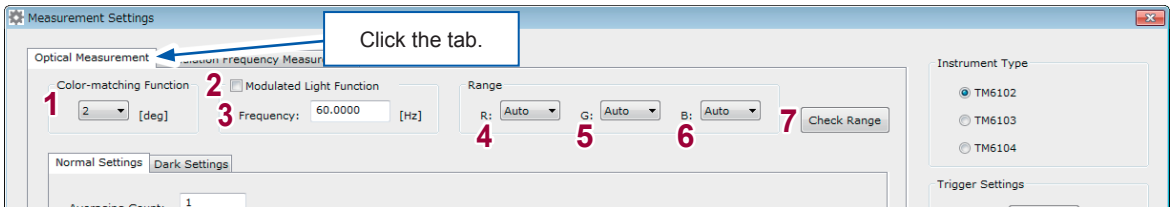
(2) Set the trigger.



1	Trigger source	**[EXT]**: External trigger, **[BUS]**: Communication trigger
2	Trigger edge	**[RISE]**: Rising edge, **[FALL]**: Falling edge
3	Trigger delay	

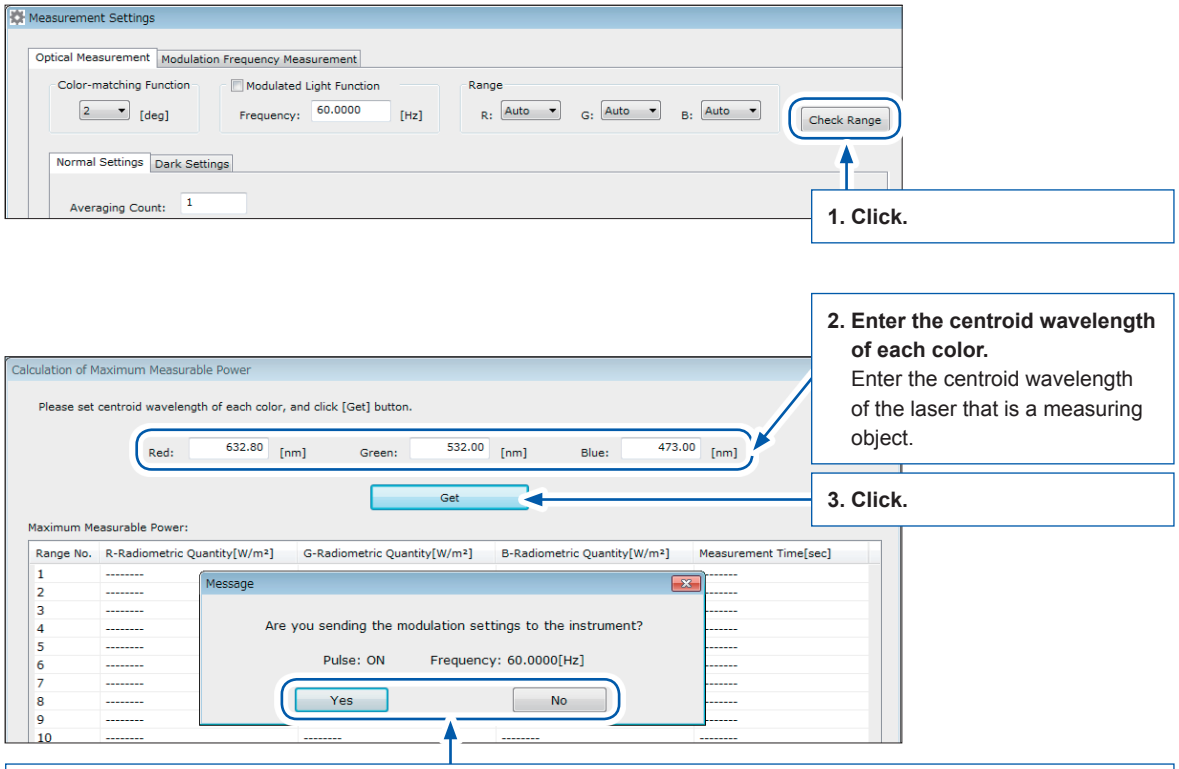
2 Make the settings common to the normal measurement and dark measurement.

(1) Make the detailed settings.



1	Setting for color-matching functions	
2	Modulated light function	
3	Modulation frequency	
4	Sensor range settings for red laser *	*:When the **Auto** range is selected and the settings are transmitted to the instrument using RGBLaserUtility, the initial value of the range is set to Range 1. To set the centroid wavelength input mode to ON, select the fixed range. (When the centroid wavelength input mode is ON, the instrument does not perform the auto range operation.)
5	Sensor range settings for green laser *	
6	Sensor range settings for blue laser *	
7	Used to check the maximum measurable radiometric quantity and measurement time in the measurement range. See: "Acquire the upper limit of measurable radiometric quantity." (p.61)	

(2) Acquire the upper limit of measurable radiometric quantity.



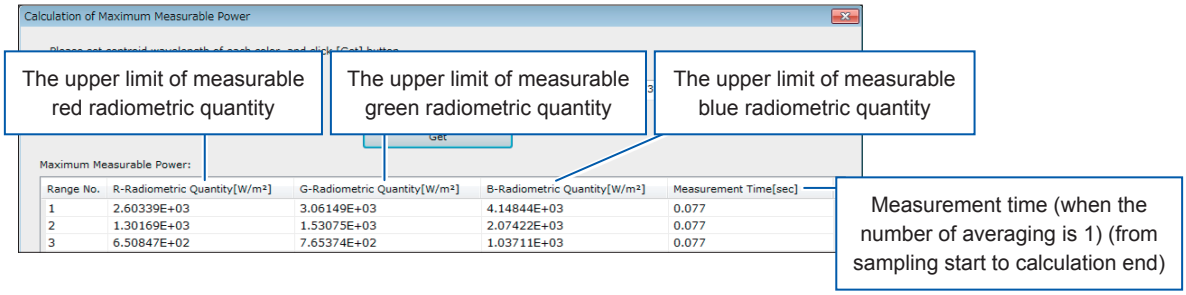
4. Check the sending of the modulated light function and modulation frequency setting.

(When **[Yes]** is clicked and the upper limit of measurable radiometric quantity is acquired, the **[Cancel]** of measurement setting dialog will be invalid.)

[Yes]:Transmits the modulated light function and modulation frequency setting to acquire the upper limit of measurable radiometric quantity and measurement time. The modulated light function and modulation frequency setting of the instrument will change.

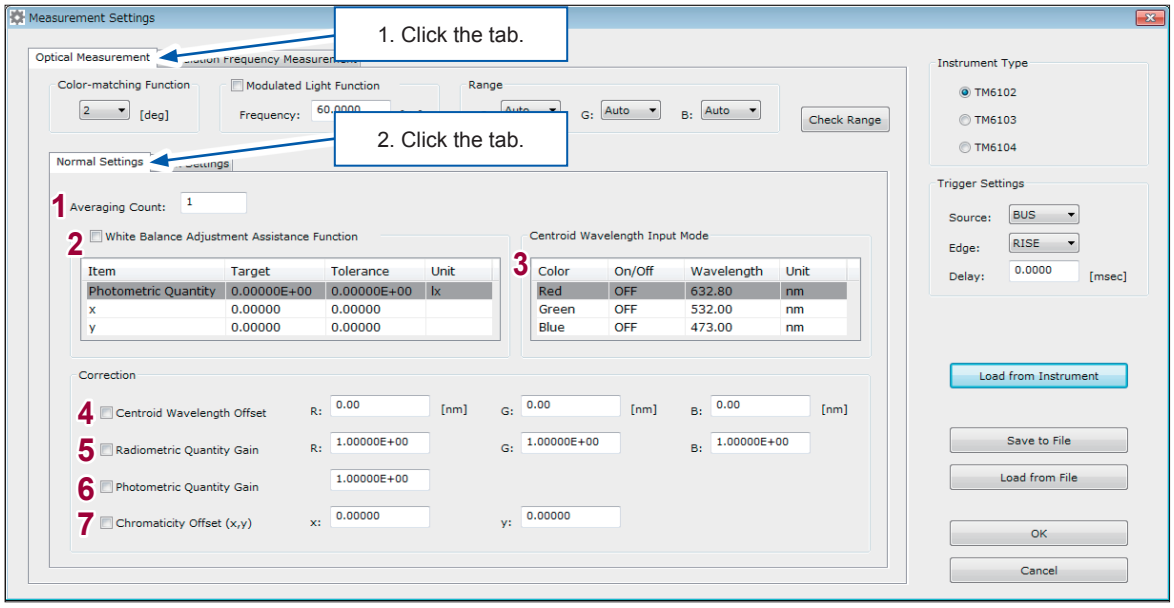
[No]: Stops acquiring the upper limit of measurable radiometric quantity and measurement time.

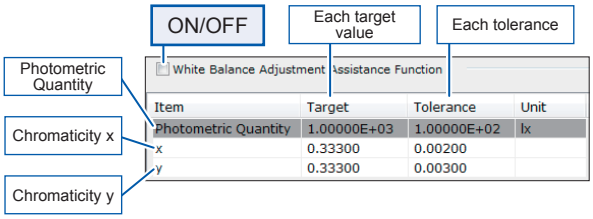
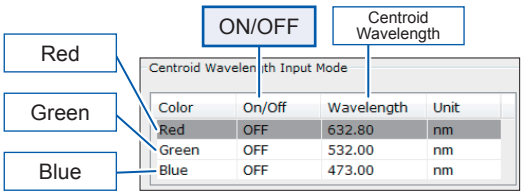
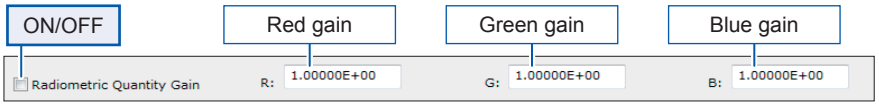
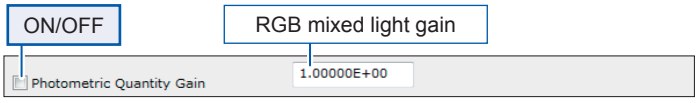
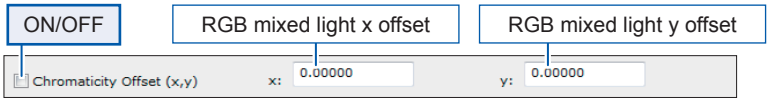
When the acquisition is completed, the upper limit of measurable radiometric quantity and measurement time of each color are displayed.
However, when the TCP/IP connection to the instrument cannot be performed, the upper limit of measurable radiometric quantity and measurement time cannot be checked.



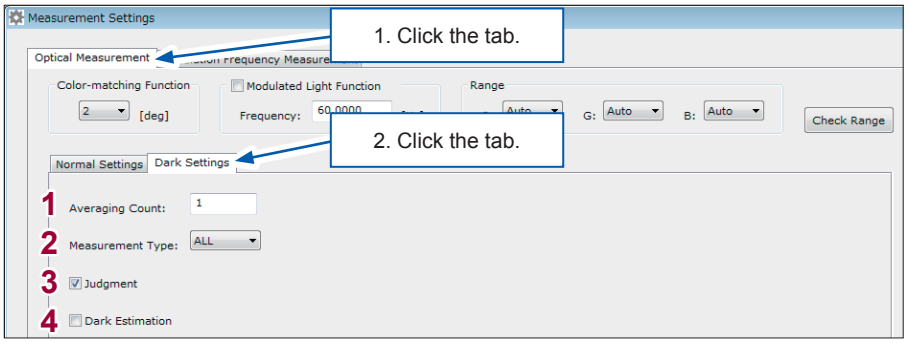
The upper limit of measurable radiometric quantity may exceed the maximum input. However, the radiometric quantity to be input to the instrument should not exceed the maximum input.

3 Make the normal measurement settings.



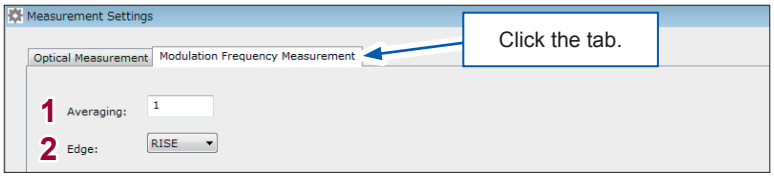
1	Average times
2	White balance adjustment assistance function settings (p.46)  The following shows the PASS judgment conditions of the instrument. Each Target Value − Each Tolerance ≤ Each Measured Value ≤ Each Target Value + Each Tolerance For the figure shown on the left, the PASS judgment conditions are as follows. 900 ≤ Photometric Quantity ≤ 1100 0.331 ≤ Chromaticity x ≤ 0.335 0.330 ≤ Chromaticity y ≤ 0.336
3	Centroid wavelength input mode settings (p.39)  When the centroid wavelength input mode is set to ON, the auto range operation is not performed. Be sure to specify an appropriate range, and then perform the measurement.
4	Centroid wavelength offset correction settings (p.39) 
5	Radiometric quantity gain correction settings (p.40) 
6	Photometric quantity gain correction settings (p.40) 
7	Chromaticity xy offset correction settings (p.40) 

4 Make the dark measurement settings.



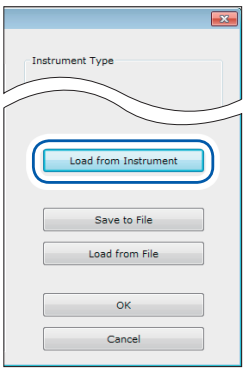
1	Average times	
2	Range in which the dark measurement is performed	**[ALL]**: Executes the dark measurement in all ranges. **[FIX]**: Executes the dark measurement only in the currently set range.
3	Dark measurement result judgment	When this judgment is set to ON, the dark measurement failure message appears if the dark measurement result is the error judgment.
4	Dark estimation	

5 Make the modulation frequency measurement settings.



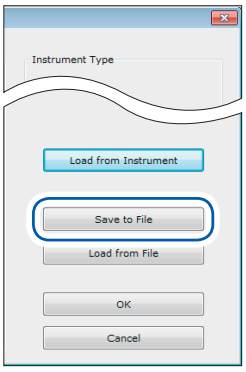
1	Average times	
2	Measurement edge	**[RISE]**: Measures the period between the rising edge and the next rising edge of the SYNC signal. **[FALL]**: Measures the period between the falling edge and the next falling edge of the SYNC signal.

6 Read the settings of the instrument.



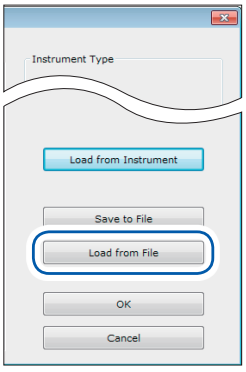
When you click **[Load from Instrument]**, the settings are read from the instruction at the connection destination set in the **[Communication Settings]** dialog, and then they are reflected in the **[Measurement Settings]** dialog.
If the connection to the instrument cannot be performed or if the command send or receive has failed, the settings in the dialog are not updated.

7 Save the settings to a file.



When you click **[Save to File],** the settings displayed in the **[Measurement Settings]** dialog are saved to a specified file (extension .dcm).

8 Read the settings from the file.

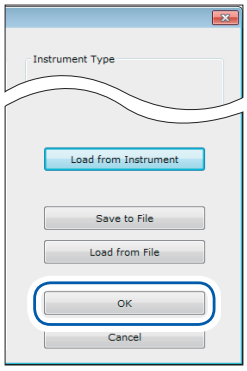


Clicking **[Load to File]** displays the load file selection screen.
When you select a setting file (extension .dcm), the settings saved in this file are reflected in the **[Measurement Settings]** dialog.

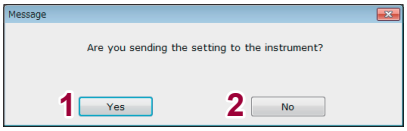
9 Reflect the settings in the instrument.

RGBLaserUtility is started with these settings at the next startup.

1. **Click [OK].**



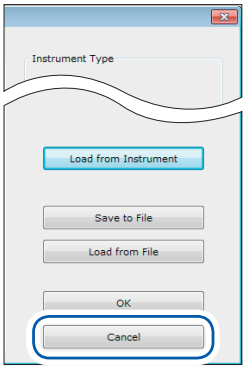
2. **Select whether the settings are transmitted to the instrument or not.**
(Select **[Yes]** or **[No]**.)



[Yes]: **Transmits the settings to the instrument and closes the [Measurement Settings] dialog.**

[No]: **Does not transmit the settings to the instrument and closes the [Measurement Settings] dialog.**

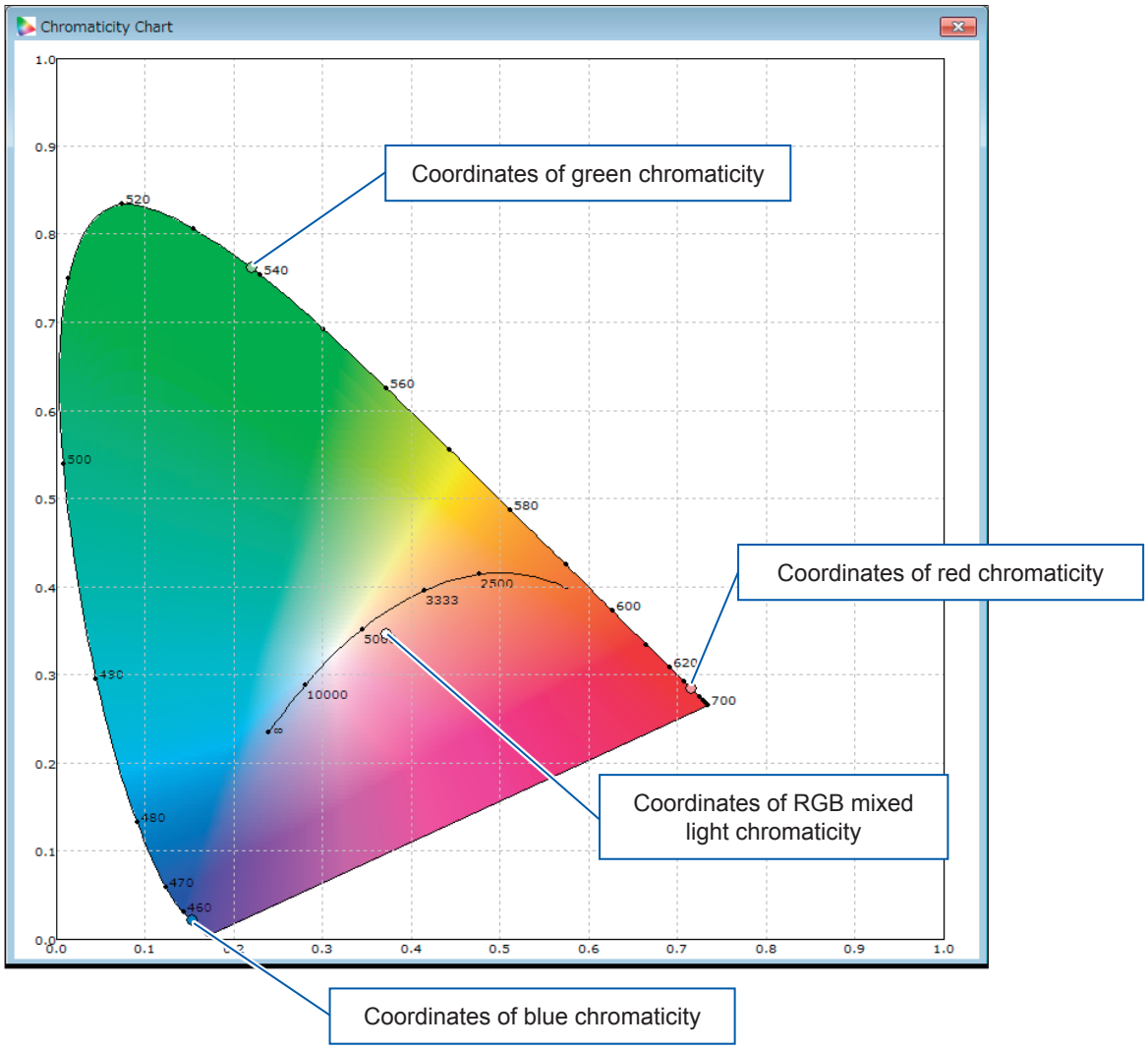
10 Cancel to change the settings.



Clicking **[Cancel]** closes the **[Measurement Settings]** dialog.

6.5 Chromaticity xy Chart Display

Select **[Tool]** on the menu bar, and then check on the **[Chroma Chart]** check box (☑).
When the measurement is started, the chromaticity xy chart is displayed.

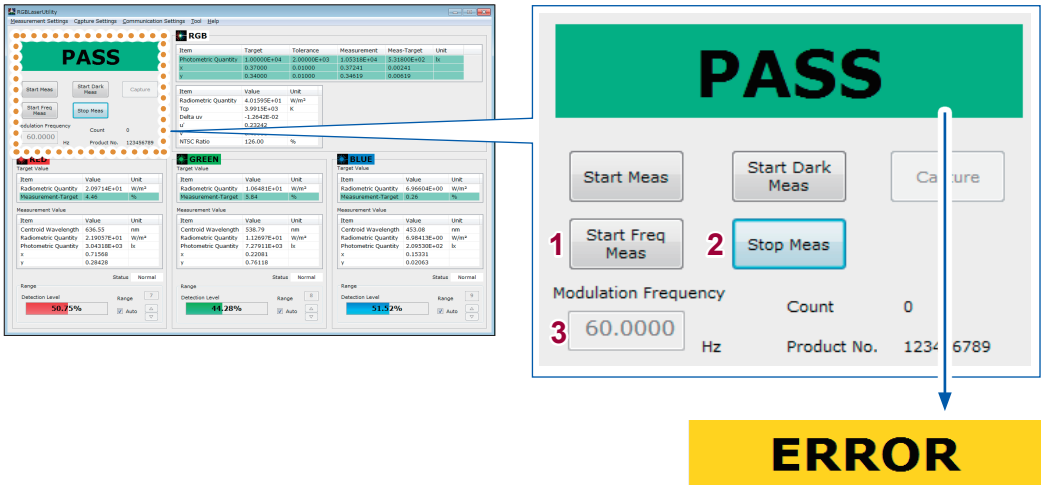


Hiding the chromaticity xy chart

1. **Stop the measurement.**
2. **Select the menu bar > [Tool], and then check off the [Chroma Chart] check box (☐).**
3. **Click [×] of the chromaticity xy chart.**

CAUTION
The measured value is not updated while the display size of the chromaticity xy chart is changed. Changing the display size repeatedly may cause slow updating of the measured value.

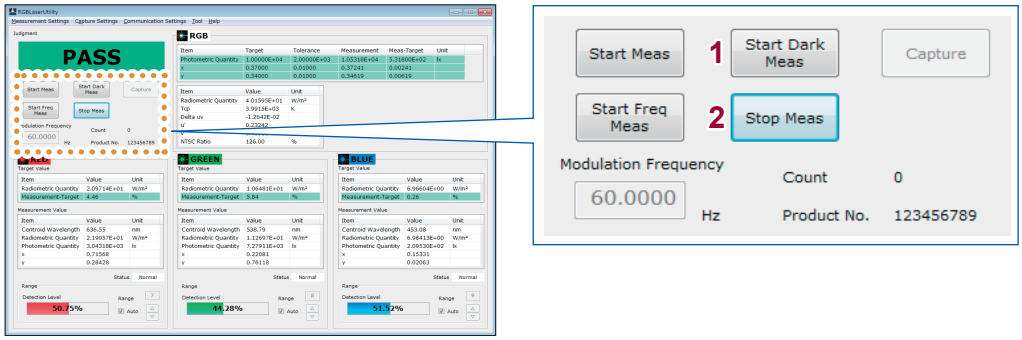
6.6 Modulation Frequency Measurement



This display is shown when the measurement cannot be performed correctly. (p.78)

1	Start Modulation Frequency Measurement Measures the modulation frequency to be input between the SYNC terminal and the ground. When the modulated light function of the instrument is ON, RGBLaserUtility sets the measured modulation frequency for the instrument.
2	Stop Measurement Stops the measurement during measurement of the modulation frequency.
3	Modulation Frequency Measurement Result Displays the modulation frequency value. **[--------]** is displayed during measurement. If correct measurements cannot be performed, **[ERROR]** is displayed.

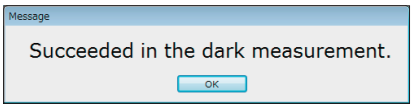
6.7 Dark Measurement



1	Start Dark Measurement
2	Stop Measurement Stops the measurement during dark measurement.

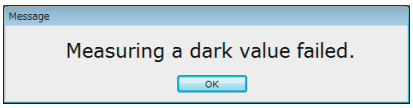
When the dark measurement is completed, the following is displayed.

Dark measurement succeeded:



Click **[OK]** to close the dialog.

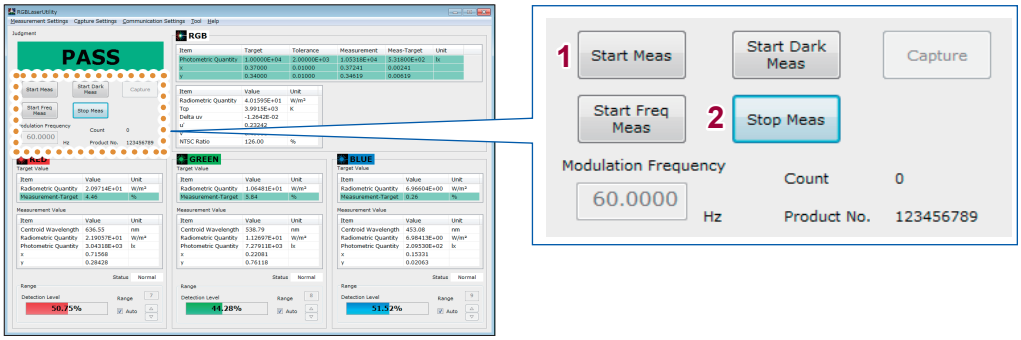
Dark measurement failed:



The dark level is too large.
Take corrective actions such as attaching the cap, and then perform the dark measurement again.

6.8 Normal Measurement

Executing the normal measurement



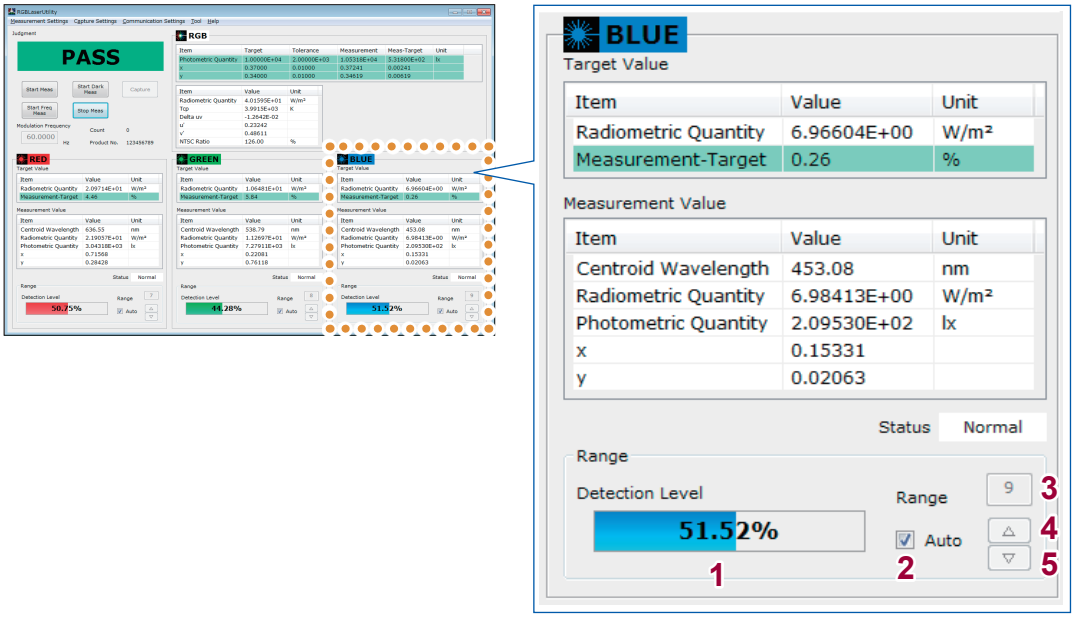
1	Start Normal Measurement
2	Stop Measurement

If the measurement start cannot be executed, check the following items.

Symptom	Check item or cause	Corrective action and reference page
The communication with the instrument could not be performed.	The LAN settings may be incorrect.	Check the LAN settings. (p.57)
The model of the instrument set in RGBLaserUtility did not match the instrument at the connection destination.	Set the model of the instrument to be connected.	"Select the model of the instrument to be connected." (p.60)
The file at the save destination could not be opened.	Saving to a text file.	The file at the save destination may already be opened.
	Saving to an Excel® text.	The Excel® file could not be opened for some reason.

Measurement range optimization

When the manual range is selected, select the measurement range of each color in which the detection level becomes maximum.



1	Detection Level
2	Auto range settings* Check on: Auto range is ON. Check off: Auto range is OFF (manual range). When the auto range is changed from ON to OFF in a weak light or unstable light measurement status, the subsequent measurement may be performed in an inappropriate range. When the auto range is set to OFF, select a range in which the detection level becomes maximum.
3	Measurement range that is used when the displayed measured value has been measured.*
4	Increase the range. (Increase the measurement sensitivity.)
5	Decrease the range. (Decrease the measurement sensitivity.)

*: The settings are sent to the instrument when the normal measurement or dark measurement is started.

Capturing the measured values

When the measurement is started, the measured values are captured and saved in accordance with the contents of the measured value capture settings.
See: "Measured Value Capture Settings" (p.58)

When **[With Capture button or ENTER key]** is selected for the measured value capture method, the measured values displayed at this time are captured to a text file or an Excel® file.
There are two kinds of capture methods as described below.

- Click **[Capture]** (capture the measured values) during measurement.
- Press the **[Enter]** key on the keyboard.

Save item name	Color	Details	Remarks
Count	–	Measurement counter	Save or non-save can be set.
Date	–	Measurement completion date	
Time	–	Measurement completion time	
RGB:Photometry[lx]	RGB mixed light	Measured value of photometric quantity (RGB mixed light)	The unit varies depending on the connected instrument.
RGB:Delta Photometry[lx]		Measured value of photometric quantity (RGB mixed light) − Target value of photometric quantity	
RGB:x		Measured value of chromaticity x (RGB mixed light)	–
RGB:Delta-x		Measured value of chromaticity x (RGB mixed light) − Target value of chromaticity x	
RGB:y		Measured value of chromaticity y (RGB mixed light)	
RGB:Delta-y		Measured value of chromaticity y (RGB mixed light) − Target value of chromaticity y	
Target_Photometry[lx]		Target value of photometric quantity	The unit varies depending on the connected instrument.
Target_x		Target value of chromaticity x	–
Target_y		Target value of chromaticity y	
Tolerance Photometry[lx]		Tolerance of photometric quantity	The unit varies depending on the connected instrument.
Tolerance x		Tolerance of chromaticity x	–
Tolerance y		Tolerance of chromaticity y	
Judge		Overall judgment	
RGB:Radiometry[W/m2]		Radiometric quantity (RGB mixed light)	The unit varies depending on the connected instrument.
RGB:X		Tristimulus value X (RGB mixed light)	Save or non-save can be set.
RGB:Y		Tristimulus value Y (RGB mixed light)	
RGB:Z		Tristimulus value Z (RGB mixed light)	
RGB:Tcp[K]		Correlated color temperature	–
RGB:Delta uv		Delta uv	
RGB:u’		Chromaticity u’	
RGB:v’		Chromaticity v’	
RGB:NTSC Ratio[%]		NTSC ratio	

Save item name	Color	Details	Remarks
R:Status	R (Red)	Measurement status	The displayed measurement status is saved.
R:Centroid Wavelength[nm]		Measured value of centroid wavelength	–
R:Dominant Wavelength[nm]		Dominant wavelength	Save or non-save can be set.
R:Radiometry[W/m2]		Radiometric quantity	The unit varies depending on the connected instrument. (p.61)
R:Photometry[lx]		Photometric quantity	The unit varies depending on the connected instrument. (p.61)
R:x		Chromaticity x	–
R:y		Chromaticity y	
R:X		Tristimulus value X	Save or non-save can be set.
R:Y		Tristimulus value Y	
R:Z		Tristimulus value Z	
R:Target(P)[W/m2]		Target value of radiometric quantity	The unit varies depending on the connected instrument. (p.61)
R:Target-Meas(P)[%]		(Measured value of radiometric quantity − Target value of radiometric quantity)/Target value of radiometric quantity × 100	–
R:Target Min(P)[W/m2]		Target lower limit value of radiometric quantity	The unit varies depending on the connected instrument. (p.61)
R:Target Max(P)[W/m2]		Target upper limit value of radiometric quantity	The unit varies depending on the connected instrument. (p.61)
R:Range		Range	–
R:Detection Level[%]		Detection level	
G:Status	G (Green)	Measurement status	The displayed measurement status is saved.
G:Centroid Wavelength[nm]		Measured value of centroid wavelength	–
G:Dominant Wavelength[nm]		Dominant wavelength	Save or non-save can be set.
G:Radiometry[W/m2]		Radiometric quantity	The unit varies depending on the connected instrument. (p.61)
G:Photometry[lx]		Photometric quantity	The unit varies depending on the connected instrument. (p.61)
G:x		Chromaticity x	–
G:y		Chromaticity y	
G:X		Tristimulus value X	Save or non-save can be set.
G:Y		Tristimulus value Y	
G:Z		Tristimulus value Z	
G:Target(P)[W/m2]		Target value of radiometric quantity	The unit varies depending on the connected instrument. (p.61)
G:Target-Meas(P)[%]		(Measured value of radiometric quantity − Target value of radiometric quantity)/Target value of radiometric quantity × 100	–
G:Target Min(P)[W/m2]		Target lower limit value of radiometric quantity	The unit varies depending on the connected instrument. (p.61)
G:Target Max(P)[W/m2]		Target upper limit value of radiometric quantity	
G:Range		Range	–
G:Detection Level[%]		Detection level	

Save item name	Color	Details	Remarks
B:Status	B (Blue)	Measurement status	The displayed measurement status is saved.
B:Centroid Wavelength[nm]		Measured value of centroid wavelength	–
B:Dominant Wavelength[nm]		Dominant wavelength	Save or non-save can be set.
B:Radiometry[W/m2]		Radiometric quantity	The unit varies depending on the connected instrument. (p.61)
B:Photometry[lx]		Photometric quantity	The unit varies depending on the connected instrument. (p.61)
B:x		Chromaticity x	–
B:y		Chromaticity y	
B:X		Tristimulus value X	Save or non-save can be set.
B:Y		Tristimulus value Y	
B:Z		Tristimulus value Z	
B:Target(P)[W/m2]		Target value of radiometric quantity	The unit varies depending on the connected instrument. (p.61)
B:Target-Meas(P)[%]		(Measured value of radiometric quantity − Target value of radiometric quantity)/Target value of radiometric quantity × 100	–
B:Target Min(P)[W/m2]		Target lower limit value of radiometric quantity	The unit varies depending on the connected instrument. (p.61)
B:Target Max(P)[W/m2]		Target upper limit value of radiometric quantity	The unit varies depending on the connected instrument. (p.61)
B:Range		Range	–
B:Detection Level[%]		Detection level	
Modulation Frequency[Hz]	–	Modulation frequency setting	Save or non-save can be set. When the modulated light function is OFF, the setting is saved as “CW”.

Saving to a text file (p.59)

Every time the measured value is captured, a line feed is inserted.
After the measurement has been started, a header (save item name) is added to the save file only when the measurement counter is 0.

Before starting the measurement, be sure to check that a file to be saved using RGBLaserUtility is not opened by other software.
If the file you want to save is opened by other software, the following symptoms may occur.

- An error occurs and the measurement cannot be started.
- The measured value cannot be saved correctly.

Saving to an Excel® file (p.59)

The measured data is saved to the **[RGB_LASER]** sheet of Excel®. Every time the measured value is captured, a line feed is inserted.

If Excel® is not started or there is no [RGB_LASER] sheet of Excel®.

Create a new book and save the data from cell A1 of the **[RGB_LASER]** sheet.

If there is the [RGB_LASER] sheet.

The measurement counter is 0: The data is saved beginning from the cell that is selected at the start of the measurement.
The measurement counter is not 0: The data is saved in the cell one line below the one that contains the previously measured data.

The measurement counter increments every time the measured value is saved to the file.
After the measurement has been started, a header (save item name) is added to the save file when the measurement counter is 0 and Excel® is not started.

CAUTION

- Do not perform any operation on Excel® while the data is saved to an Excel® file. If any operation is performed during saving, the save operation will fail and the measurement will be canceled.
- When saving the data to an Excel® file, do not save it to merged cells. Doing so may cause the data to be saved incorrectly.

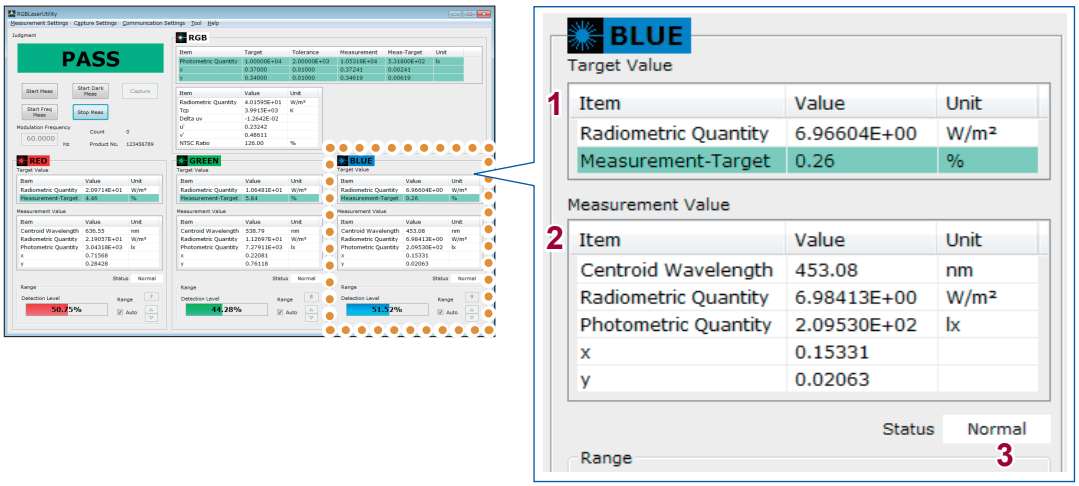
Resetting the measurement counter

In the following cases, the measurement counter is reset to 0.

- When RGBLaserUtility is started.
- When **[OK]** is clicked in the Capture Settings dialog.
- When **[OK]** is clicked in the Measurement Settings dialog.
- When **[Tool]** is selected on the menu bar > **[Reset Counter]**.

Measured values of each color

Even when all measured values of the radiometric quantities of three colors, R, G, and B, are within the adjustment target values of the radiometric quantities, in rare cases the overall judgment may not become the PASS judgment. In this case, perform the adjustment so that the radiometric quantity of each color gets close to the target value until the overall judgment becomes the PASS judgment.
Before starting the white balance adjustment, check on the white balance adjustment assistance function (**[White Balance Adjustment Assistance Function]**) check box (☑). (p.63)
If each measured value is not a valid value, **[--------]** is displayed.



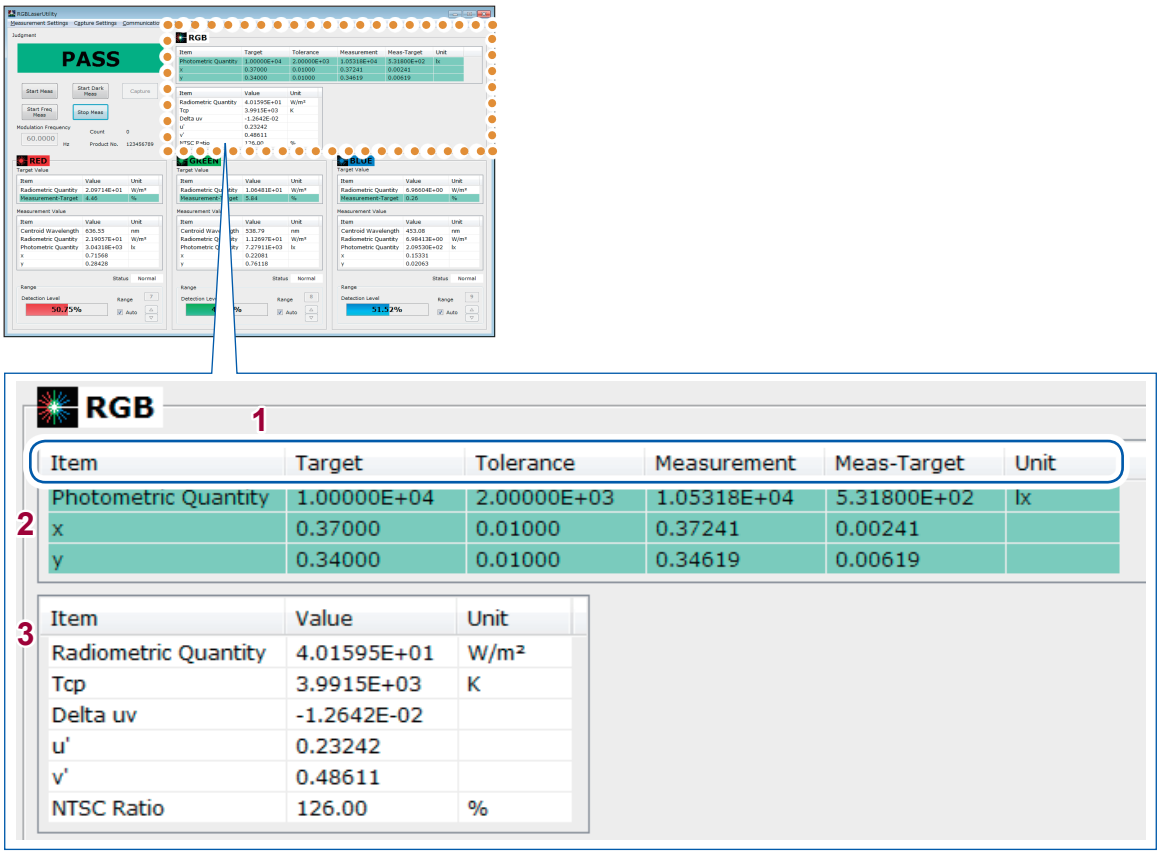
1	**[Radiometric Quantity]**: Target value of radiometric quantity **[Measurement-Target]**: Difference between radiometric quantity and target value of radiometric quantity The calculation formula is as follows. (Measured Value of Radiometric Quantity − Adjustment Target Value of Radiometric Quantity)/Measured Value of Radiometric Quantity × 100 Adjust the output of each laser so that it gets close to 0%. Color of **[Measurement-Target]** Green: The measured value of the radiometric quantity is within the tolerance of the radiometric quantity. Red: The measured value of the radiometric quantity is out of the tolerance of the radiometric quantity. White: The white balance adjustment assistance function is OFF.
2	**[Centroid Wavelength]**: Centroid wavelength **[Radiometric Quantity]**: Radiometric quantity **[Photometric Quantity]**: Photometric quantity **[x]**: Chromaticity x **[y]**: Chromaticity y
3	Measurement status (Details: p.48)

Measurement status	Details
Illegal	Error status
Overflow	Overflow status
Underflow	Underflow status
HighLevel	Excessive input status
Unbalance	Unbalance status
LowLevel	Low input status

Measurement status	Details
NoDark	No dark status
WaveInput	Centroid wavelength input mode status
Stop	Measurement stop status
Normal	Normal status
NoMeas	Non-measurement status

Measured values of RGB mixed light

Before starting the white balance adjustment, check on the white balance adjustment assistance function (**[White Balance Adjustment Assistance Function]**) check box (☑). (p.63)
If each measured value is not a valid value, **[--------]** is displayed.



1	**[Target]**: Each target value **[Tolerance]**: Each tolerance **[Measurement]**: Each measured value **[Meas-Target]**: Each measured value - each target value
2*	**[Photometric Quantity]**: Photometric quantity **[x]**: Chromaticity x **[y]**: Chromaticity y Cell color Green: Each measured value is within each target value ± each tolerance. Red: Each measured value is out of each target value ± each tolerance. White: The white balance adjustment assistance function is OFF.
3	**[Radiometric Quantity]**: Radiometric quantity **[Tcp]**: Correlated color temperature **[Delta uv]**: Delta uv **[u']**: Chromaticity u' **[v']**: Chromaticity v' **[NTSC Ratio]**: NTSC ratio

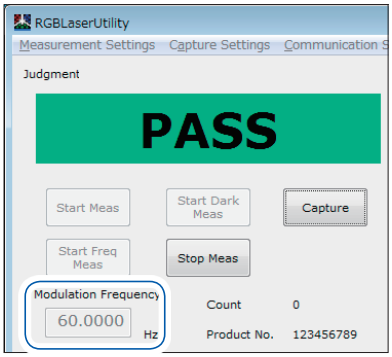
*:The overall judgment is performed by the instrument. The photometric quantity and chromaticity xy are judged by the application software and the display color is changed to the relevant color. Therefore, in rare cases the overall judgment may not match the judgments of the photometric quantity and chromaticity xy due to effects of the rounding error. In this case, use the overall judgment as the judgment result.

Overall judgment display

Display	Details
-	Non-judgment status. This status is displayed in the following cases. • Immediately after RGBLaserUtility is started. • The white balance adjustment assistance function is OFF. • The measurement is started.
PASS	The photometric quantity and chromaticity xy are within their tolerances.
FAIL	The photometric quantity and chromaticity xy are out of their tolerances.
ERROR	• The measurement could not be started. • The correct measurement could not be performed.

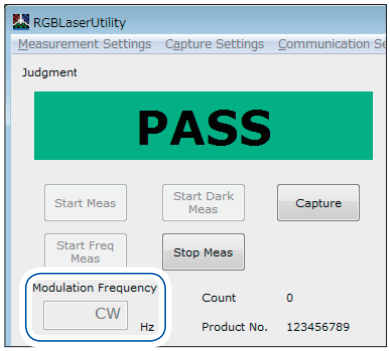
Modulation frequency display during measurement

The modulated light function is ON:



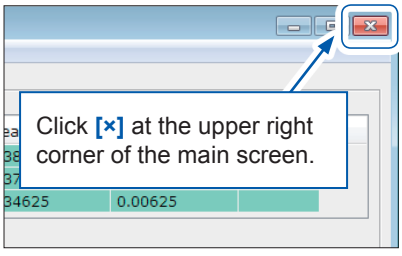
The modulation frequency set on the instrument is displayed.

The modulated light function is OFF:



[CW] (Continuous Wave) is displayed.

6.9 Exiting the Application Software



When the application software is started next time, it is started with the settings (communication settings, capture settings, and measurement settings) that are set when the software is terminated.

When the application software is terminated, the following files may be created in the folder in which **[RGBLaserUtility.exe]** is located. Do not delete these files as they are backup files of the settings.

• MeasSetData.ini
• RGBLaserUtility.ini

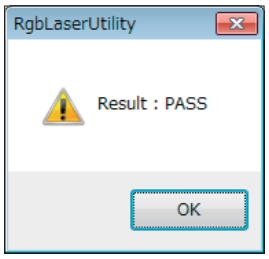
6.10 Others

Self-test

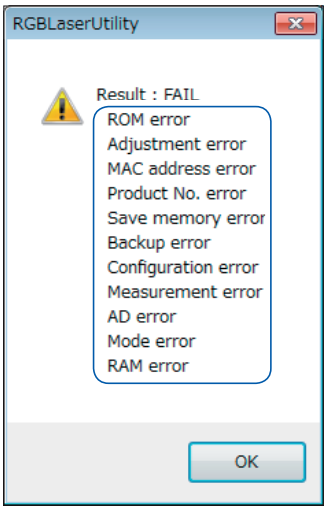
Select **[Tool]** on the menu bar > **[Self Test]**.

When the self-test is completed, the following is displayed.

The self-test is the PASS judgment:



The self-test is the FAIL judgment:



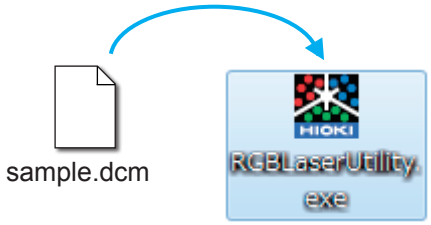
Errors that occurred are displayed.
Check the table shown below and take corrective actions.
When the instrument needs to be repaired, contact your authorized Hioki distributor or reseller.

Error	Details	Corrective action
[ROM error]	An operation error occurred in the internal ROM.	The repair is required.
[Adjustment error]	The adjustment value showed an abnormal value.	
[MAC address error]	The MAC address showed an abnormal value. This may cause the communication failure to occur.	
[Product No. error]	The written serial No. is inappropriate.	
[Save memory error]	The operation of the memory for storage of settings was abnormal.	
[Backup error]	The instrument was started with the default settings as the stored settings showed an abnormal value.	When the error is cleared by restarting the instrument, there is no problem.
[Configuration error]	The configuration at startup failed.	The repair is required.
[AD error]	The AD value showed an abnormal value.	
[Measurement error]	The sampling failed during measurement.	
[Mode error]	An inappropriate process was performed.	Please inform your authorized Hioki distributor or reseller of the details of the process you have performed.
[RAM error]	An operation error occurred in the internal RAM.	The repair is required.

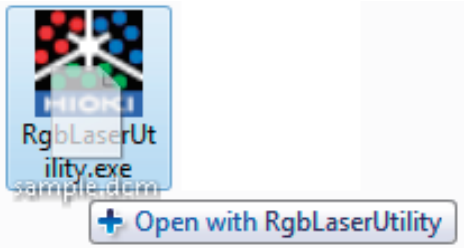
Starting RGBLaserUtility by specifying the measurement setting file (.dcm file)

Start RGBLaserUtility by dragging and dropping the measurement setting file.

1 **Drag and drop the measurement setting file (.dcm file) to [RGBLaserUtility.exe].**



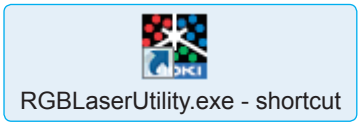
2 **Start RGBLaserUtility.**
Transmit the measurement setting file to the instrument, to start RGBLaserUtility.



- This function can not be used when the measurement setting file is dragged and dropped to the shortcut.
- RGBLaserUtility is not started when the measurement setting file is dragged and dropped to the shortcut.

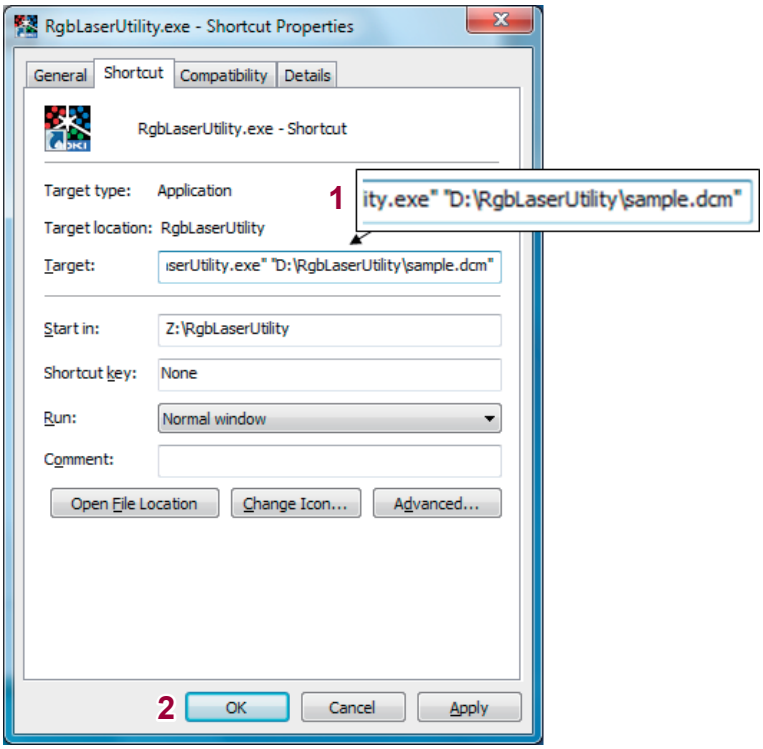
Start RGBLaserUtility using the shortcut.

1 **Create a shortcut of RGBLaserUtility anywhere in your computer.**



2 **Right-click the shortcut you have created, and then click [Properties].**

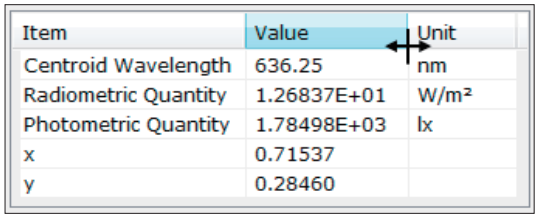
3 **Enter a space and the full path to the file in the [Target:] field, and then click [OK].**



4 **Double-click the shortcut specified in the [Target:] field.**
Transmit the measurement setting file to the instrument, to start RGBLaserUtility.

Adjusting the width of the measured value display list

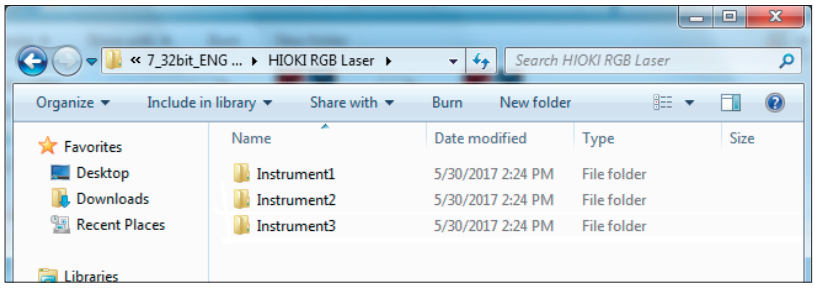
Dragging the right end of each column can adjust the width of the relevant column in the measured value display list on the measurement screen.
To return the width of the column to the default setting, click **[Tool]** on the menu bar > **[Reset Column Width]**.



Controlling multiple instruments

1 **Create folders for the number of connected instruments in a folder other than [ProgramFile] or [ProgramFile(x86)].**

2 **Copy [RGBLaserUtility.exe] in the installation folder into each folder you have created.**



3 **Power on the instrument for which you set the communication settings, start [RGBLaserUtility.exe] corresponding to this instrument, and then make the LAN settings.**

Set the instruments one by one while referring to "Using a LAN" (p.29).

4 **Make the measured value capture settings and perform the measurement using RGBLaserUtility.**

- When controlling multiple instruments, select the text format to save the measured values. The measured values from the multiple instruments cannot be saved to the same Excel® file.
- The operation may become slow depending on the computer specifications. If the operation is slow, upgrade the computer specifications.

6.11 Menu List

Menu		Description
Communication Settings		Opens the Communication Settings dialog.
Capture Settings		Opens the Measured Value Capture Settings dialog.
Measurement Settings		Opens the Measurement Settings dialog.
Tool	Chroma Chart	Sets to show or hide the Chromaticity xy Chart dialog.
	Reset Column Width	Returns the width of the measured value display list to the default value.
	Reset Counter	Resets the measurement counter to zero (0).
	Self Test	Performs the self-test.
Help		Displays the version information of RGBLaserUtility.

6.12 Message List

Message	Description	Corrective action
Initializing LAN communications failed.	Initializing the LAN communication failed.	Restart RGBLaserUtility. If the same message appears even after RGBLaserUtility has been restarted, RGBLaserUtility cannot be used in this environment.
The setting file contains an error.	The read measurement setting file contains an inappropriate format, causing a read failure.	The measurement setting file in which an error occurred cannot be used.
A connection failed.	The TCP/IP connection to the instrument failed.	Check the TCP/IP settings on the computer or instrument.
Succeeded in a connection.	The TCP/IP connection to the instrument succeeded.	–
Sending a command failed.	Sending commands to the instrument failed.	There may be an obstruction such as a noise in the communication environment.
Receiving a response failed.	Receiving responses from the instrument failed.	There may be an obstruction such as a noise in the communication environment.
Configuring settings failed.	Setting the instrument failed. The value set on the instrument did not match the read value.	Make the settings again.
Succeeded in the configuring settings.	Setting the instrument succeeded.	–
The connected instrument is not Model TM6102, TM6103, or TM6104.	The connected instrument was not the TM6102, TM6103, or TM6104.	–
The connected instrument is different from the instrument type setting.	The model of the instrument set in RGBLaserUtility did not match the model of the connected instrument.	Set the model of the instrument set in RGBLaserUtility to the model of the connected instrument.

Message	Description	Corrective action
The settings of RGBLaserUtility is different from the instrument settings.	The measurement settings specified in the instrument did not match the settings in RGBLaserUtility. (Except for the auto range settings and range settings.)	• To use the measurement settings set in RGBLaserUtility, transmit the settings. (p.66) • To use the measurement settings set in the instrument, load the settings. (p.65)
Starting measurement failed.	Starting the measurement failed.	–
Opening the file failed.	Opening the text file for storage of the measured values failed.	• Close the text file for storage of the measured values if it is opened. • If the file name is inappropriate, enter an appropriate file name in the “file name.extension” format. • If the folder name is inappropriate, select an appropriate folder.
Opening the Excel file failed.	Opening Excel® for storage of the measured values failed.	Install Excel®.
Saving the settings failed.	Saving the measurement setting file failed.	The save file may be in use. Stop using the save file.
Loading the settings failed.	Reading the measurement setting file failed.	The read file cannot be used.
Saving the measurement data failed.	Saving the measured data failed.	• Do not perform the save operation when there is no measured data. • Do not perform any operation on Excel® during the measurement while the data is saved to an Excel® file.
Measuring a dark value.	The dark measurement is being performed.	–
Succeeded in the dark measurement.	The dark measurement succeeded.	–
Dark measurement failed.	The dark measurement failed.	Perform the dark measurement with the cap attached.
Are you sending the modulation settings to the instrument?	An attempt was made to set the modulated light function and modulation frequency settings for the instrument. This massage is displayed when the measurable radiometric quantity is acquired.	–
The file to be loaded is not a DCM file.	The extension of the measurement setting file to be read was different or the file does not exist.	–
The program has started with all the default values set.	The program was started with the default measurement settings as the read measurement setting file, or backup measurement settings were inappropriate.	–
Transferring the settings.	The settings are being sent to the instrument.	–
The connection was reset.	The TCP/IP connection to the instrument was disconnected during measurement.	A noise problem is assumed.
Are you sending the setting to the instrument?	Check whether the measurement settings are transmitted to the instrument. This message is displayed when you click **[OK]** in the Measurement Settings dialog.	–
Setting the modulation frequency failed.	Setting the modulation frequency failed.	Make the settings again.
Estimating a dark value failed.	The dark estimation failed.	Perform the dark measurement with the cap attached.

Message	Description	Corrective action
Cancellation is invalid. Please click OK button.	The measurement upper limit radiometric quantity is acquired, and the modulated light function and modulation frequency setting is changed. **[Cancel]** is invalid.	Click **[OK]**.
Getting command-string failed.	An internal error occurred.	Contact your authorized Hioki distributor or reseller.
Internal error!!		

7 Specifications

7.1 General Specifications

Operating environment	Indoors, Pollution Degree 2, altitude up to 2000 m (6562 ft.)	
Operating temperature and humidity	Temperature	5°C to 35°C (41°F to 95°F)
	Humidity	80% RH or less (no condensation)
Storage temperature and humidity	Temperature	−5°C to 45°C (23°F to 113°F)
	Humidity	Less than 35°C (95°F), 80% RH or less (with no condensation) 35°C (95°F) or higher and less than 40°C (104°F), 55% RH or less (no condensation) 40°C (104°F) or higher and less than 45°C (113°F), 45% RH or less (no condensation)
Standards	Safety	EN 61010
	EMC	EN61326 Class A
Power supply	Model Z1008 AC Adapter (12 V, 1.25 A) Rated supply voltage: 100 V AC to 240 V AC (Voltage fluctuations of ±10% from the rated supply voltage are taken into account.) Rated supply frequency: 50 Hz/60 Hz Anticipated transient overvoltage: 2500 V Maximum rated power: 9.5 VA (including the AC adapter), 1.9 VA (instrument only)	
Interface	LAN	
Dimensions	TM6102: Approx. 65W × 83H × 126D mm (2.56″W × 3.27″H × 4.96″D) (Protrusions are not included.) TM6103: Approx. 65W × 83H × 175.7D mm (2.56″W × 3.27″H × 6.92″D) (Protrusions are not included.) TM6104: Approx. 65W × 83H × 135.5D mm (2.56″W × 3.27″H × 5.33″D) (Protrusions are not included.)	
Mass	TM6102: Approx. 700 g (24.7 oz.) TM6103: Approx. 790 g (27.9 oz.) TM6104: Approx. 720 g (25.4 oz.)	
Product warranty period	3 year	
Accessories	See: “Main unit and accessories” (p.2)	
Option	See: “Option” (p.2)	

7.2 Input Specifications/Output Specifications/ Measurement Specifications

(1) Basic specifications

Measurement item

TM6102	TM6103	TM6104
Irradiance	Radiance	Radiant flux (Optical power)
Illuminance	Luminance	Luminous flux

- Centroid Wavelength
- Tristimulus values XYZ
  In conformity with CIE standard colorimetric observers defined in JIS Z8781-1: 2012.
- Chromaticity (xy, u'v')
  In conformity with CIE standard colorimetric observers defined in JIS Z8781-1: 2012.
- Correlated color temperature, Delta uv
  In conformity with Methods for determining distribution temperature and colour temperature or correlated colour temperature of light sources defined in Annex B (Reference) of JIS Z8725: 2015.
- Dominant Wavelength
  1. The excitation purity is set to 100% based on the assumption that the width of the emission spectrum is very small.
  2. Complies with chromaticity display method by the main wavelength (or complementary-color main wavelength) and excitation purity defined in Annex JA (Reference) of JIS Z8781-3: 2016.
- NTSC Ratio
- Target value of radiometric quantity for white balance adjustment

Radiometric quantity

TM6102	TM6103	TM6104
Irradiance	Radiance	Radiant flux (Optical power)
0.2 mW/m^2 to 200 W/m^2	2 mW/sr·m^2 to 600 W/sr·m^2	10 nW to 130 mW

Specified conditions
- Modulated light function: OFF
- Centroid wavelength: 473 nm, 532 nm, 632.8 nm

When the detection level is lower than 10%, it is recommended to change the range or use the centroid wavelength input mode.

Photometric quantity

TM6102	TM6103	TM6104
Illuminance	Luminance	Luminous flux
0.2 lx to 110,000 lx	2 cd/m^2 to 300,000 cd/m^2	10 µlm to 60 lm

Specified conditions
- Modulated light function: OFF
- Centroid wavelength: 473 nm, 532 nm, 632.8 nm
- Output ratio of blue, green, or red radiometric quantity: Ratio at which the chromaticity is D65.

When the detection level is lower than 10%, it is recommended to change the range or use the centroid wavelength input mode.

Centroid wavelength

Blue: 435 nm to 477 nm
Green: 505 nm to 550 nm
Red: 615 nm to 665 nm

Oblique-incidence characteristic

TM6102	TM6103	TM6104
Approximate to cosine law	–	–

Diameter of detector window

TM6102	TM6103	TM6104
ϕ11.3 mm ± 0.1 mm	–	ϕ11.3 mm ± 0.1 mm

Measurement field diameter

TM6102	TM6103		TM6104
	Measurement distance	Measurement field diameter	
–	Closely contact	Approx. ϕ12 mm	–
	5 mm	Approx. ϕ14 mm	
	10 mm	Approx. ϕ16 mm	

Angle-of-visibility	TM6102	TM6103	TM6104
	–	Approx. 22°	–
Measurement time	15 ms to 460 ms (The measurement time depends on the measurement range. The number of averaging time is 1. Fixed range) But excludes communication time.		
Measurement method	Discrete centroid wavelength method		

(2) Accuracy specifications

Conditions of guaranteed accuracy	Guaranteed accuracy period: 1 year Guaranteed accuracy period after adjustment made by Hioki: 1 year Accuracy guarantee for temperature and humidity: 23°C±5°C (73°F±9°F), 80% RH or less Warm-up time: at least 30 minutes Modulated light function: OFF After implementation of the dark measurement Optimal range setting in auto range Number of averaging: 5 times By calibration conditions
Centroid wavelength	±0.5 nm (435.8 nm) ±0.5 nm (546.1 nm) ±0.5 nm (632.8 nm) Calibration conditions 1 (435.8 nm, 546.1 nm): • Mercury lamp • Irradiation to entire detector window • The radiometric quantity conforms to the conditions specified by Hioki. Calibration conditions 2 (632.8 nm): • Laser light (CW) • 0.1 mW • Approx. ϕ1.5 mm (Beam diameter) • Linear polarization (Polarization plane: Perpendicular to the bottom) • Vertical incidence to the center of the detector window

Radiometric quantity (relative)

TM6102	TM6103	TM6104
±4.6% rdg. (473 nm) Reference (532 nm) ±4.6% rdg. (633 nm)	±4.6% rdg. (473 nm) Reference (532 nm) ±4.6% rdg. (633 nm)	–
Calibration conditions • Approx. 40 µW (473 nm) • Approx. 60 µW (532 nm) • Approx. 80 µW (633 nm) • CW light • Vertical incidence of the beam with a size of approx. 5 mm × 1.5 mm to the center of the detector window	Calibration conditions • Approx. 40 µW (473 nm) • Approx. 60 µW (532 nm) • Approx. 80 µW (633 nm) • CW light • Vertical incidence of the beam with a size of approx. 5 mm × 1.5 mm to the center of the detector window	–

Radiometric quantity	TM6102	TM6103	TM6104
	±6.5% rdg.	±8% rdg.	±4.2% rdg. (473 nm) ±4.2% rdg. (532 nm) ±4.2% rdg. (632.8 nm)
	Calibration conditions • Laser light (CW) • Approx. 9 mW/m^2 • 532 nm • Uniform irradiation to entire detector window	Calibration conditions • Laser light (CW) • Approx. 3 W/sr·m^2 • 532 nm • Uniform luminance area	Calibration conditions • Laser light (CW) • 0.1 mW • 473 nm, 532 nm, 632.8 nm • Approx. ϕ1.5 mm (Beam diameter) • Linear polarization (Polarization plane: Perpendicular to the bottom) • Vertical incidence to the center of the detector window

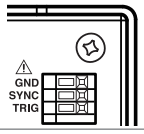
7.3 Functional specifications

Trigger	Source	Settings	Communication/External
		Default	Communication
	Edge	Settings	Rise/Fall
		Default	Rise
	Delay time (The modulation frequency measurement is not supported.)	Settings	0.0 s to 1.0 s (Resolution 100 ns)
		Default	0.0 s
Modulated light function		Settings	ON/OFF
		Default	OFF
Modulation frequency		Settings	10 Hz to 300 Hz
		Default	60 Hz
Measurement range		Settings	Auto range: ON/OFF (Settable for each color of RGB) Range: 16-range configuration (For each color of RGB)
		Default	Auto range: ON (All colors) Range: Minimum sensitivity range
Calculation of maximum measurable power		The calculated maximum measurable power of each range (16 ranges) is available using communication commands.	
Measurement mode		Settings	Normal measurement/Dark measurement/Modulation frequency measurement
		Default	Normal measurement

Normal measurement	Averaging		Settings	1 to 100
			Default	1
	Setting for color-matching functions		Settings	2°/10°
			Default	2°
	Correction	Centroid wavelength input mode	Settings	User setting enabled: ON/OFF (Settable for each color of RGB) User setting centroid wavelength: Measurement centroid wavelength range (Settable for each color of RGB)
			Default	Enabled: OFF (All colors) Set centroid wavelength: 473 nm, 532 nm, 632.8 nm
		Centroid wavelength offset	Settings	Offset enabled: ON/OFF Offset: −2.00 nm to 2.00 nm (Settable for each color of RGB)
			Default	Offset enabled: OFF Offset: 0.00 nm (All colors)
		Radiometric quantity gain	Settings	Gain enabled: ON/OFF Gain: 1.00000e-3 to 1.00000e+3 (Settable for each color of RGB)
			Default	Gain enabled: OFF Gain value: 1.00 (All colors)
		Chromaticity xy offset	Settings	Offset enabled: ON/OFF Offset: −1.0000 to 1.0000 (Settable for xy of RGB mixed light)
			Default	Offset enabled: OFF Offset: 0.0000 (xy)
		Photometric quantity gain	Settings	Gain enabled: ON/OFF Gain: 1.00000e-3 to 1.00000e+3 (Settable only for RGB mixed light)
			Default	Gain enabled: OFF Gain: 1.00
	White balance adjustment assistance function		Settings	Function enabled: ON/OFF Target value of photometric quantity: 0.00000 to 3.00000e+8 Tolerance of photometric quantity: 0.00000 to 3.00000e+8 Target value of chromaticity xy: 0.00000 to 1.00000 (Set for each of x and y.) Tolerance of chromaticity xy: 0.00000 to 1.00000 (Set for each of x and y.)
			Default	Function enabled: OFF Target value of photometric quantity: 0.00000 Tolerance of photometric quantity: 0.00000 Target value of chromaticity xy: 0.00000 (Set for each of x and y.) Tolerance of chromaticity xy: 0.00000 (Set for each of x and y.)
	Measured value		• Centroid wavelength (R, G, B) • Radiometric quantity (R, G, B, RGB mixed light) The radiometric quantity differs from the irradiance/radiance/radiant flux (optical power) depending on the type. • Photometric quantity (R, G, B, RGB mixed light) The photometric quantity differs from the irradiance/radiance/radiant flux depending on the type. • Tristimulus values XYZ (R, G, B, RGB mixed light) • Chromaticity xy (R, G, B, RGB mixed light) • Chromaticity u' v' (R, G, B, RGB mixed light) • Dominant wavelength (R, G, B) • Correlated color temperature Tcp • Delta uv • NTSC ratio	

Dark measurement	Measurement result judgment	Settings	ON/OFF
		Default	ON
	Averaging	Settings	1 to 100
		Default	1
	Dark measurement range	Settings	All range measurement/Fixed range measurement
		Default	All range measurement
	Dark estimation	When the modulation frequency is changed, the presently acquired dark value and integral time are used to estimate the dark value without executing the dark measurement.	
		Settings	ON/OFF
		Default	OFF
Modulation frequency measurement	Measurement frequency range	10 Hz to 300 Hz	
	Averaging	Settings	1 to 10
		Default	1
	Count edge	Settings	Rise/Fall
		Default	Rise
	Measured value	Frequency of the signal input to the SYNC terminal	
Self-test		ROM test, RAM test	
Reset	Reset	Returns to the factory default settings. (Except for the interface settings)	
	System reset	Returns all settings to their factory default settings.	

7.4 Interface specifications

LAN	Electrical specifications	Compliance with IEEE802.3		
	Command specifications	Command structure that refers to the IEEE 488.2 and SCPI standards		
	Transmission method	100BASE-TX Full duplex communication, half-duplex communication		
	Protocol	TCP/IP		
	Connector	RJ-45		
	Communication setting change-over function	Changes to the user setting mode or fixed setting mode using the slide switch.		
	Settings	IP address, subnet mask, default gateway Communication command port: 1024 to 65535		
	User setting mode	Default settings IP address: 0.0.0.0 Subnet mask: 255.255.255.0 Default gateway: 0.0.0.0 (None) Communication command port: 1024		
	Fixed setting mode	IP address: 192.168.0.254 Subnet mask: 255.255.255.0 Default gateway: 0.0.0.0 (None) Communication command port: 1024		
External input	Connector	Terminal block (3 terminals) Usable electric wire: AWG28 to AWG22		
	Input	Electrical specifications	Insulation	Digital isolator
			Maximum applied voltage	6 V
			Input HI	2.4 V to 5 V
			Input LO	0 V to 0.4 V
			Response pulse width	300 µs or longer
	Control logic	Rising edge or falling edge can be selected.		
	Layout		GND	GND
			SYNC	Modulation frequency signal
			TRIG	External trigger

7.5 List of default settings

Settings			Default
Trigger	Source		Communication
	Edge		Rise
	Delay time		0.0 s
Modulated light function			OFF
Modulation frequency			60 Hz
Auto range			All colors ON
Measurement range			All-color range 1 (Minimum sensitivity range)
Measurement mode			Normal measurement
Normal measurement	Averaging		1
	Centroid wavelength input mode	Enabled	All colors OFF
		Set centroid wavelength	Red: 632.8 nm, Green: 532 nm, Blue: 473 nm
	Centroid wavelength offset	Enabled	OFF
		Offset	All colors 0.0
	Radiometric quantity gain	Enabled	OFF
		Gain	All colors 1.0
	Chromaticity xy offset	Enabled	OFF
		Offset	0.0
	Photometric quantity gain	Enabled	OFF
		Gain	1.0
	White balance adjustment assistance function	Enabled	OFF
		Target value (Photometric quantity, chromaticity xy)	All parameters 0.0
		Tolerance range (Photometric quantity, chromaticity xy)	All parameters 0.0
Dark measurement	Measurement result judgment		ON
	Averaging		1
	Dark measurement range		All range measurement
	Dark estimation		OFF
Modulation frequency measurement	Averaging		1
	Count edge		Rise
Setting for color-matching functions			2°
LAN	User setting mode	IP address	0.0.0.0 (Disabled)
		Subnet mask	255.255.255.0
		Default gateway	0.0.0.0 (None)
		Communication command port	1024

8 Maintenance and Service

⚠WARNING

Customers are not allowed to modify, disassemble, or repair the instrument. Doing so may cause incorrect measurement results.

Calibrations

- The calibration period varies depending on the status of the instrument or installation environment. We recommend that the calibration period be determined in accordance with the status of the instrument or installation environment. Please contact your Hioki distributor to have your instrument periodically calibrated.
- We do not support calibration of the TM6103 only. If you request calibration of the TM6103, the calibration is performed with adjustment. Please understand this point in advance.

Backing up the data

The instrument may be initialized (returned to the factory default settings) when it is repaired or calibrated.
Before you ask for repair or calibration, it is recommended to back up (save or record) the measurement conditions and measured data.

Precautions during shipment

- To ensure safe handling, when transporting the instrument, please use the original box and packing materials, but do not use if the box is damaged or warped, or if the packing materials are in poor condition or incomplete. If the original box or packing materials provided with the instrument cannot be used, contact your authorized Hioki distributor or reseller. We will send appropriate box or packing materials.
- When packing the instrument, make sure to disconnect any cords including the power supply cord from the main device.
- When transporting, avoid dropping or other excessive impacts.
- When sending the instrument for repair, include details of the problem.
- To prevent dew condensation during transportation, pack the instrument after putting it in a bag that can be sealed. When moisture absorbents such as silica gel can be prepared, pack them together with the instrument.
- Note that if the instrument is damaged due to transportation without using the original packing boxes and cushioning materials, the repair cost will be charged even within the warranty period.

Cleaning

- Never use solvents that contain benzene, alcohol, acetone, ether, ketones, thinners or gasoline. They can deform and discolor the instrument.
- To clean the instrument, wipe it gently with a soft cloth moistened with water or mild detergent.
- If the detector window is contaminated, wipe it gently with a lint-free cloth such as lens cleaning paper.
- If any fiber remains on the detector window, blow it out with a blower for optical lenses.

Disposal

Handle and dispose of the instrument in accordance with local regulations.

8.1 Troubleshooting

If damage is suspected, check the following before contacting your authorized Hioki distributor or reseller.

Before sending the instrument for repair

Symptom	Check item or cause	Corrective action and reference page
The power LED does not light up even when the power switch is turned on.	• Is the power cord disconnected? • Is the power cord connected correctly?	Check that the power cord is connected correctly. (p.26)
The power LED blinks in red when the communication is performed.	An error occurs as the sent commands include an improper command.	Perform one of the following. • Send the commands one by one to check for the command that causes the power LED to blink in red. • After sending the commands, send `*ESR?` to check the error occurrence location. Details about `*ESR?`: Communication Command Instruction Manual (CD)
The measured value of the centroid wavelength is always the same value.	Is the centroid wavelength input mode set to ON?	Check the setting of the centroid wavelength input mode. (p.39)
Even when the auto range setting is set to ON, the auto range does not operate.		
The measured value varies.	Is the modulated light function set to ON?	Set the modulated light function to ON, and then set the modulation frequency. (p.41)
	Is the detector window contaminated?	Clean the detector window. (p.93)
	Is the instrument used in a noisy environment?	If the instrument is used in a noisy environment, investigate the corrective actions shown below. • Take the noise prevention measures. (p.100) • Keep the instrument away from noise generation sources (motor, inverter, electromagnetic switch, electric power line, or device in which sparks occur), or perform the measurement in another room. • Get the power supply from an outlet that is installed securely. • Get the power supply from a power supply line different from a device that generates noises.
The measurement cannot be performed correctly.	Was the dark measurement performed appropriately?	Enable the judgment function of the dark measurement, and then perform the dark measurement. (p.42)
	Is an unintentional correction function enabled?	Check the settings of each correction function. (p.38)

Symptom	Check item or cause	Corrective action and reference page
The communication cannot be performed via LAN.	Does the computer support 100BASE?	Check that the auto negotiation is enabled in the network adapter settings of the computer and that the 100 M link is set.
	Are the communication settings correct?	Check the communication setting mode switch. (p.26)
	• Are the computer settings correct? • Are the instrument settings correct?	Check the network environment and the LAN settings between the computer and instrument. (p.29 to p.34)
	Is the TCP/IP connection process performed before the instrument is started?	Perform the TCP/IP connection process approximately 5 sec. after the instrument has been started.
The TCP/IP connection of the LAN is disconnected.	Is there a broken wire in the LAN cable or a connection failure of the connector?	Prepare a new LAN cable equivalent to the cable supplied with the product, and check the TCP/IP connection again.
	Is the instrument used in a noisy environment?	See the corrective actions stated in “The measured value varies.” (p.94) shown above.
The LAN communication may become slow.	Are the TcpNoDelay settings correct?	See “Cautions on Communication Program Creation” stated in the Communication Command Instruction Manual (CD).
	Is the instrument used in a noisy environment?	See the corrective actions stated in “The measured value varies.” (p.94) shown above.

Error display

See “Self-test” (p.79) or `*ESR?`, `:SYSTem:ERRor?` stated in the Communication Command Instruction Manual (CD).

9 License Information

The instrument uses a lwIP open source.

lwIP's License

lwIP is licensed under the BSD license:

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10 Appendix

10.1 Relationship between Radiometric Quantity and Photometric Quantity

Definition of radiometric quantity

The radiometric quantity is an absolute power of the light.
The radiometric quantity is classified into the irradiance, radiance, and radiant flux (optical power) in accordance with the unit.
The irradiance is expressed as a power per unit area.
The radiance is expressed as a power per solid angle in unit area.
The radiant flux (optical power) is expressed as a power itself.

Definition of photometric quantity

The photometric quantity is a power sensed by human eyes when the light is seen through human eyes.
The photometric quantity is classified into the illuminance, luminance, and luminous flux in accordance with the unit.
The illuminance is expressed as a power per unit area that is sensed by human eyes.
The luminance is expressed as a power per solid angle in unit area that is sensed by human eyes.
The luminous flux is expressed as only the power that is sensed by human eyes.

Definition of power sensed by human eyes

The sensitivity of human eyes vary depending on the wavelength (color) of the received light.
For example, the sensitivity to the green light is high and the sensitivity to the red light is relatively low.
The power sensed by human eyes is expressed by the mathematical expression shown below.

$$\text{Photometric quantity} = \int \text{Radiometric quantity}(\lambda) \times \text{Sensitivity of human eyes}(\lambda)\, d\lambda$$

Here, λ is the wavelength.
Wavelength dependence of human eyes' sensitivity is standardized by the CIE.

Correspondence table of radiometric quantity and photometric quantity (with units)

The radiometric quantity uses a physical unit.
On the other hand, the photometric quantity uses a unit related to a power sensed by human eyes.

Radiometric Quantity	Photometric Quantity
Irradiance [W/m^2]	Illuminance [lx]
Radiance [$W/sr \cdot m^2$]	Luminance [cd/m^2]
Radiant flux (optical power) [W]	Luminous flux [lm]

10.2 Prevention of External Noise Entry

The instrument is so designed that it does not malfunction even when noises enter from the measurement cable and power supply line.
However, significantly large noises may cause a measurement error or malfunction. Refer to the following noise prevention examples if a malfunction occurs.

Prevention measures against noise entry from power supply line

When noises enter from the power supply line, take the following measures to reduce the effects of the noise.

Connecting the protection grounding cable

The protection grounding of the instrument has a structure in which the power cable is used as a grounding line to perform the grounding.
The protection grounding plays an important role to prevent an electrical shock accident and remove noises that enter from the power supply line through the built-in filter in case of an accident.
Be sure to connect the grounding line to a grounded commercial power supply using the power cord supplied with the instrument.

Inserting a noise filter into the power supply line

Connect a generally available socket type noise filter to a power outlet and connect the instrument to the output of the noise filter to prevent entry of noises from the power supply line.
Socket type noise filters are sold by various manufacturers.

Inserting an anti-EMI ferrite core into the power cord

Pass the power cord through a generally available EMI ferrite core and mount it as close to the AC power inlet of the instrument as possible to prevent entry of noises from the power supply line.
In addition, also mounting an anti-EMI ferrite core near the power plug is more effective.
Furthermore, when there is extra space inside a through-type ferrite core or separation-type ferrite core, winding the power cord on the core several times increases the attenuation to the noise.
EMI ferrite cores and ferrite beads are sold by various dedicated manufacturers.

10.3 LAN Settings on the Computer

Windows version		Setting procedure
Windows 7	1	Click **[Start]**, and then click **[Control Panel]**.
	2	The **[Control Panel]** window appears. Click **[View network status and tasks]** in **[Network and Internet].** When the classic view is set, double-click **[Network and Sharing Center].**
	3	The **[Network and Sharing Center]** window appears. Click **[Change adapter settings]** on the left menu.
	4	The **[Network Connection]** window appears. Right-click **[Local Area Connection]** to be connected to the instrument, and then click **[Properties]** on the displayed menu.
	5	The **[Local Area Connection]** window appears. Select **[Internet Protocol Version 4 (TCP/IPv4)]**, and then click **[Properties]**.
	6	The **[Properties of Internet Protocol Version 4 (TCP/IPv4)]** window appears. Select **[Use the following IP address:]**, and then make the following settings. (p.29) • IP address • Subnet mask • Default gateway
Windows 8, Windows 8.1	1	Press the **[Windows]** and **[X]** keys at the same time to display the menu, and then click **[Control Panel]**.
	2	The **[Control Panel]** window appears. Click **[View network status and tasks]**. When the icon view is set, double-click **[Network and Sharing Center]**.
	3	The **[Network and Sharing Center]** window appears. Click **[Change adapter settings]** on the left menu.
	4	The **[Network Connection]** window appears. Right-click **[Ethernet]** to be connected to the instrument, and then click **[Properties]** on the displayed menu.
	5	The **[Ethernet Properties]** window appears. Select **[Internet Protocol Version 4 (TCP/IPv4)]**, and then click **[Properties]**.
	6	The **[Properties of Internet Protocol Version 4 (TCP/IPv4)]** window appears. Select **[Use the following IP address:]**, and then make the following settings. (p.29) • IP address • Subnet mask • Default gateway
Windows 10	1	Right-click **[Start]** to display the menu, and then click **[Network Connections]**.
	2	The **[Network Connection]** window appears. Right-click **[Ethernet]** to be connected to the instrument, and then click **[Properties]** on the displayed menu.
	3	The **[Ethernet Properties]** window appears. Select **[Internet Protocol Version 4 (TCP/IPv4)]**, and then click **[Properties]**.
	4	The **[Properties of Internet Protocol Version 4 (TCP/IPv4)]** window appears. Select **[Use the following IP address:]**, and then make the following settings. (p.29) • IP address • Subnet mask • Default gateway

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Warranty Certificate

HIOKI

Model	Serial number	Warranty period Three (3) years from date of purchase (___ / ___)

Customer name: _____

Customer address: _____

Important

- Please retain this warranty certificate. Duplicates cannot be reissued.
- Complete the certificate with the model number, serial number, and date of purchase, along with your name and address. The personal information you provide on this form will only be used to provide repair service and information about Hioki products and services.

This document certifies that the product has been inspected and verified to conform to Hioki's standards.
Please contact the place of purchase in the event of a malfunction and provide this document, in which case Hioki will repair or replace the product subject to the warranty terms described below.

Warranty terms

1. The product is guaranteed to operate properly during the warranty period (three [3] years from the date of purchase). If the date of purchase is unknown, the warranty period is defined as three (3) years from the date (month and year) of manufacture (as indicated by the first four digits of the serial number in YYMM format).
2. If the product came with an AC adapter, the adapter is warrantied for one (1) year from the date of purchase.
3. The accuracy of measured values and other data generated by the product is guaranteed as described in the product specifications.
4. In the event that the product or AC adapter malfunctions during its respective warranty period due to a defect of workmanship or materials, Hioki will repair or replace the product or AC adapter free of charge.
5. The following malfunctions and issues are not covered by the warranty and as such are not subject to free repair or replacement:
   -1. Malfunctions or damage of consumables, parts with a defined service life, etc.
   -2. Malfunctions or damage of connectors, cables, etc.
   -3. Malfunctions or damage caused by shipment, dropping, relocation, etc., after purchase of the product
   -4. Malfunctions or damage caused by inappropriate handling that violates information found in the instruction manual or on precautionary labeling on the product itself
   -5. Malfunctions or damage caused by a failure to perform maintenance or inspections as required by law or recommended in the instruction manual
   -6. Malfunctions or damage caused by fire, storms or flooding, earthquakes, lightning, power anomalies (involving voltage, frequency, etc.), war or unrest, contamination with radiation, or other acts of God
   -7. Damage that is limited to the product's appearance (cosmetic blemishes, deformation of enclosure shape, fading of color, etc.)
   -8. Other malfunctions or damage for which Hioki is not responsible
6. The warranty will be considered invalidated in the following circumstances, in which case Hioki will be unable to perform service such as repair or calibration:
   -1. If the product has been repaired or modified by a company, entity, or individual other than Hioki
   -2. If the product has been embedded in another piece of equipment for use in a special application (aerospace, nuclear power, medical use, vehicle control, etc.) without Hioki's having received prior notice
7. If you experience a loss caused by use of the product and Hioki determines that it is responsible for the underlying issue, Hioki will provide compensation in an amount not to exceed the purchase price, with the following exceptions:
   -1. Secondary damage arising from damage to a measured device or component that was caused by use of the product
   -2. Damage arising from measurement results provided by the product
   -3. Damage to a device other than the product that was sustained when connecting the device to the product (including via network connections)
8. Hioki reserves the right to decline to perform repair, calibration, or other service for products for which a certain amount of time has passed since their manufacture, products whose parts have been discontinued, and products that cannot be repaired due to unforeseen circumstances.

HIOKI E.E. CORPORATION
http://www.hioki.com 18-07 EN-3

HIOKI

http://www.hioki.com

Our regional contact information

HEADQUARTERS
81 Koizumi
Ueda, Nagano 386-1192 Japan

HIOKI EUROPE GmbH
Rudolf-Diesel-Strasse 5
65760 Eschborn, Germany
hioki@hioki.eu

1808EN

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