HIOKI

TM6101

Instruction Manual

LED OPTICAL METER

Video

Scan this code to watch the instructional video(s).
Carrier charges may apply.

EN

May 2021 Revised edition 6
TM6101A981-06 21-05H

600341246

Contents

Introduction

Thank you for purchasing the HIOKI Model TM6101 LED Optical Meter. To obtain maximum performance from the instrument, please read this manual first, and keep it handy for future reference.

This manual uses the following conventions:
- The TM6101 LED Optical Meter (consisting of the sensor unit and TM6101 main unit) is referred to as the “instrument.”
- The TM6101 itself is referred to as the “main unit.”
- The TM6101 sensor is referred to as the “sensor unit.”

The "TM6101 Utility" and "TM6101 Measuring Library" software packages are included with the instrument. Use of both is subject to the terms of a license agreement. Please use the software only after reading and accepting the license agreement at the back of the book.

Trademarks

- Adobe and Reader are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States and/or other countries.
- Microsoft, Windows, Visual Studio, Visual C++, Visual Basic, VIsual C#, and .NET Framework are either registered trademarks or trademarks of Microsoft Corporation in the United States and other countries.

Other Conventions

- Unless otherwise specified, “Windows” represents Windows 7, Windows 8, or Windows 10.
- Dialog box represents a Windows dialog box.
- Menus, commands, dialogs, buttons in a dialog, and other names on the screen and the keys are indicated in brackets.

Mouse Operation

- 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.
- Activate: Click on a window on the screen to activate that window.

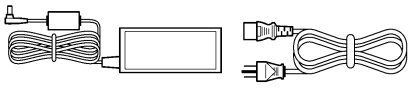
Confirming Package Contents

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

Confirm that these contents are provided.

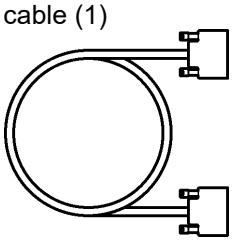
☐ Model TM6101 LED Optical Meter (main unit + sensor unit) (1)

☐ Model 9418-15 AC Adapter (1)



☐ USB Cable (1)

☐ Main unit/sensor unit connection cable (1)



☐ Cap (1)

(Instrument ships with cap attached to sensor unit.)

☐ Port connection screws (4)

☐ Ferrite cores (3)

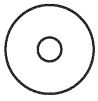
(Instrument ships with one ferrite core attached to the Main unit/sensor unit connection cable.)

☐ Rubber feet (4)

☐ TM6101 Instruction Manual (1)

☐ CD (1)

- PC application software* (TM6101 Utility)
- Library software (TM6101 Measuring Library)
- TM6101 Utility Instruction Manual
- TM6101 Measuring Library Instruction Manual
- TM6101 Instruction Manual



* The latest version can be downloaded from our website.

Safety Information

⚠WARNING

This instrument is designed to comply with IEC 61010 Safety Standards, and has been thoroughly tested for safety prior to shipment. However, mishandling during use could result in injury or death, as well as damage to the instrument. Using the instrument in a way not described in this manual may negate the provided safety features.
Be certain that you understand the instructions and precautions in the manual before use. We disclaim any responsibility for accidents or injuries not resulting directly from instrument defects.

This manual contains information and warnings essential for safe operation of the instrument and for maintaining it in safe operating condition. Before using it, be sure to carefully read the following safety precautions.

Safety Symbols

⚠	In the manual, the ⚠ symbol indicates particularly important information that the user should read before using the instrument. The ⚠ symbol printed on the instrument indicates that the user should refer to a corresponding topic in the manual (marked with the ⚠ symbol) before using the relevant function.
⎓	Indicates DC (Direct Current).

The following symbols in this manual indicate the relative importance of cautions and warnings.

⚠DANGER	Indicates that incorrect operation presents an extreme hazard that could result in serious injury or death to the user.
⚠WARNING	Indicates that incorrect operation presents a significant hazard that could result in serious injury or death to the user.
⚠CAUTION	Indicates that incorrect operation presents a possibility of injury to the user or damage to the instrument.
NOTE	Indicates advisory items related to performance or correct operation of the instrument.

Other symbols

⊘	Indicates a prohibited action.
(p. #)	Indicates the location of reference information.
*	Indicates that descriptive information is provided below.
[ ]	Menus, commands, dialogs, buttons in a dialog, and other names on the screen and the keys are indicated in brackets.

Operating Precautions

Follow these precautions to ensure safe operation and to obtain the full benefits of the various functions.

Preliminary Checks

Before using the instrument for the first time, verify that it operates normally to ensure that no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.

Instrument Installation

Operating temperature and humidity:
5 to 35°C at 80%RH or less (non-condensing)
Temperature and humidity range for guaranteed accuracy:
23±5°C, 80%RH or less (non-condensing)
At least 60 minutes after power-on
Within ±5°C after performing dark correction

Avoid the following locations that could cause an accident or damage to the instrument.

Exposed to direct sunlight
Exposed to high temperature

In the presence of corrosive or explosive gases

Exposed to water, oil, other chemicals, or solvents
Exposed to high humidity or condensation

Exposed to strong electromagnetic fields
Near electromagnetic radiators

Exposed to high levels of particulate dust

Near electromagnetic radiators (e.g., high-frequency induction heating systems and IH cooking utensils)

Subject to vibration

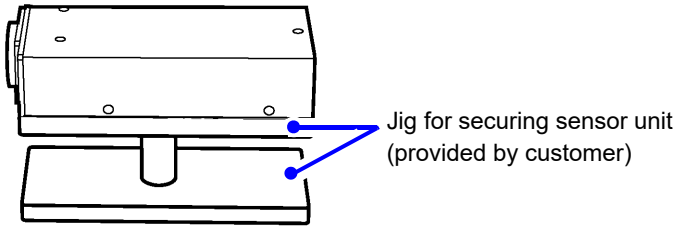
⚠CAUTION

The instrument's sensor unit consists of precision optical components. Dropping the sensor unit or subjecting it to mechanical shock may damage it. Optical components inside the sensor unit may fall out of alignment if the unit is dropped or subjected to mechanical shock, affecting measured values.

Installation

⚠CAUTION

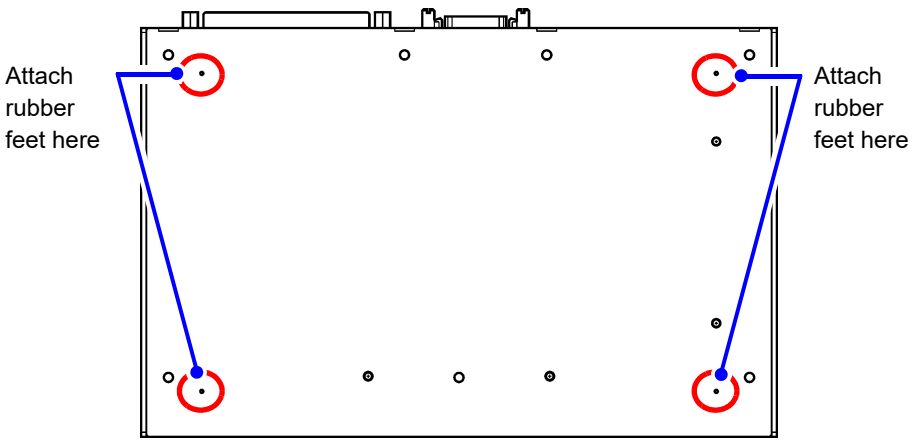
- Do not slant the instrument or place it on top of an uneven surface. Dropping or knocking down the instrument can cause injury or damage to the instrument.
- The instrument's sensor unit consists of precision optical components. The sensor unit should be secure mounted on a jig using the screw hole in its base. Dropping the sensor unit or subjecting it to mechanical shock may damage it.
- When orienting the instrument's main unit 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 main unit.
- 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.



Attaching rubber feet to the main unit

- The instrument ships with four rubber feet for use with the main unit. Attach the rubber feet to the bottom of the instrument as necessary.
- When attaching the rubber feet to the base of the main unit, refer to the following diagram for a rough indication of how the feet should be positioned.

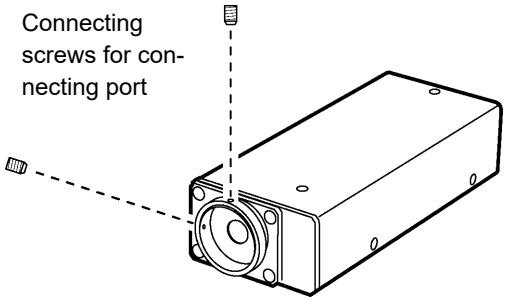
Base of main unit

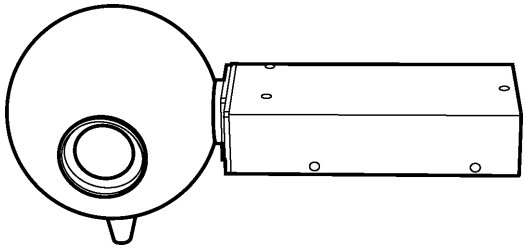


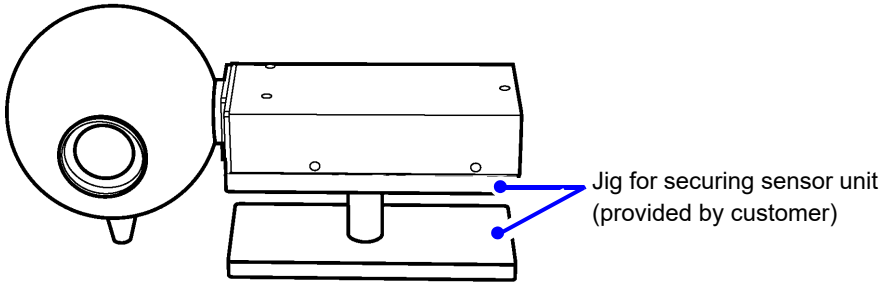
Connecting the sensor unit to an integration sphere

⚠CAUTION

- When connecting the sensor unit to an integration sphere, use the included screws to affix it to the integration sphere's port. If the instrument is not compatible with the size of the integration sphere's port, please contact HIOKI.
- Small pieces of paint may fall out of the screw holes when attaching the screws. Remove any pieces of paint before affixing the instrument to the integration sphere.
- When connecting the sensor unit to the integration sphere, you are responsible for providing a jig to support the sensor unit. Use the screw hole in the base of the sensor unit to attach it securely to the jig.







Handling the Instrument

⚠DANGER

To avoid electric shock, do not remove the instrument's cover and panel. The internal components of the instrument carry high voltages and may become very hot during operation.

⚠WARNING

- **Do not allow the instrument to get wet, and do not take measurements with wet hands. This may cause an electric shock.**
- **Do not use the instrument where it may be exposed to corrosive or combustible gases. The instrument/ device/ product may be damaged or cause an explosion.**

⚠CAUTION

- To avoid damage to the instrument, protect it from physical shock when transporting and handling. Be especially careful to avoid physical shock from dropping.
- The instrument's sensor unit consists of precision optical components. Dropping the sensor unit or subjecting it to mechanical shock may cause operation to diverge from its accuracy specifications. An inspection is necessary in the event the instrument is subject to mechanical shock.
- The upper limit of the instrument's measurement range is 100,000 lx. Do not expose the instrument to light in excess of 100,000 lx. Doing so may cause degradation of the sensor unit's internal optical components.
- This instrument is designed for use indoors. It can be operated at temperatures between 5 and 35°C without degrading safety.
- Do not store or use the instrument where it could be exposed to direct sunlight, high temperature or humidity, or condensation. Under such conditions, the instrument may be damaged and insulation may deteriorate so that it no longer meets specifications.
- This instrument is not designed to be entirely water- or dust-proof. Do not use it in an especially dusty environment, nor where it might be splashed with liquid. This may cause damage.
- This instrument is not drip-proof. Water droplets on the connector may result in malfunctions.
- Do not allow the instrument to get wet, and do not take measurements with wet hands. This may cause an electric shock.
- Do not use the instrument near a source of strong electromagnetic radiation, or near a highly electrically charged object. These may cause a malfunction.
- Do not use the instrument in the vicinity of induction heating equipment (high-frequency induction heating equipment, induction heating cook tops, etc.). Doing so may damage the instrument or cause fire.

NOTE

Correct measurement may be impossible in the presence of strong magnetic fields, such as near transformers and high-current conductors, or in the presence of strong electromagnetic fields such as near radio transmitters.

Handling the sensor unit's detector window

⚠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.
- The detector window is made of glass and should never be subject to mechanical shock. Doing so may damage the detector window.
- Do not use organic solvents other than ethyl alcohol to clean the detector window. Doing so may cause the detector window's performance to deteriorate.
  "Cleaning the sensor unit's detector window" (p.58)

Handling the Cords

⚠WARNING

Before using the instrument, make sure that the insulation on the cords is undamaged and that no bare conductors are improperly exposed. Using the instrument in such conditions could cause an electric shock, so contact your dealer or Hioki representative for replacements.

NOTE

Use only the specified connection cables. Using a non-specified cable may result in incorrect measurements due to poor connection or other reasons.

Handling the AC Adapter

⚠WARNING

Use only the supplied Model 9418-15 AC Adapter. AC adapter input voltage range is 100 to 240 VAC (with ±10% stability) at 50/60 Hz. To avoid electrical hazards and damage to the instrument, do not apply voltage outside of this range.

CD

⚠CAUTION

- Always hold the disc by the edges, so as not to make fingerprints on the disc or scratch the printing.
- Never touch the recorded side of the disc. Do not place the disc directly on anything hard.
- Do not wet the disc with volatile alcohol or water, as there is a possibility of the label printing disappearing.
- To write on the disc label surface, use a spirit-based felt pen. Do not use a ballpoint pen or hard-tipped pen, because there is a danger of scratching the surface and corrupting the data. Do not use adhesive labels.
- Do not expose the disc directly to the sun's rays, or keep it in conditions of high temperature or humidity, as there is a danger of warping, with consequent loss of data.
- To remove dirt, dust, or fingerprints from the disc, wipe with a dry cloth, or use a CD cleaner. Always wipe from the inside to the outside, and do no wipe with circular movements. Never use abrasives or solvent cleaners.
- Hioki shall not be held liable for any problems with a computer system that arises from the use of this disc, or for any problem related to the purchase of a Hioki product.

Before Connecting

⚠WARNING

Before turning the instrument on, make sure the supply voltage matches that indicated on the AC adapter. Connection to an improper supply voltage may damage the instrument or AC adapter and present an electrical hazard.

Chapter 1 Overview

1.1 Product Overview and Features

This section describes the principles by which the Model TM6101 measures light and color.

The instrument's light detector consists of diffusion optics that diffuse incident light and a series of optical sensors that detect the diffused light. The optical sensors detect light by separating the diffused incident light into 16 wavelength regions in the visible spectrum. The characteristics of the 16 optical sensors have been precisely measured with a spectroscope, and correction coefficients that approximate the color matching function have been calculated.

Chromaticity and illuminance are calculated from the strength of the light detected with the 16 optical sensors and the correction coefficients. The sensors use measurement photodiode arrays and microcurrent measurement technology to deliver a high signal-to-noise ratio and high dynamic range.

Illuminance measured with the instrument is calibrated with a luminous intensity standard lamp and HIOKI standard illuminometer*1, while chromaticity is calibrated with a spectral irradiance standard lamp*2.

*1: The standard illuminometer is calibrated by a calibration facility.
*2: The spectral illuminance of the spectral irradiance standard lamp is calibrated by a calibration facility.

High-speed, high-precision measurement of LED light

- The integration time can be set as low as 0.1 ms
- Instrumental error can be corrected using the reference value correction function
- Low incident angle dependence enables illuminance measurement, CIE averaged LED intensity measurement, and light and color measurement while the instrument is attached to an integration sphere.

Measurement items

(1) Illuminance, luminous flux, and luminous intensity
(2) Chromaticity
(3) Color rendering index
(4) Correlated Color Temperature and Δuv
(5) Dominant Wavelength and Excitation Purity

Functionality facilitating automatic testing

Standard USB 2.0 interface

- PC connectivity and automatic control
- High-speed reception of measured values

Digital I/O equipped (p.43)

- Automatic measurement using an external trigger
- Signal output at completion of measurement

Reference value correction function (p.31)

- Correction of instrument sensitivity based on standard light source spectral data provided by the customer and measured values

Auto range function (p.29)

- Auto-ranging at start of measurement, eliminating troublesome adjustments

PC-based instrument control

Instrument ships standard with Windows® software.

- Measurement control and data transfer via PC operation
  Display of measurement results and ability to save data as a CSV file
- Display items
  Illuminance, luminous flux, luminous intensity, chromaticity (xy), color rendering index (R1 to R15, Ra), correlated color temperature, Δuv, dominant wavelength, excitation purity

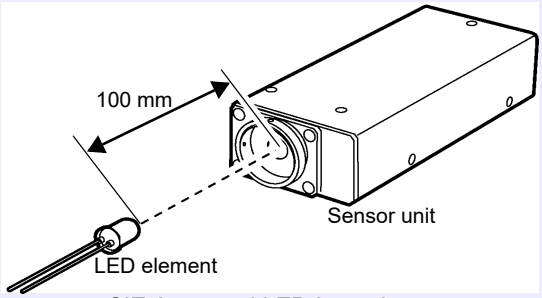
Software development library

- Windows® API
  Enables customer development of Windows software.
- Supported development environments
  Visual Studio® 2017, 2019 (Visual C++®, Visual Basic®, Visual C#®)

Support for a variety of testing applications (p.39)

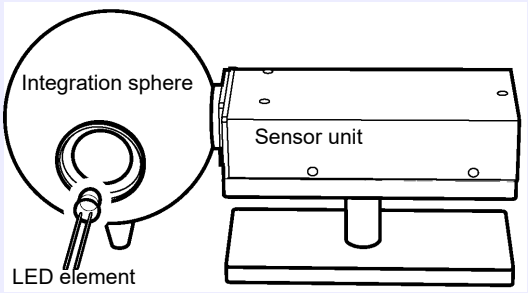
Testing of white LEDs

- Measurement of CIE averaged LED intensity, chromaticity, and color rendering index



CIE Averaged LED Intensity Measurement Setup (0.01 sr)

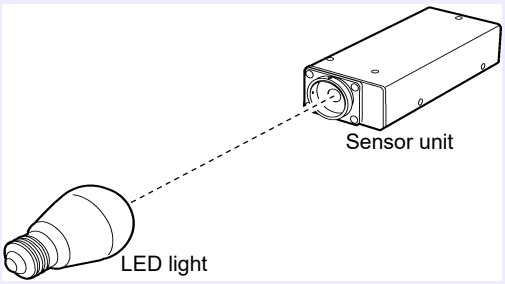
- Measurement of total luminous flux, chromaticity, and color rendering index



Total Luminous Intensity Measurement Setup

Testing of white LED light

- Measurement of illuminance and testing of chromaticity and color rendering index

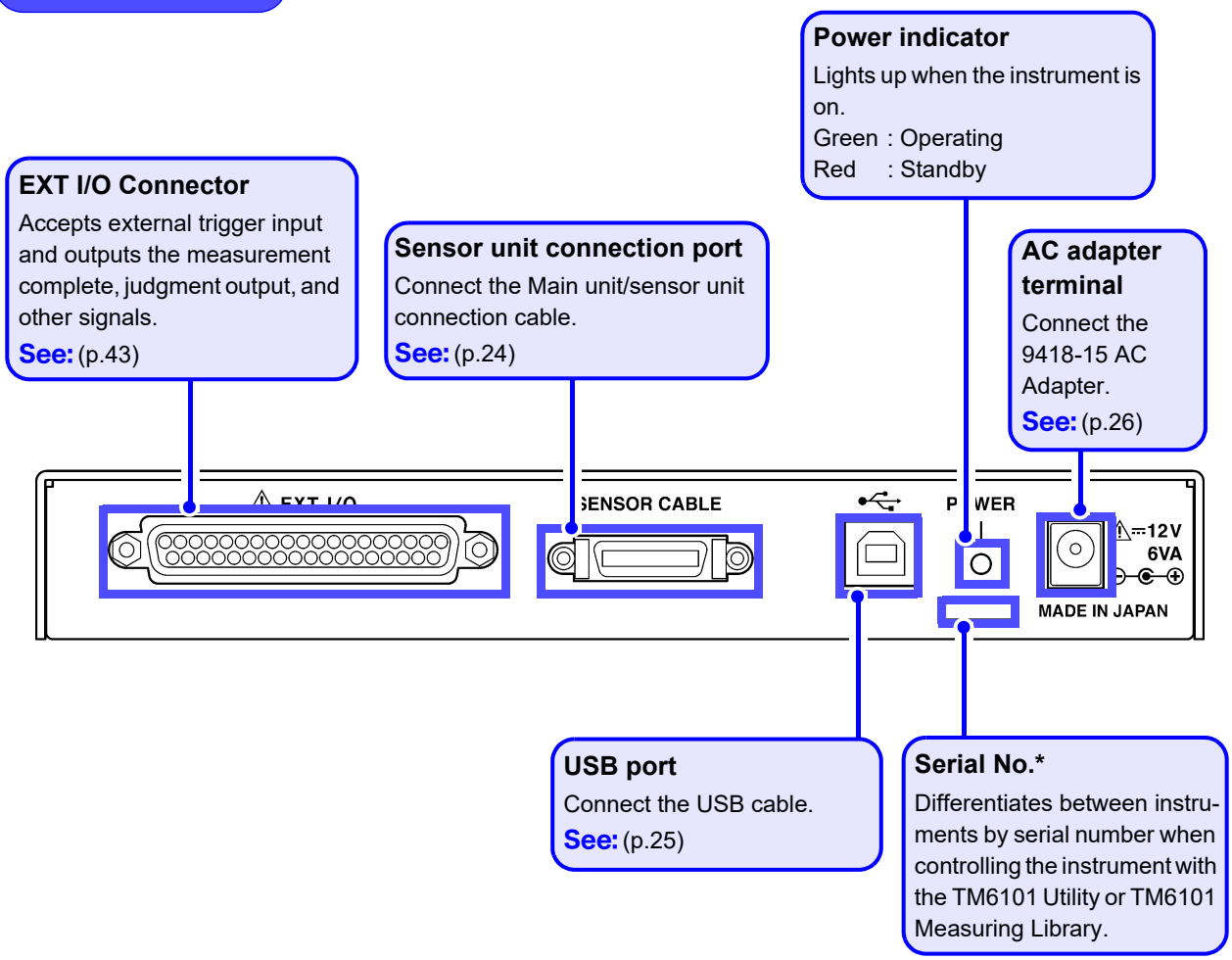


1.2 Names and Functions of Parts

Main Unit

Front panel

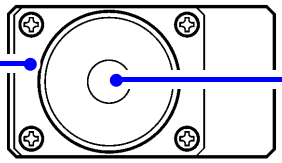
Rear panel



*: Serial number
The first four digits of the 9-digit number indicate the year (the first two digits omitted) and the month of manufacture.

Sensor Unit

Incident light detector window

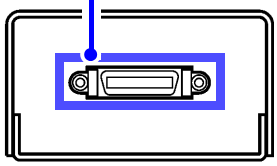


Integration sphere port
Allows an integration sphere to be attached.
See: (p.6)

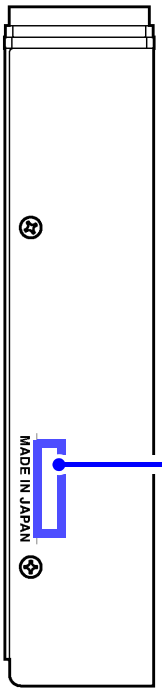
Detector window
Receives light.

Rear panel

Sensor unit connection port
Connect the Main unit/sensor unit connection cable.
See: (p.24)

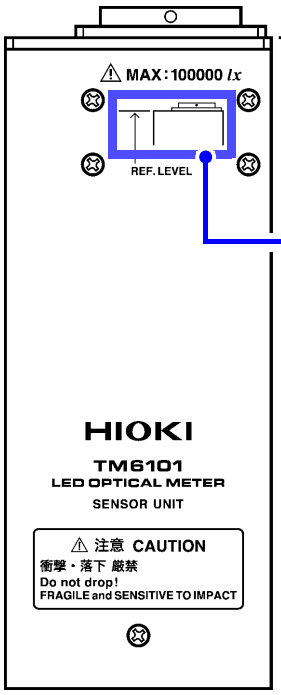


Right side



Serial No.
Differentiates between instruments by serial number when controlling the instrument with the TM6101 Utility or TM6101 Measuring Library.

Top

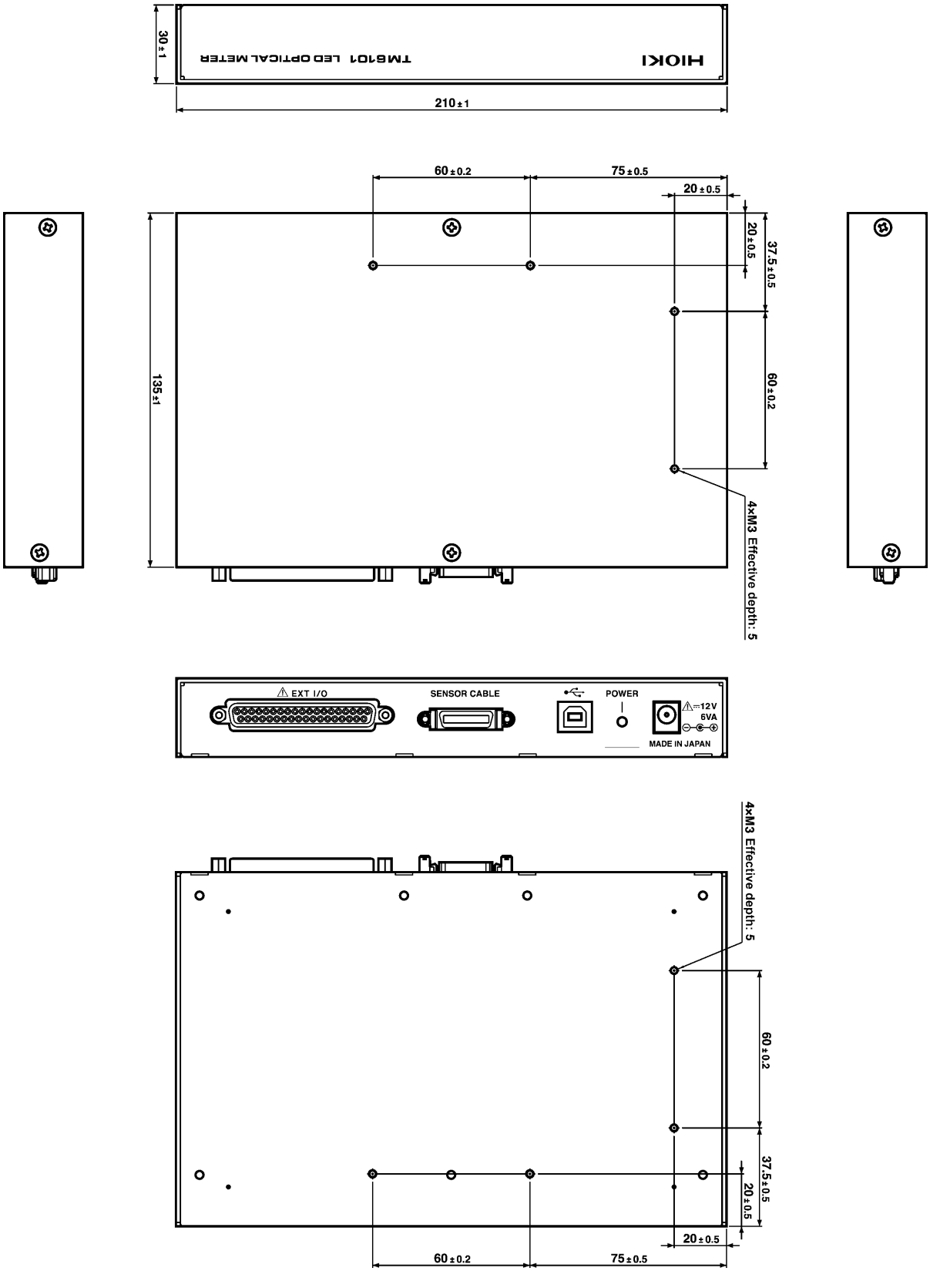


Measurement reference surface
Serves as the measurement reference surface.

Measurement reference surface mark
Indicates the measurement reference surface.

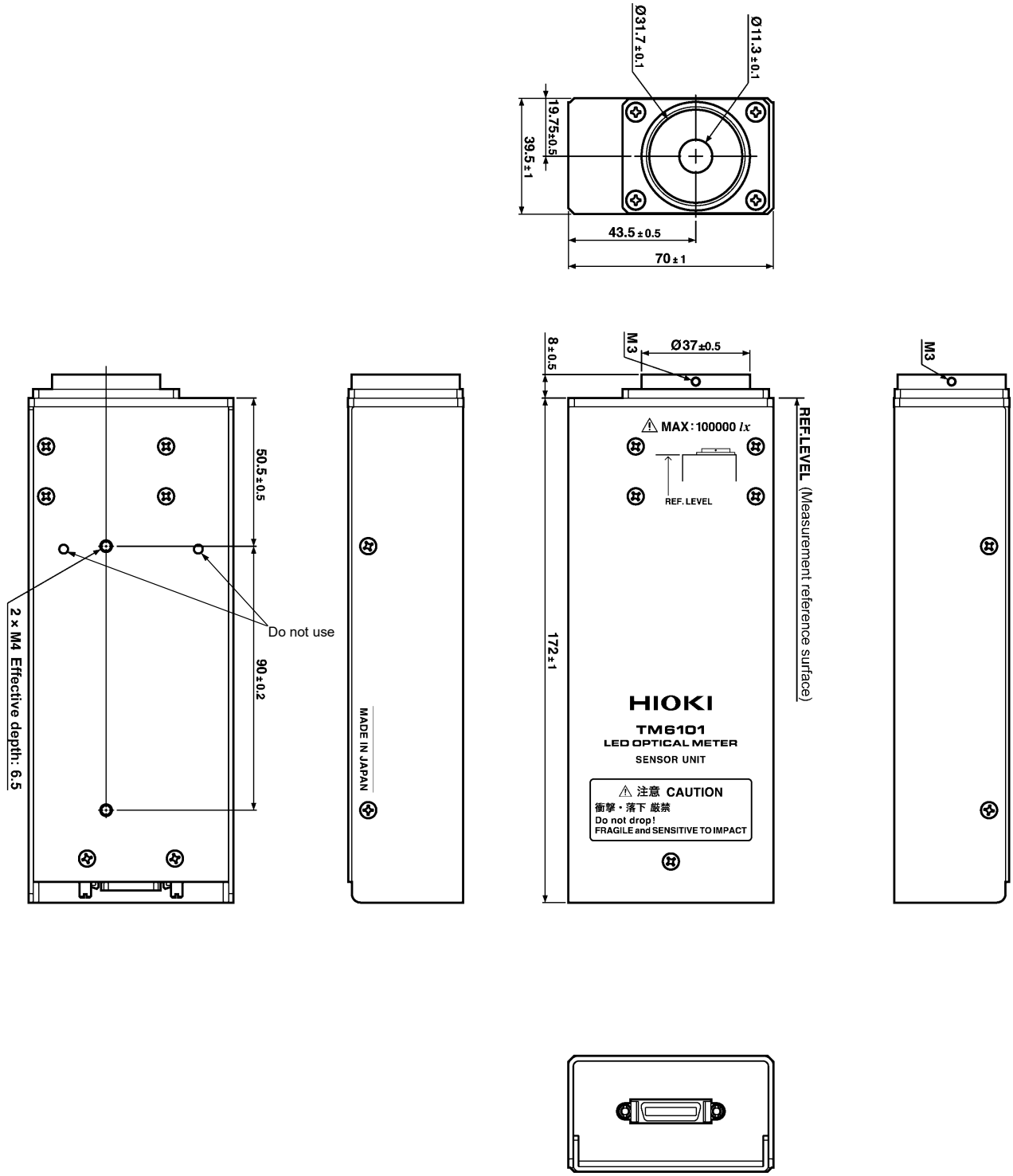
1.3 External Dimensions

Main Unit



Sensor Unit

"REF.LEVEL" indicates the measurement reference surface.



1.4 Measurement Flowchart

Measurement Preparations (p.19)

1. Verify that the sensor unit's detector window is free of dust and dirt and attach the cap.
2. Position the sensor unit (take care not to drop the unit or subject it to mechanical shock).
3. Verify that the AC adapter is not connected to the main unit.
4. Connect the main unit and sensor unit with the dedicated cable and connect the USB cable to the main unit.
5. If using external I/O signals such as an external trigger, verify that the external control device is not turned on and connect it to the main unit, referring to "Chapter 4" (p.43).
6. Connect the AC adapter to the main unit and plug it into an outlet.
7. Turn on the PC (provided by customer).
8. Connect the USB cable connected to the main unit to the PC.
9. Launch the PC application software or open the instrument with the measuring library.
10. Verify that the main unit's power indicator changes from red to green and allow the instrument to warm up for at least 60 minutes.

Settings (p.27)

1. Perform dark correction with the cap affixed to the sensor unit.
2. Set the measurement mode, measurement range, integration time, times of continuous measurement, average times, and external trigger.
3. Set the data to be used in luminous intensity measurement and color rendering index measurement calculations.

Measurement (p.35)

1. Remove the cap.
2. Turn on the LED.
3. Perform continuous measurement with the PC application software or measuring library.
4. Select the measurement range and integration time while verifying each sensor's detection level.

After Completing Measurement

1. Exit the PC application software or perform completion processing with the measuring library.
2. Click the Windows® taskbar and click [Remove USB Device]. (The taskbar may not be displayed on all PCs. If the taskbar is not displayed, this step need not be performed.)
3. Disconnect the USB cable from the PC.
4. Disconnect the AC adapter from the main unit.
5. Attach the cap to the sensor unit.

1.4 Measurement Flowchart

Measurement Preparations Chapter 2

2.1 Installation & Connection Procedures

Be sure to read the "Operating Precautions" (p.4) before installing and connecting this instrument.

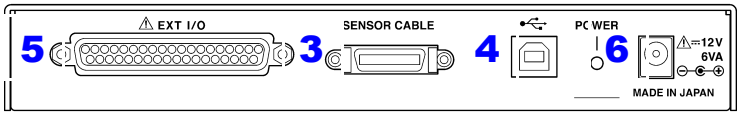
⚠WARNING

- **Always turn both devices OFF when connecting and disconnecting an interface connector. Otherwise, an electric shock accident may occur.**
- **To avoid electric shock, turn off the power to all devices before plugging or unplugging any cables or peripherals.**

⚠CAUTION

- For safety reasons, disconnect the power cord when the instrument is not used.
- Avoid using an uninterruptible power supply (UPS) or DC/AC inverter with rectangular wave or pseudo-sine-wave output to power the instrument. Doing so may damage the instrument.

1 Position the instrument (p.4).
Avoid dropping the instrument or subjecting it to mechanical shock.



Rear panel of main unit

2 Verify that the sensor unit's detector window is free of dust and dirt and attach the cap.

3 Verify that the AC adapter is not connected to the main unit and connect the main unit and sensor unit with the cable (p.24).
Be sure to use the same serial number for the main unit and sensor unit.

4 Connect the USB cable to the main unit (p.25).

5 If using external I/O signals such as an external trigger, verify that the external control device is not turned on and connect it to the main unit (p.43).

6 Connect the AC adapter to the main unit and plug it into an outlet (p.26).

7 Turn on the PC (provided by customer).

8 Connect the USB cable connected to the main unit to the PC (p.25).

9 Open the instrument with the PC application software or measuring library.
(See TM6101 Utility Instruction Manual or TM6101 Measuring Library Instruction Manual)

The main unit's power indicator will change from red to green. Allow the instrument to warm up for at least 60 minutes.

2.2 Installing the Software

System Requirements

Computer	CPU : 1 GHz or h igher OS : Windows 7 (32 bit/ 64bit), Windows 8 (32 bit/ 64 bit), Windows 10 (32 bit/ 64 bit) (Japanese or English)
Memory	At least 1 GB
Display	1920 × 1080 dots resolution, At least 256 colors
Hard disk	At least 100 MB of empty space
Interface	USB2.0 or higher
CD-ROM drive	For installing software

Recommended System

Computer	CPU : 1.7 GHz or higher OS : Windows 10
Memory	At least 1 GB
Display	1920 × 1080 dots resolution, At least 64000 colors
Hard disk	At least 100 MB of empty space
Interface	USB2.0 or higher
CD-ROM drive	For installing software

NOTE

TM6101 Utility performance may lag depending on your PC's operating environment and the type of any application software being run concurrently. It is recommended to use the software on a system that meets or exceeds the specifications described in "Recommended System" above.

Installing Hardware Drivers

Perform this procedure before connecting the main unit to the PC with a USB cable. If already connected, disconnect the USB cable while you perform the procedure.
Use the software that came with the product (latest version). Using an earlier version of the software may cause the system to fail to work correctly.

Installation Procedure

1 **Log into the PC using the "administrator" account or other account with administrative privileges.**

2 **Exit all applications running on the PC before installing the hardware drivers.**

3 **Execute the following software from the TM6101 Utility Disc (CD):**

- For a 32-bit Windows system:
X:\driver\x32\dpinst.exe (where **X:** indicates the CD-ROM drive)

- For a 64-bit Windows system:
X:\driver\x64\dpinst.exe (where **X:** indicates the CD-ROM drive)

After executing dpinst.exe, follow the instructions on the screen to continue the installation.

A warning message will be displayed since the software has not been certified under the Windows® logo program. Continue the installation.

4 **Once the installation is complete, the TM6101 will be automatically detected when the main unit is connected to the PC with a USB cable.**

If the "Found New Hardware" wizard dialog box is displayed, select **[No, not this time]** under "Can Windows connect to Windows® Update to search for software?" and select **[Install the software automatically]**.

A warning message will be displayed since the software has not been certified under the Windows logo program. Continue the installation.

Uninstallation Procedure

Select [Control Panel]-[Add and Remove Programs] and delete Windows Driver Package - HIOKI TM6101 Driver Package.

Installing PC application software

Installation Procedure

1 **Log into the PC using the "administrator" account or other account with administrative privileges.**

2 **Exit all applications running on the PC before installing the software.**

3 **Execute X:\installer\english\setup.exe from the TM6101 Utility Disk (CD) (where X: indicates the CD-ROM drive).**
After executing setup.exe follow the instructions on the screen to continue the installation.

You may be required to restart the PC during the installation. If the installation fails to resume after restarting the PC, run **setup.exe** again. A warning message will be displayed since the software has not been certified under the Windows® logo program. Continue the installation.

4 **Once the installation is complete, make all the necessary connections and then launch the program by selecting [Programs]-[HIOKI]-[TM6101]-[TM6101 Utility].**

See: "2.4 Connecting the Sensor Unit" (p.24)
"2.5 Connecting the USB Cable" (p.25)
"2.6 Connecting the AC Adapter" (p.26)

NOTE

- Do not launch the program before connecting the main unit and PC.
- Use the software that came with the product (latest version). Using an earlier version of the software may cause the system to fail to work correctly.

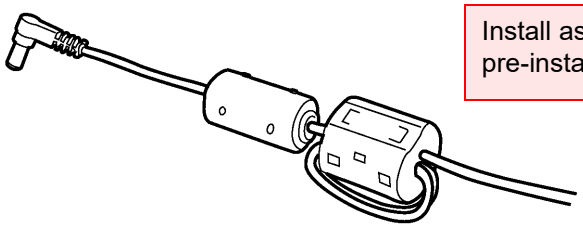
Uninstallation Procedure

Select [Control Panel]-[Add and Remove Programs] and delete TM6101 Utility.

2.3 Install the Ferrite Cores

In order to prevent malfunctions due to external magnetic waves, install ferrite cores onto the AC adapter, main unit/sensor unit connection cable, and USB cable.

1 **Install a ferrite core onto the AC adapter.**

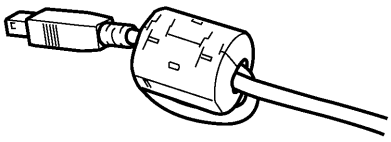


Install as close as possible to the pre-installed ferrite core.

Wrap the output side of the cable two times around the ferrite core.

2 **Verify that a ferrite core has been attached to the main unit/sensor unit connection cable.**

3 **Install a ferrite core onto the USB cable.**



Wrap the USB cable once around the ferrite core.

Install the ferrite core as close as possible to the connector which connects to the main unit (B plug side).

NOTE Close the ferrite core until it makes a clicking sound.

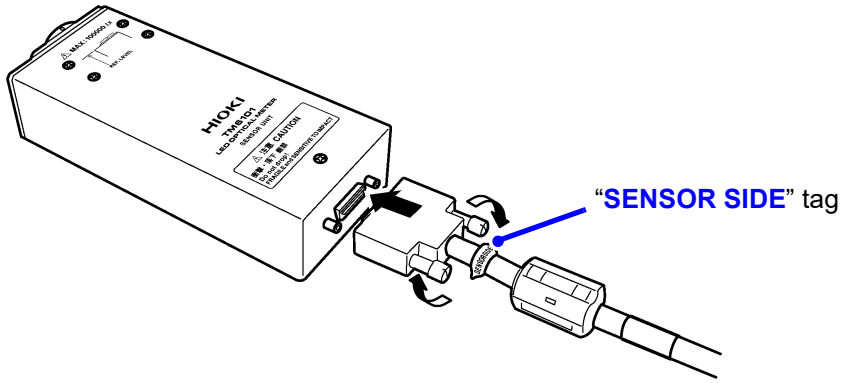
2.4 Connecting the Sensor Unit

Connection procedure

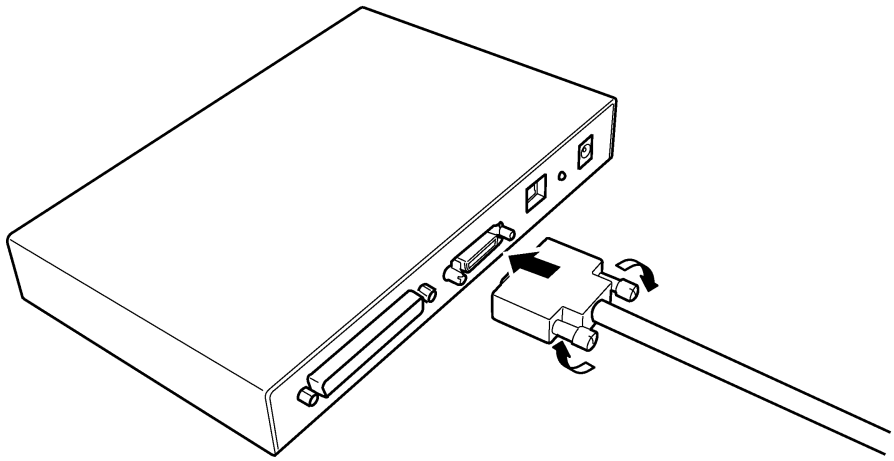
1 **Confirm the following.**

☐ The AC adapter is not connected to the main unit.
☐ The cap is attached to the sensor unit.

2 **Connect the "SENSOR SIDE" of the main unit/sensor unit connection cable to the sensor unit.**
Tighten the connector securely in place with the mating screws.



3 **Connect the other end of the cable to the main unit's sensor unit connection port and tighten the connector securely in place with the mating screws.**



NOTE Be sure to use the same serial number for the main unit and sensor unit.

2.5 Connecting the USB Cable

Connection procedure

1 **Connect the USB cable to a USB port on the main unit.**

2 **Connect the AC Adapter.**

See: "2.6 Connecting the AC Adapter" (p.26)

3 **If your'e connecting the instrument to the PC for the first time, install the included software.**

See: "2.2 Installing the Software" (p.20)

NOTE Be sure to install the software before connecting the USB cable.

4 **Verify that the PC has started up and connect the other end of the cable to a USB port on the PC.**

2.6 Connecting the AC Adapter

Use only the supplied Model 9418-15 AC Adapter.

⚠WARNING

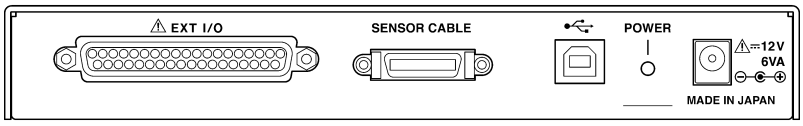
- **Before turning the instrument on, make sure the supply voltage matches that indicated on the AC adapter. Connection to an improper supply voltage may damage the instrument or AC adapter and present an electrical hazard.**
- **To avoid electrical accidents and to maintain the safety specifications of this instrument, connect the power cord only to a 3-contact (two-conductor + ground) outlet.**

⚠CAUTION

- Be careful to avoid connecting the supply voltage improperly. Doing so may damage the instrument's internal circuitry.
- To avoid damaging the power cord, grasp the plug, not the cord, when unplugging it from the power outlet.

Connection procedure

Rear panel of main unit

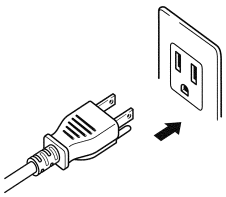


1 **Confirm the following.**

☐ The AC adapter is not connected to the main unit.
☐ The cap is attached to the sensor unit.
☐ The main unit and sensor unit have been connected with the dedicated cable.

2 **Confirm that the mains supply voltage matches the instrument, and connect the power cord to the power inlet on the main unit.**

3 **Plug the power cord into the mains outlet.**



2.7 Configuring the Instrument for Measurement

For more information about how to operate the instrument, see the Instruction Manual on the included CD.

- Configuring the instrument with the included software → TM6101 Utility Instruction Manual
- Configuring the instrument with library functions → TM6101 Measuring Library Instruction Manual

Setting the Measurement Mode

The instrument can take measurements in either of two measurement modes.

Normal measurement mode

Use this mode when measuring DC-powered light sources.
The sensitivity range and integration time can be set.

See: "Setting the Sensitivity Range" (p.28)
"Setting the Integration Time" (p.28)

AC measurement mode

Use this mode when measuring AC-powered light sources (light sources powered at an AC commercial frequency). When using AC measurement mode, the integration time will be adjusted to reflect the period of the power supply, allowing stable measurement. The power frequency and measurement range (3 settings) can be set.

(1) Power frequency: 50/60 Hz

(2) Measurement range

The measurement sensitivity of each range is as follows:
Range 1: × 1
Range 2: × 9
Range 3: × 63

Setting the Sensitivity Range

The sensitivity range is set by sensor pair. It can be set in normal measurement mode.

The sensitivity range can be set to either high or low. Setting the sensitivity range to high enables measurement of dim light sources. This parameter should be set after checking the detection level for each sensor. Accurate measurement is not possible when the detection level reaches 100%. The sensitivity range should be set in combination with the integration time.

The measurement sensitivity for each sensitivity range is as follows:

Low : × 1
High : × 7 (Setting cannot be used when the integration time is 0.1 ms.)

The instrument takes measurements using 16 optical sensors with different optical characteristics. Each pair of sensors has its own measurement range setting.

Sensor 1 Sensor 2	Sensor 3 Sensor 4	Sensor 5 Sensor 6	Sensor 7 Sensor 8	Sensor 9 Sensor 10	Sensor 11 Sensor 12	Sensor 13 Sensor 14	Sensor 15 Sensor 16
High/ Low	High/ Low	High/ Low	High/ Low	High/ Low	High/ Low	High/ Low	High/ Low

The sensor's sensitivity characteristics are as follows:

Sensor 1, Sensor 2, ..., Sensor 16
Wavelength sensitivity characteristics: 380 nm ← → 780 nm

Setting the Integration Time

This section describes how to set the integration time. The following settings are available in normal measurement mode:

0.1 (low sensitivity range only), 0.5, 1.0, 2.0, 4.0, 8.0, 10.0, 16.666, 20.0, 33.333, 40.0 ms (in the TM6101 Utility, 16.666 ms is displayed as 16.7 ms, and 33.333 ms is displayed as 33.3 ms)

Set the integration time after checking the detection level for each sensor. It is recommended to set the integration time so that the maximum detection level for each sensor is 10% to 90%. The integration time should be set in combination with the sensitivity range. Note that accurate measurement is not possible when the detection level reaches 100%. Since stable measurement is not possible when the maximum detection level for each sensor is extremely low (for example, less than 1%), a longer integration time setting should be used in that situation.

Configuring Auto-range Operation

When auto-ranging is set to “on”, auto-range operation is performed before each measurement is started.

Auto-ranging checks the detection level for each sensor and controls its sensitivity range and integration time accordingly. The auto-range function cannot control both the sensitivity range and integration time at the same time. Auto-range operation can only be used in normal measurement mode. This functionality is not available in AC measurement mode.

The following auto-range settings are available:
- Auto range: OFF
- Auto range: ON (integration time)
- Auto range: ON (sensitivity range)

When using auto-ranging, it is recommended to take measurements using the “ON (integration time)” setting.

Setting the Detection Level Upper and Lower Limits

The detection level upper and lower limits must be set when using the auto-range function.

After auto-range operation has been performed, the integration time or sensitivity range is controlled so that the maximum detection level for the optical sensors falls within the range defined by the upper and lower limits.

When the upper and lower limits are close (for example, when the difference between them is less than 50%), it may be impossible to control the integration time or sensitivity range so that the maximum optical sensor detection level falls between the upper and lower limits.

The upper and lower limits should be set so that they differ by at least 50%.

The detection level upper and lower limit settings cannot be configured with the TM6101 Utility. Instead, use the measuring library.

Setting the Average Times

Averaging will be performed the specified number of times.

Average times: 1 to 100

Setting a Trigger

Measurement can be synchronized with an input signal by setting a trigger.

Trigger type
EXT: Enables the external trigger.
INT: Disables the external trigger.

Trigger edge
Sets the trigger signal polarity to either rising or falling.

Trigger delay
Sets the delay from the trigger signal to the start of measurement. When the external trigger is disabled, the trigger delay does not function.

For more information about external trigger timing, see "4.2 Timing Chart" (p.46).

Setting Calculation Data

(1) Measurement length (mm) for luminous intensity measurement

The measurement length (mm) must be set when measuring luminous intensity.

Measurement length refers to the distance from the light source to the sensor unit's measurement reference surface. The instrument measures luminous intensity by measuring the solid angle at which light enters the detector window from the measurement length. This parameter must be set when measuring luminous intensity.

The measurement length will be 100 (mm) when performing CIE averaged LED intensity Condition B measurement.

(2) Reference light source for evaluating the color rendering index

This parameter sets the reference light when measuring the color rendering index.

It should typically be set to "[Black Body]" when the correlated color temperature for the light source being measured is less than 5000 K and to "[Daylight CIE]" when the correlated color temperature is 5000 K or greater.

Performing Dark Correction

Dark measurement is performed prior to measurement in order to obtain dark-corrected measurement results.
If dark correction if not performed, you will not be able to obtain normal measured values. Be sure to perform dark measurement before making measurements.

See: "Dark Correction" (p.32)

2.8 Using Correction Functions

The instrument offers the following correction functions. For more information about function operation, see the Instruction Manual on the included CD.

- Configuring the instrument with the included software → TM6101 Utility Instruction Manual
- Configuring the instrument with library functions → TM6101 Measuring Library Instruction Manual

(1) Dark Correction

Dark measurement is performed in order to yield measure values from which dark values have been subtracted.

(2) Chromaticity Correction

The instrument's chromaticity measured values can be adjusted to match chromaticity measured values from a spectral-type measuring instrument that is being use as a reference instrument.

(3) Illuminance Correction

Corrects the instrument's illuminance measured values.

(4) Luminous Intensity Correction

Corrects the instrument's luminous intensity measured values.

(5) Luminous Flux Correction

Corrects the instrument's luminous flux values.

Dark Correction

- Dark measurement is performed before measurement (after a warm-up period of at least 60 minutes) in order to obtain dark-corrected measurement results. If dark correction if not performed, you will not be able to obtain normal measured values. Be sure to perform dark measurement before making measurements.
- In order to obtain higher-precision measurement results, repeat dark measurement if the ambient air temperature changes after performing dark measurement.
- Once dark measurement has been performed, dark value-corrected values will be applied to measurement results. Dark measurement results are valid until the instrument is turned off.
- If dark measurement is not performed after turning on the instrument, the default dark correction values (with which the instrument shipped) will be applied to measurement results. However, when using the TM6101 Utility, the previous dark value correction results will be applied to measurement results since the correction values are saved by the PC.

Dark measurement can be performed by using either the following two methods:

Perform dark measurement for all integration time and sensitivity range settings.
This approach takes more time but eliminates the need to repeat dark measurement when the integration time or sensitivity range settings are changed. When enabling auto-range operation (p.29), dark measurement must be performed for all integration time and sensitivity range settings.

Perform dark measurement for the current integration time and sensitivity range settings.
This approach takes less time, but dark measurement must be performed whenever the integration time and sensitivity range settings are changed.

Procedure

1 **Attach the cap to the sensor unit.**

2 **Perform dark measurement.**

The average times setting can be configured for dark measurement.
Average times: 1 to 100

Chromaticity Correction

A spectral irradiance standard lamp (JPD100-500CS) is used to calibrate the optical power axis for spectral-type measuring instruments. Spectral irradiance standard lamps are evaluated by third-party calibration facilities, but uncertainty remains for each wavelength.
In short, the uncertainty in calibrated values for the spectral irradiance standard lamp used by HIOKI as a chromaticity reference and the spectral irradiance standard lamp you're using as a reference differ. This difference in calibration values will affect chromaticity and other values as instrumental error. By using the chromaticity correction function, it is possible to correct this difference.

NOTE

Measurement error may result for certain relationships between the emission spectra for the light source used to perform chromaticity correction and the object being measured. For example, using a blue LED as the reference correction light source may prevent accurate correction due to noise in measured values from the reference instrument and this instrument since there is no emission spectrum for the red region. When a white LED is measured under these circumstances, measurement error will result. A light source with an emission spectrum across the entire visible region, such as a spectral irradiance standard lamp, is ideal.

Procedure

1 **Measure the spectral characteristics of the chromaticity correction target light source with the reference instrument (spectral-type measuring instrument) and prepare a text file of the measurement results. Spectral measurement results for every 5 nm from 380 nm to 780 nm are needed. The measurement results file should be saved in the format "wavelength (nm), measured value (NR3 format), carriage return..." as shown below.**

Example measurement results file format:

```
380, 2.93097E-13
385, 3.02346E-13
390, 1.98844E-13
395, 1.21438E-13
400, 1.11047E-13
405, 1.88709E-13
  ⋮
770, 3.36329E-13
775, 4.10941E-13
780, 2.38844E-13
```

2 **Measure the chromaticity correction target light source with the instrument.**

3 **Load the measurement results file and perform chromaticity correction.**

Illuminance Correction

Illuminance varies with the distance from the light source to the detector window (sensor unit measurement reference surface). Illuminance measurements from the instrument are adjusted to match illuminance reference values.

Measure the illuminance correction target light source with the instrument and perform illuminance correction.

Luminous Intensity Correction

Luminous intensity values measured by the instrument are adjusted to match luminous intensity values for a luminous intensity-calibrated light source.

Measure the luminous intensity correction target light source with the instrument and perform luminous intensity correction.

Luminous Flux Correction

When measuring luminous flux using an integration sphere, the luminous flux that enters the integration sphere is diffused and reflected inside the sphere, and only some of the light enters the detector window. To address this issue, luminous flux values are corrected using a light source for which luminous flux has been calibrated.

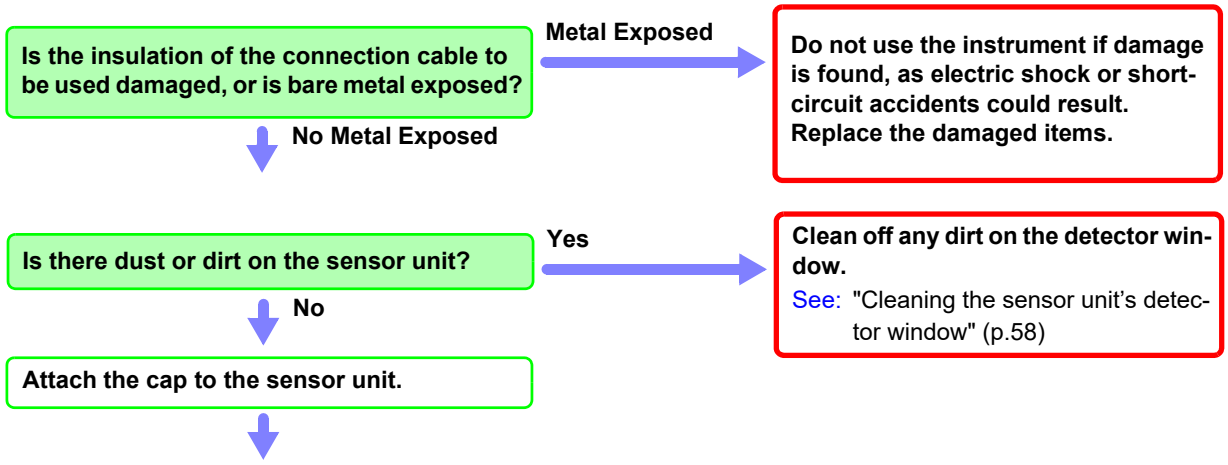
Measure the luminous flux correction target light source with the instrument and perform luminous flux correction.

Measurement Chapter 3

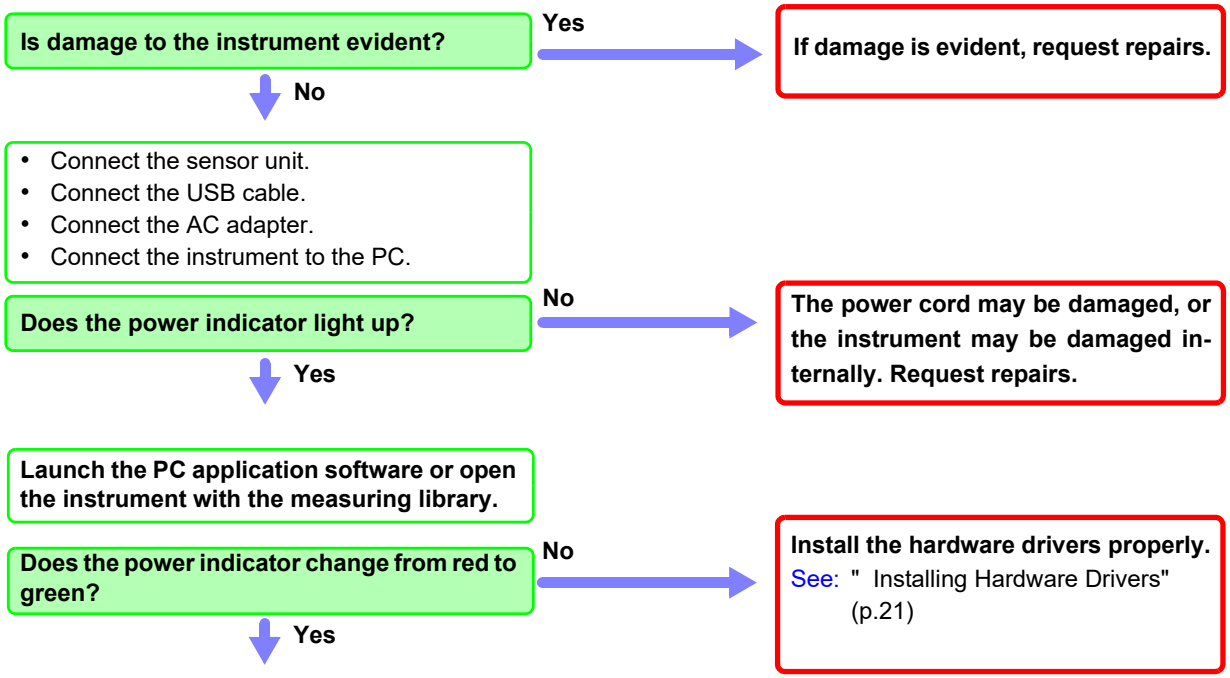
3.1 Pre-Operation Inspection

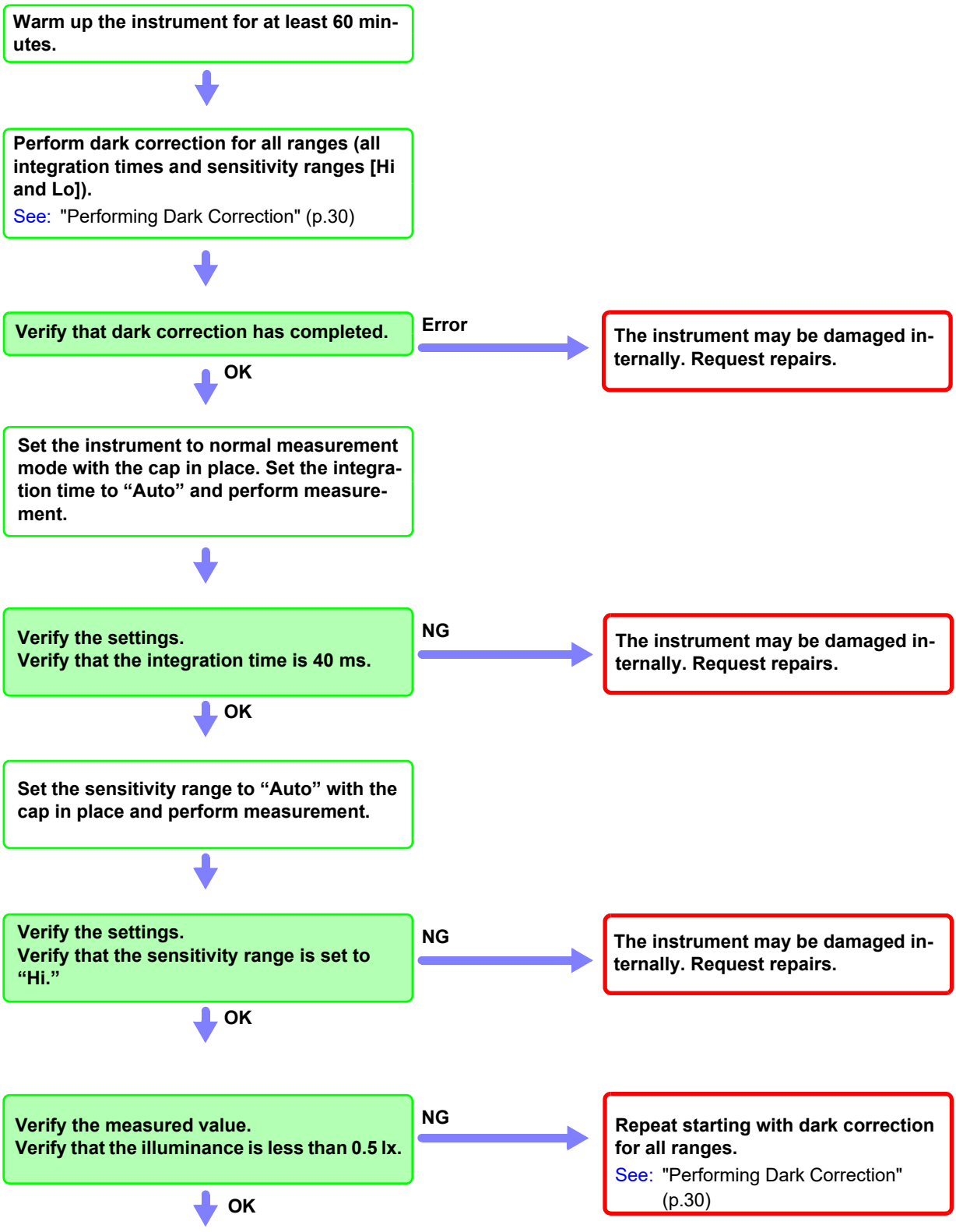
Before using the instrument the first time, verify that it operates normally to ensure that the no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.

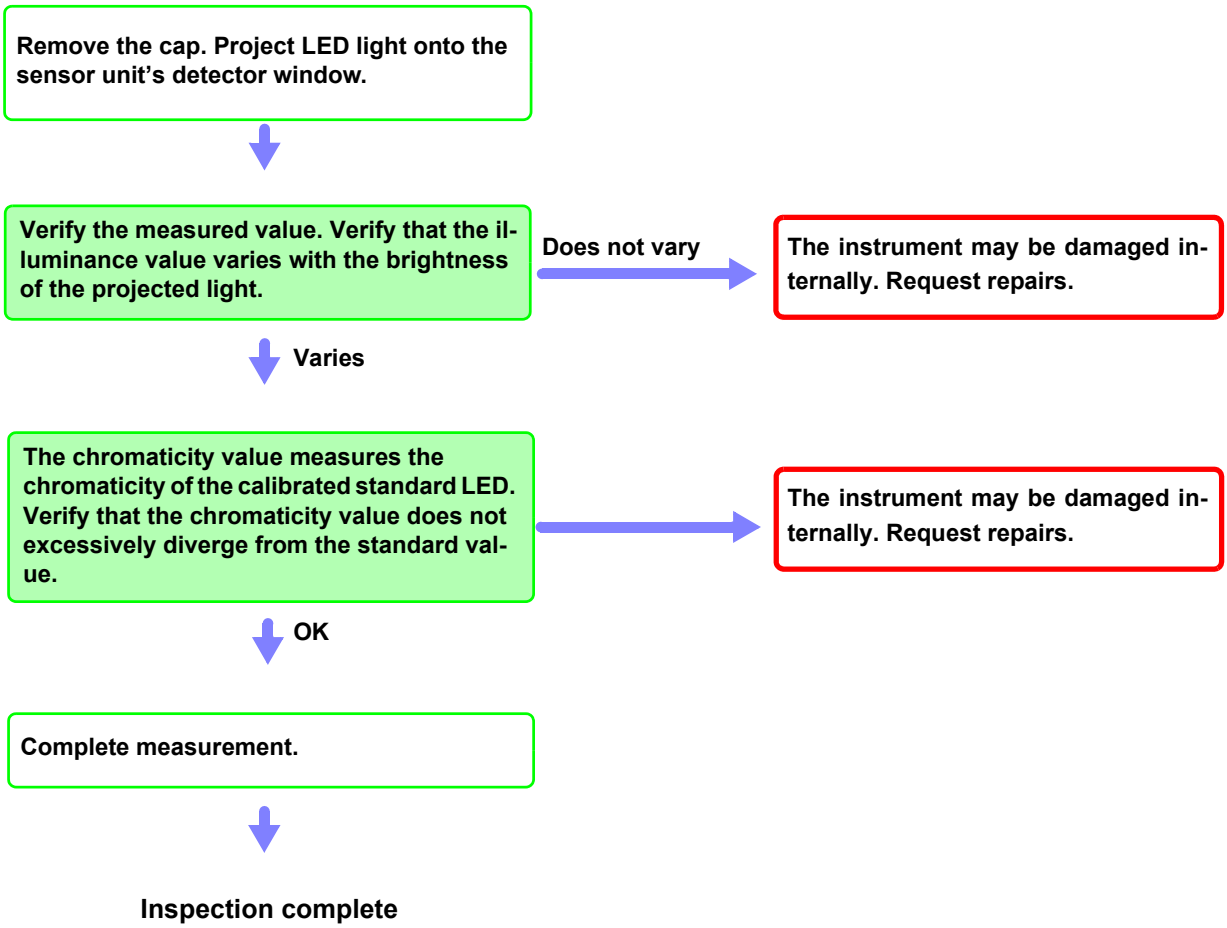
1 Peripheral Device Inspection



2 Instrument Inspection




Warm up the instrument for at least 60 minutes.
Perform dark correction for all ranges (all integration times and sensitivity ranges [Hi and Lo]).
See: "Performing Dark Correction" (p.30)
Verify that dark correction has completed.
Error
The instrument may be damaged internally. Request repairs.
OK
Set the instrument to normal measurement mode with the cap in place. Set the integration time to "Auto" and perform measurement.
Verify the settings.
Verify that the integration time is 40 ms.
NG
The instrument may be damaged internally. Request repairs.
OK
Set the sensitivity range to "Auto" with the cap in place and perform measurement.
Verify the settings.
Verify that the sensitivity range is set to "Hi."
NG
The instrument may be damaged internally. Request repairs.
OK
Verify the measured value.
Verify that the illuminance is less than 0.5 lx.
NG
Repeat starting with dark correction for all ranges.
See: "Performing Dark Correction" (p.30)
OK


Remove the cap. Project LED light onto the sensor unit's detector window.
Verify the measured value. Verify that the illuminance value varies with the brightness of the projected light.
Does not vary
The instrument may be damaged internally. Request repairs.
Varies
The chromaticity value measures the chromaticity of the calibrated standard LED. Verify that the chromaticity value does not excessively diverge from the standard value.
The instrument may be damaged internally. Request repairs.
OK
Complete measurement.
Inspection complete

3.2 Measurement

This section describes how to measure the luminous intensity, illuminance, luminous flux, color characteristics (chromaticity and color rendering index) for a light source that serves as the measurement target.

Measurements can be made using the following two methods:

(1) Conducting measurements using the PC application software
(2) Building software and making measurements using library functions

Conducting Measurements Using the PC application software

1 **Install the hardware drivers and PC application software.**
See: "2.2 Installing the Software" (p.20)

2 **Prepare for measurement.**
See: "1.4 Measurement Flowchart" (p.17)
"2.7 Configuring the Instrument for Measurement" (p.27)

3 **Once you have prepared for measurement, follow the instructions in the TM6101 Utility Instruction Manual.**

Building Software and Making Measurements Using Library Functions

You can also use the included library to build software for performing measurements with the instrument.

1 **Install the hardware drivers and PC application software.**
See: "2.2 Installing the Software" (p.20)

2 **Build measurement software, referring to the reference information in the TM6101 Measuring Library Instruction Manual as necessary.**

3 **In order to use the measurement software you have developed, it is necessary to install hardware drivers and DLLs. These files should be redistributed as necessary to users of the software. Such redistribution is authorized only for systems using the instrument.**

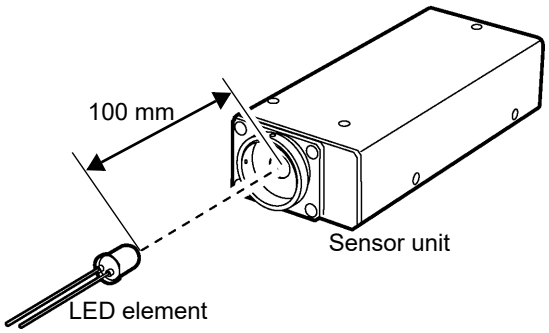
3.3 Measurement Example

For more information about how to operate the instrument, see the Instruction Manual on the included CD-R disc.

- Configuring the instrument using the included software:
  TM6101 Utility Instruction Manual
- Configuring the instrument using library functions:
  TM6101 Measuring Library Instruction Manual

Measuring CIE Averaged LED Intensity, Chromaticity, and Other Properties

(1) The area of the detector window is 100 mm^2. By placing a white LED (the measurement target) and the sensor unit's measurement reference surface 100 mm apart, it is possible to make measurements that comply with CIE averaged LED intensity Condition B. Alternately, by changing the distance to 316 mm, it is possible to make measurements that comply with Condition A.



CIE averaged LED intensity measurement setup (0.01 sr)

CIE Averaged LED Intensity Condition B
(see JIS standard JISC8152)

(2) Setting the instrument's calculation data

Set the measurement distance (mm).

(3) Configuring measurement settings

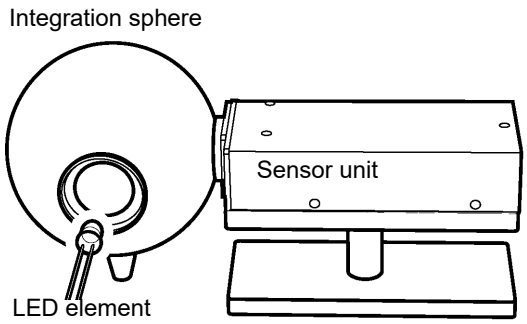
Check the detection level and set the integration time and sensitivity range.

(4) Making measurements.

- Measure chromaticity.
- Measure luminous intensity.
- Measure color rendering index.
- Measure correlated color temperature.

Measuring Total Luminous Flux, Chromaticity, and Other Properties Using an Integration Sphere

(1) Setting up the optical components



Total Luminous Flux Measurement Setup

(2) Calibrating luminous flux values

1. When using an integration sphere to make measurements, only some of the light that diffuses inside the sphere is measured. Consequently, the LED's total luminous flux does not match the luminous flux as measured with the instrument. It is necessary to correct luminous flux values so that the LED's total luminous flux matches the luminous flux values obtained with the instrument.
   See: "Luminous Flux Correction" (p.34)
2. Prepare the LED that will be used to calibrate total luminous flux.
3. Load the calibration value file that you have prepared.
4. Configure settings and measure the LED with the instrument.
5. Perform the correction function.

(3) Positioning the measurement target LED

Fix the measurement target LED in place, referring to the diagram in "Setting up the optical components" as necessary.

(4) Configuring the instrument

Check the detection level and set the integration time and sensitivity range.

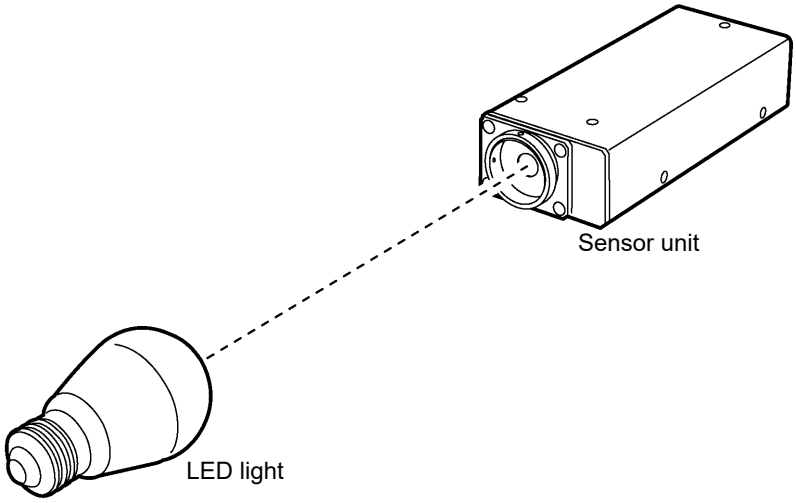
(5) Making measurements

- Measure chromaticity.
- Measure total luminous flux.
- Measure color rendering index.
- Measure correlated color temperature.

Measuring the Brightness, Chromaticity, and Color Rendering Index of a Light

(1) Setting up the optical components

When using a LED bulb or similar light, fix it in place at a distance of 1 m.



(2) Configuring the instrument

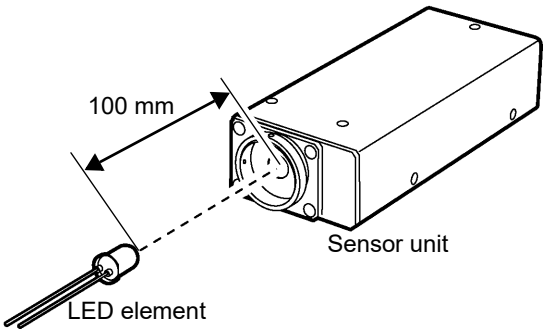
Check the detection level and set the integration time and sensitivity range.

(3) Making measurements

- Measure chromaticity.
- Measure illuminance.
- Measuring color rendering index.
- Measure correlated color temperature.

More Rigorous Chromaticity and Luminous Intensity Measurement (Comparison with a Calibrated Sample)

(1) Setting up the optical components



CIE averaged LED intensity setup (0.01 sr)

CIE Averaged LED Intensity Condition B
(see JIS standard JISC8152)

(2) Calibrating chromaticity values

1. Prepare an LED whose emission spectrum (380 to 780 nm, in 5 nm steps) has been calibrated.
2. Load the calibration values (emission spectrum).
3. Configure settings and measure the LED with the instrument.
4. Perform the correction function.

(3) Calibrating luminous intensity values

1. Prepare an LED whose luminous intensity has been calibrated.
2. Fix the LED in place so that the distance to the sensor unit's measurement reference surface is 100 mm, referring to the diagram in "Setting up the optical components" as necessary.
3. Configure the instrument's calculation data (set the measurement length to 100 mm).
4. Configure settings (integration time, etc.) and measure the LED with the instrument.
5. Perform the correction function.

(4) Positioning the measurement target LED

Fix the measurement target LED in place, referring to the diagram in "Setting up the optical components" as necessary.

(5) Configuring the instrument

Check the detection level and set the integration time and sensitivity range.

(6) Making measurements

- Measure chromaticity.
- Measure luminous intensity.

Chapter 4 External Control

The EXT I/O connector on the rear of the main unit supports external control by providing output of the end-of-measurement, and accepting input of measurement trigger. All signals are isolated by optocouplers (inputs and outputs share a common signal ground).

Confirm input and output ratings, understand the safety precautions for connecting a control system, and use accordingly.

4.1 External Input/Output Connector and Signals

⚠WARNING

To avoid electric shock or damage to the equipment, always observe the following precautions when connecting to the EXT I/O terminals.

- **Always turn off the power to the instrument and to any devices to be connected before making connections.**
- **During operation, a wire becoming dislocated and contacting another conductive object can be serious hazard. Use screws to secure the external connectors.**
- **Ensure that devices and systems to be connected to the EXT I/O terminals are properly isolated.**

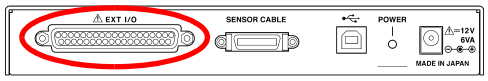
⚠CAUTION

To avoid damage to the instrument, observe the following cautions:

- Do not apply voltage or current to the EXT I/O terminals that exceeds their ratings.
- When driving relays, be sure to install diodes to absorb counter-electromotive force.
- Be careful not to short-circuit ISO_5V to ISO_COM.

See: "Connector Type and Signal Pinouts" (p.44)

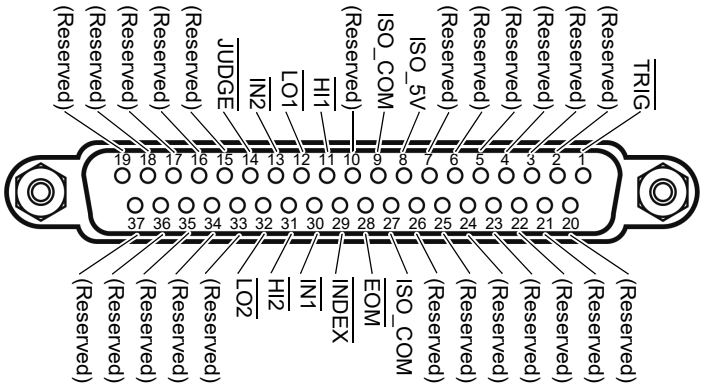
Connector Type and Signal Pinouts



Connector: (main unit side)
- 37-pin D-sub female with #4-40 screws

Mating Connectors:
- DC-37P-ULR (solder type)
- DCSP-JB37PR (pressure weld type)

Japan Aviation Electronics Industry Ltd.



EXT I/O Connector (main unit side)

Pin	Signal name	I/O	Function	Logic	
1	$\overline{\text{TRIG}}$	IN	External trigger	Pos/ Neg	Edge
2	(Reserved)	–	–	–	–
3	(Reserved)	–	–	–	–
4	(Reserved)	–	–	–	–
5	(Reserved)	–	–	–	–
6	(Reserved)	–	–	–	–
7	(Reserved)	–	–	–	–
8	ISO_5V	–	Isolated 5 V power output	–	–
9	ISO_COM	–	Isolated common signal ground	–	–
10	(Reserved)	–	–	–	–
11	$\overline{\text{HI1}}$	OUT	Judgment result 1: HI	Neg	Level
12	$\overline{\text{LO1}}$	OUT	Judgment result 1: LO	Neg	Level
13	$\overline{\text{IN2}}$	OUT	Judgment result 2: IN	Neg	Level
14	$\overline{\text{JUDGE}}$	OUT	Overall judgment result	Neg	Level
15	(Reserved)	–	–	–	–
16	(Reserved)	–	–	–	–
17	(Reserved)	–	–	–	–
18	(Reserved)	–	–	–	–
19	(Reserved)	–	–	–	–

Pin	Signal name	I/O	Function	Logic	
20	(Reserved)	–	–	–	–
21	(Reserved)	–	–	–	–
22	(Reserved)	–	–	–	–
23	(Reserved)	–	–	–	–
24	(Reserved)	–	–	–	–
25	(Reserved)	–	–	–	–
26	(Reserved)	–	–	–	–
27	ISO_COM	–	Isolated common signal ground	–	–
28	$\overline{\text{EOM}}$	OUT	End of measurement	Neg	Edge
29	$\overline{\text{INDEX}}$	OUT	Analog measurement finished	Neg	Edge
30	$\overline{\text{IN1}}$	OUT	Judgment result 1: IN	Neg	Level
31	$\overline{\text{HI2}}$	OUT	Judgment result 2: HI	Neg	Level
32	$\overline{\text{LO2}}$	OUT	Judgment result 2: LO	Neg	Level
33	(Reserved)	–	–	–	–
34	(Reserved)	–	–	–	–
35	(Reserved)	–	–	–	–
36	(Reserved)	–	–	–	–
37	(Reserved)	–	–	–	–

Do not connect to reserved pins.

NOTE The connector shell is connected to (continuous with) the main unit's metal case as well as the AC adapter's negative output and the power cord's ground pin. Be aware that it is not isolated from ground.

Input Signals

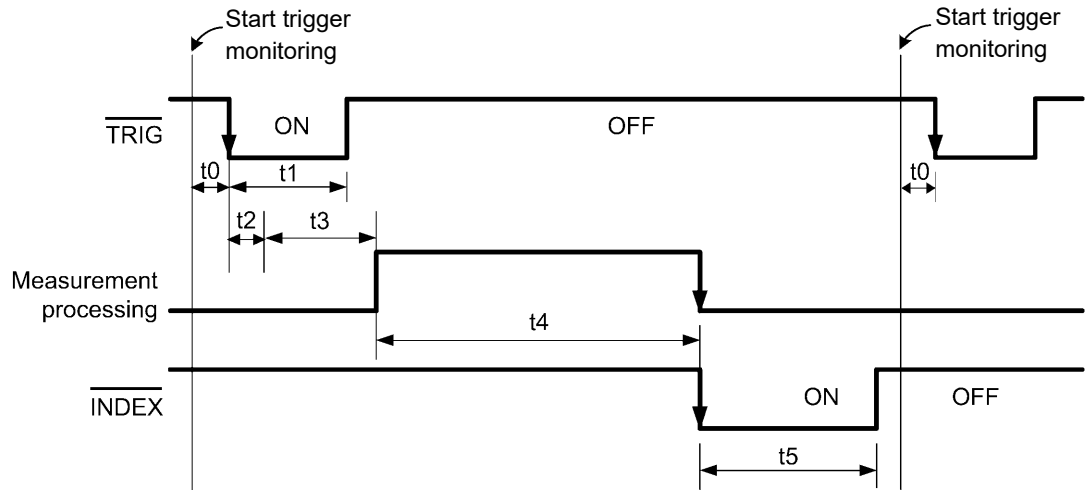
$\overline{\text{TRIG}}$	When the external trigger is on, one measurement is performed at the falling or rising edge of the $\overline{\text{TRIG}}$ signal. Polarity can be selected using the included software or library functions. When the external trigger is set to off, trigger measurement is not performed.

Output Signals

$\overline{\text{INDEX}}$	This signal indicates that A/D conversion in the measurement circuit is finished. When the asserted (low) state occurs, the measurement sample can be removed.
$\overline{\text{EOM}}$	This signal indicates the end of a measurement. At this time, the $\overline{\text{JUDGE}}$, $\overline{\text{IN1}}$, $\overline{\text{HI1}}$, $\overline{\text{LO1}}$, $\overline{\text{IN2}}$, $\overline{\text{HI2}}$ and $\overline{\text{LO2}}$ signals will have been finalized. This signal is useful when using the judgment function provided by the included PC application software (the TM6101 Utility).
$\overline{\text{JUDGE}}$	This signal indicates the overall judgment result. This signal is useful when using the judgment function provided by the included PC application software (the TM6101 Utility). Low (on) output is generated for PASS judgment results, and high (off) output is generated for FAIL and JUDGMENT OFF results.
$\overline{\text{IN1}}$, $\overline{\text{HI1}}$, $\overline{\text{LO1}}$, $\overline{\text{IN2}}$, $\overline{\text{HI2}}$, $\overline{\text{LO2}}$	These signals indicate measurement results for individual measurement items. These signals are useful when using the judgment function provided by the included PC application software (the TM6101 Utility). It is possible to output judgment results for two measurement items (judgment result 1, judgment result 2). The measurement item to output can be set with the TM6101 Utility. Judgment results for measurement item 1 are output from the $\overline{\text{IN1}}$, $\overline{\text{HI1}}$, and $\overline{\text{LO1}}$ signals, and judgment results for measurement item 2 are output from the $\overline{\text{IN2}}$, $\overline{\text{HI2}}$, and $\overline{\text{LO2}}$ signals.

4.2 Timing Chart

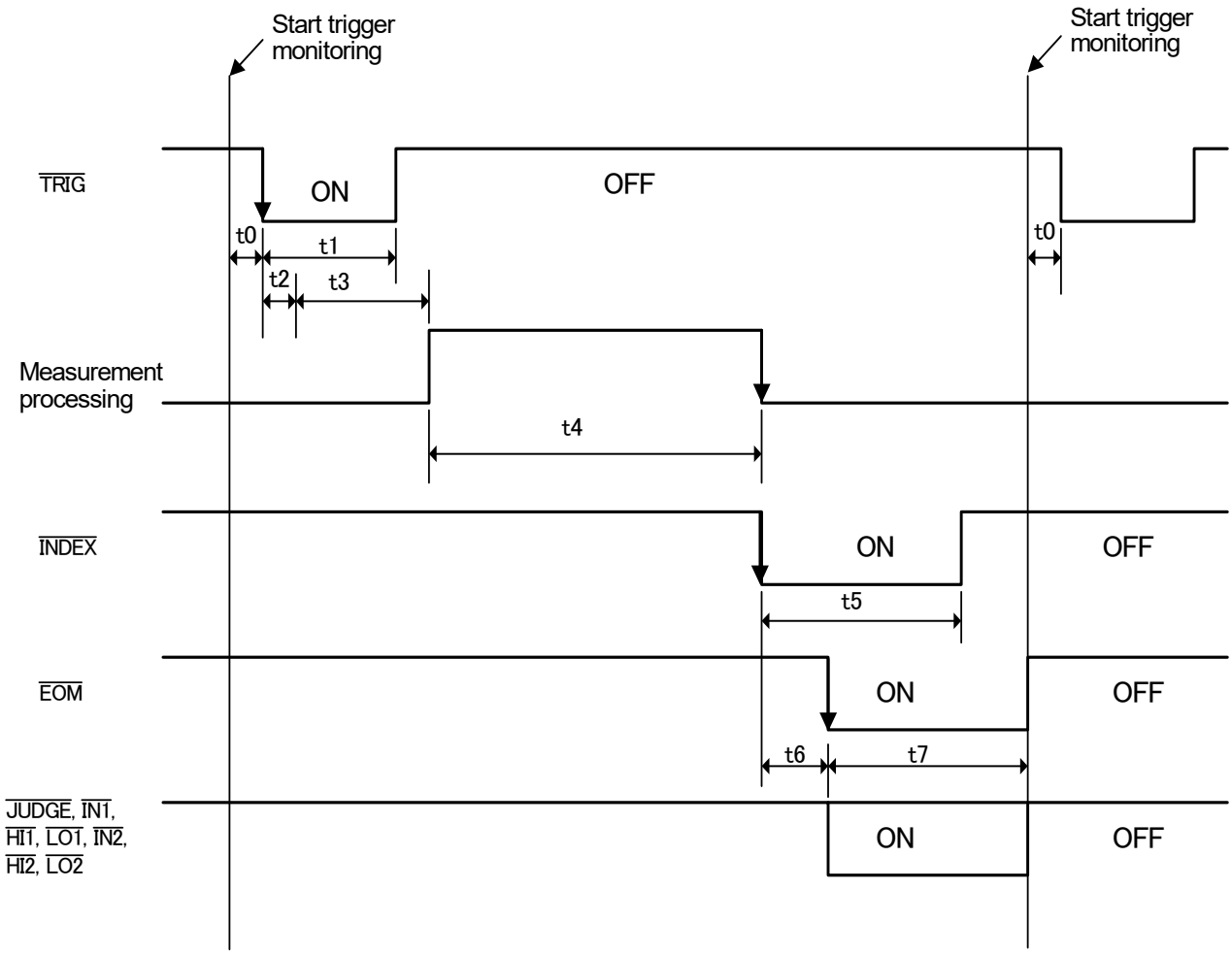
Each signal level indicates a corresponding voltage level.



NOTE

- This chart describes the instrument's operation while the external trigger is set to "on" (falling edge).
- Do not input the TRIG signal after external trigger measurement starts (the signal will be ignored). Once measurement completes, trigger input is not accepted until external trigger monitoring is started again. Start external trigger monitoring in software after INDEX output turns off.

Operation when using the judgment function



NOTE

- Operation when the external trigger is set to on (falling edge) and the judgment function is set to on is depicted. The judgment function can be used with the included PC application software (the TM6101 Utility).
- When the judgment function is off, $\overline{\text{EOM}}$, $\overline{\text{JUDGE}}$, $\overline{\text{IN1}}$, $\overline{\text{HI1}}$, $\overline{\text{LO1}}$, $\overline{\text{IN2}}$, $\overline{\text{HI2}}$, and $\overline{\text{LO2}}$ output will always be high (off). Additionally, these outputs will always be high (off) when using the measuring library to control the TM6101.
- $\overline{\text{JUDGE}}$ output is generated as shown below based on the overall judgment result.

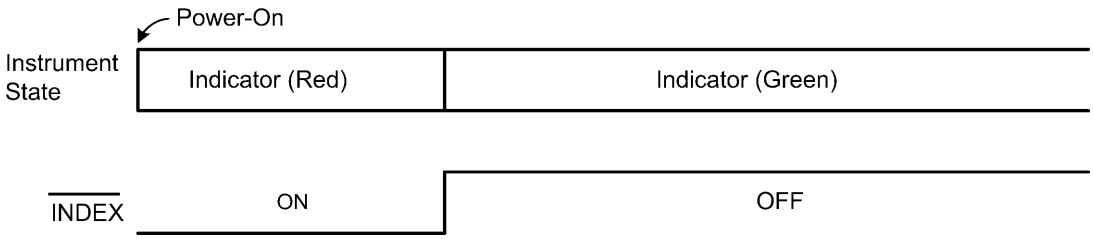
Overall judgment result	PASS	FAIL	JUDGMENT OFF
$\overline{\text{JUDGE}}$ output	Low	High	High

- Judgment output is generated as shown below based on the judgment results for the measurement items for which external output has been activated. External output can be activated for up to two measurement items with the TM6101 Utility.

Judgment results	IN	HI	LO	OUT	JUDGMENT OFF
$\overline{\text{IN1}}$, $\overline{\text{IN2}}$ output	Low	High	High	High	High
$\overline{\text{HI1}}$, $\overline{\text{HI2}}$ output	High	Low	High	Low	High
$\overline{\text{LO1}}$, $\overline{\text{LO2}}$ output	High	High	Low	Low	High

Output Signal State at Power-On

All signals are low (asserted active-low) when power is turned on.
All output signals become high (de-asserted active-low) when the power indicator turns green.

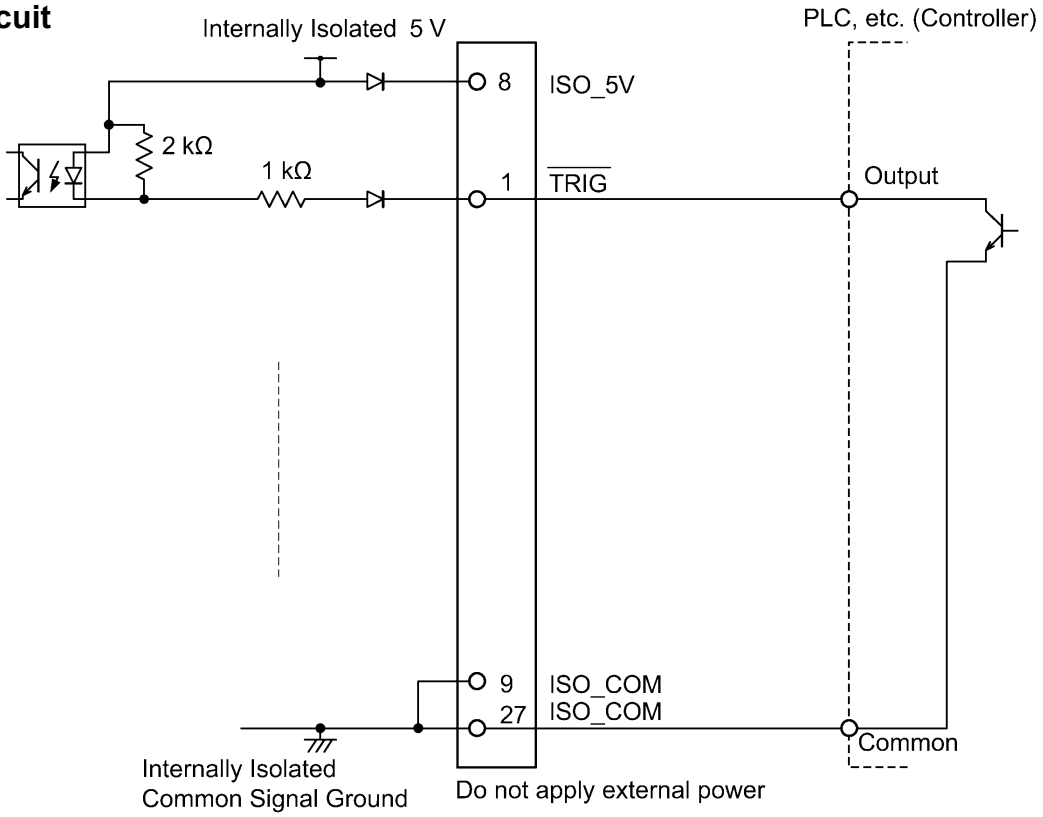


Timing Chart Interval Descriptions

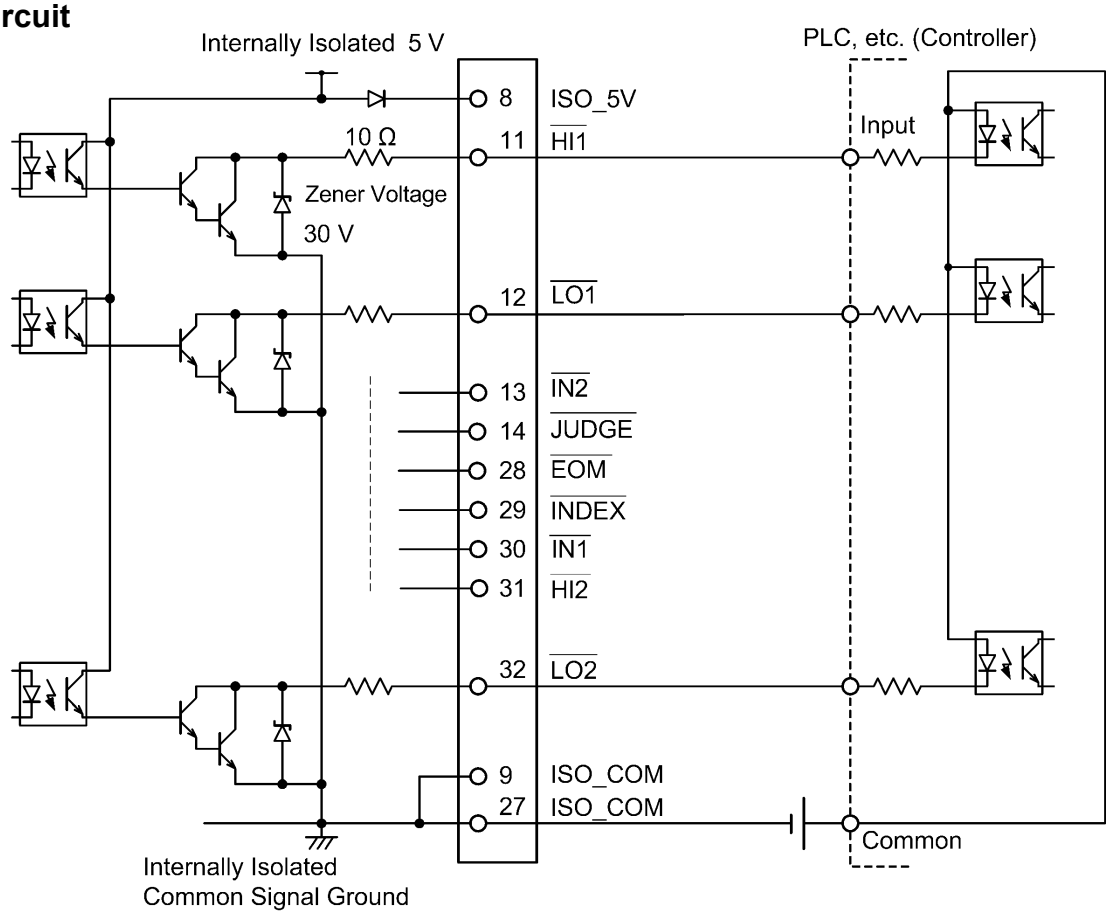
Interval	Description	Duration	Remarks
t0	Trigger Pulse De-asserted (OFF)	0.1 ms or more	
t1	Trigger Pulse Asserted (ON)	0.1 ms or more	Falling (ON)/ rising (OFF) selectable
t2	Trigger judgment time	0.1 ms	
t3	Delay	0 to 1000 ms	Setting-dependent
t4	Measurement time	0.1 to 42 ms	Integration Time (0.1 to 40.0 ms) + Internal Delay (2 ms max.)
t5	$\overline{\text{INDEX}}$ pulse width	1 to 100 ms	Setting-dependent (Actual width may exceed the set time due to the PC operating environment and communications speed.)
t6	Processing time	Undefined	The processing time varies with the computer's operating environment.
t7	$\overline{\text{EOM}}$ pulse width	1 to 100 ms	Setting-dependent (Output is generated when the judgment function is on. $\overline{\text{EOM}}$ output is held until $\overline{\text{INDEX}}$ output turns off. The actual $\overline{\text{EOM}}$ output time will be longer than the set pulse width.)

4.3 Internal Circuitry

Input Circuit



Output Circuit

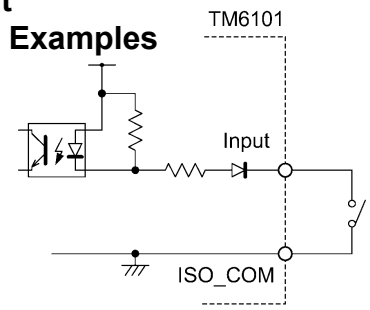


Electrical Specifications

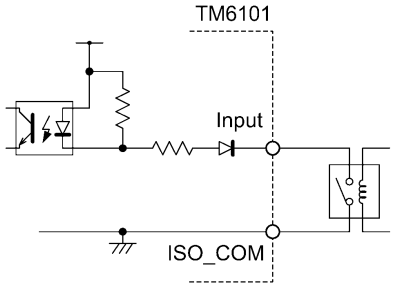
Input Signals	Input type	Optocoupler-isolated, non-voltage contact inputs (source input, active-low)
	Input asserted (ON) voltage	1 V or less
	Input de-asserted (OFF) voltage	Open or 5 to 30 V
	Input asserted (ON) current	3 mA/ch
	Maximum applied voltage	30 V
Output Signals	Output type	Optocoupler-isolated npn open-collector outputs (current sink, active-low)
	Maximum load voltage	30 V
	Maximum output current	50 mA/ch
	Residual voltage	1 V (10 mA), 1.5 V (50 mA)
Internally Isolated Power Output	Output Voltage	4.5 to 5.0 V
	Maximum output current	100 mA
	External power input	none

Connection Examples

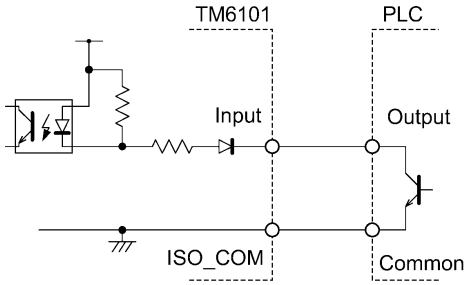
Input Circuit Connection Examples



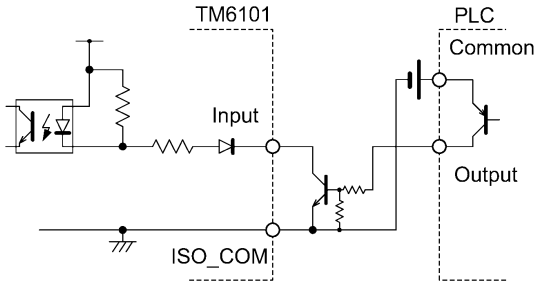
Switch Connections



Relay Connections

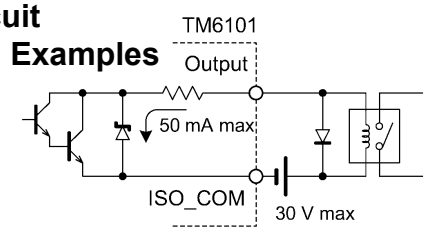


PLC Output (Sink Output) Connections

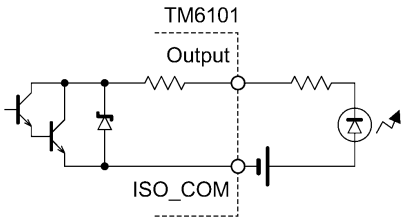


PLC Output (Source Output) Connections

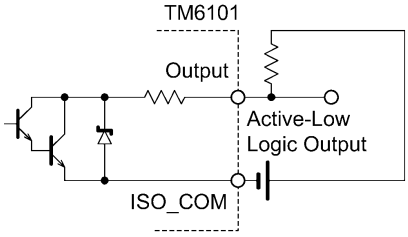
Output Circuit Connection Examples



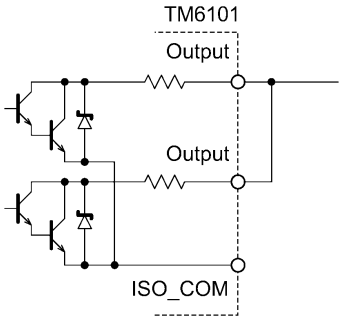
Relay Connections



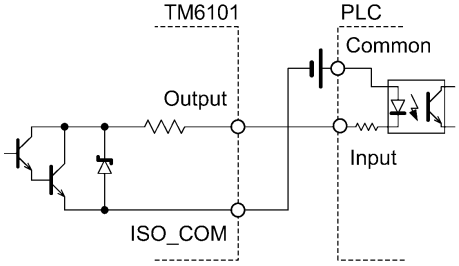
LED Connection



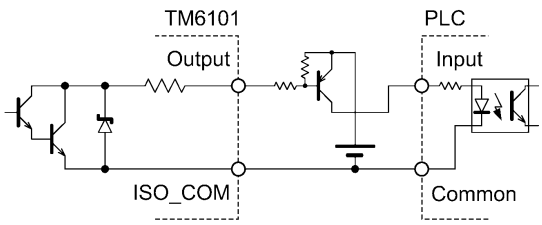
Active-Low Logic Output



Wired OR



PLC Input (Source Input) Connections



PLC Input (Sink Input) Connections

4.4 External I/O Settings

Setting Signal Output after the Completion of Measurement (INDEX Setting)

The included software or library functions can be used to set the pulse width for INDEX (measurement complete signal) output.

Setting the Trigger (TRIG) Signal Logic

The included software or library functions can be used to select whether triggering occurs at the falling or rising edge.

4.5 External Control Q&A

Common Questions	Answers
How do I connect external trigger input?	Connect the (active low) TRIG input pin to an ISO_COM pin using a switch or open-collector output.
Which pins are common ground for input and output signals?	The ISO_COM pins.
Are the common (signal ground) pins shared by both inputs and outputs?	Both common ground pins can be shared by inputs and outputs.
How do I confirm output signals?	Confirm voltage waveforms with an oscilloscope. To do this, set the voltage level by pulling output signals up (through several kΩ) to the power supply.
How do I troubleshoot input (control) signal issues?	For example, if triggering does not operate properly, bypass the PLC and short the TRIG pin directly to an ISO_COM pin. Be careful to avoid power shorts.
Why would the INDEX signal not be detected?	Try setting a longer pulse width for the INDEX output setting. Setting a longer pulse width for the INDEX output setting causes the INDEX signal to turn on for the specified pulse width only and then turn off, allowing detection of the INDEX signal with a PLC even if the measurement times are short.
Is direct connection to a PLC possible?	Direct connection is supported for relay or open-collector outputs and positive-ground optocoupler inputs. (Before connecting, confirm that voltage and current ratings will not be exceeded.)
How should external power be connected?	The instrument's external I/O input and output signals all operate from an internal isolated power source, so power must not be supplied from the PLC side.

Specifications Chapter 5

5.1 Basic Specifications

Measurement items	(1) Illuminance, Luminous Flux, Luminous Intensity (2) Chromaticity (3) Color rendering index (4) Correlated Color Temperature and Δuv (5) Dominant Wavelength and Excitation Purity
Measurement range	Illuminance (5 to 100,000 lx)
Accuracy	Chromaticity : ±0.005 (with spectral irradiance standard lamp) Illuminance : ±5% (with luminous intensity standard lamp, 1,000 lx) 23±5°C, 80%RH or less, warm-up time: 60 minutes, within ±5°C after performing dark correction, optimal range setting (*1) *1: With integration time and gain settings so that the maximum detection level is 30% f.s.
Measurement mode	Normal measurement mode Sensitivity range : High, Low Integration time : 0.1 (low sensitivity only), 0.5, 1.0, 2.0, 4.0, 8.0, 10.0, 16.666, 20.0, 33.333, 40.0 ms AC measurement mode (With commercial power supply at 60 Hz) Measurement time: 33.333 ms (range 1), 16.667 ms (range 2, range 3)

Range	Range 1	Range 2	Range 3
Sensitivity range	Low	Low	High
Integration time	1.852 ms	16.667 ms	16.667 ms
Average times	9	1	1

(With commercial power supply at 50 Hz)
Measurement time: 40 ms (range 1), 20 ms (range 2, range 3)

Range	Range 1	Range 2	Range 3
Sensitivity range	Low	Low	High
Integration time	2.222 ms	20 ms	20 ms
Average times	9	1	1

Optical detection unit	Detector window diameter: 11.3 ±0.1 mm
Applicable Standard	Compliant with s*pecial type illuminance measuring instruments** specified in Japanese Industrial Standard (JIS) C 1609-1:2006 Illuminance meters Part 1:General measuring instruments. (1) Performance 1. *Illuminance linearity*: 2%±1dgt* 2. *Visible range relative special responsivity characteristics*: 1.5%* *Terms translated into English by Hioki English translation of JIS C 1609-1:2006 has not been published by Japanese Standards Association. In the event of any doubt arising, the original standard in Japanese is to be evidence.
Spectral responsivity characteristics of colour-matching functions	(1) Performance Meets with tolerance limits specified as Table 1 (Tolerance limits to deviation of spectral responsivity of photo-electric colorimeter) in 5.2 Photoelectric colorimeter of JIS Z 8724 Methods of colour measurement - Light-source colour.

Product warranty period	3 years
Period of guaranteed accuracy	1 year

5.2 Functions

Measurement Functions

Measurement control	Controlled by included software (USB connection) Start of measurement by internal or external trigger
Trigger function	Support for internal and external triggers Trigger delay: Max. 1,000 ms
Average function	The specified number of measured values are averaged in one calculation. Average times: 1 to 100
Auto range function	Auto-ranging can be performed at the start of measurement. Includes range peak hold function. Range tolerance can be set (%): The range measurement range tolerance can be set so that the amount of light from the measurement target does not exceed the range.

Display

Measurement results can be displayed on the monitor using included software.

Display items	Display range	Display resolution
Illuminance		Min. 0.1 lx
Luminous Flux		Min. 0.01 mlm (millilumen)
Luminous Intensity		Min. 0.01 mcd (millicandela)
Chromaticity	0.0000 to 1.0000	0.0001
Color rendering index		1 (special color rendering evaluation index R1 to R15) 0.1 (average color rendering evaluation index Ra)
Correlated Color Temperature		1 K (correlated color temperature) when | Δuv | < 0.02 0.0001 (Δuv)
Dominant Wavelength	380 to 700 nm	0.1 nm (dominant wavelength), 0.1% (excitation purity)

Correction Functions

Dark current correction (Cancels dark current offset for each channel.)	Averaging times can be set. Select all ranges or specified range only.	
Reference value correction functions	Illuminance value correction function	: Calculates gain correction value for illuminance value input; average times can be set.
	Luminance flux value correction function	: Calculates gain correction value for luminance flux value input; average times can be set.
	Luminous intensity value correction function	: Calculates gain correction value for luminous intensity value input; average times can be set.
	Chromaticity value correction function	: Average times can be set.

Interface

USB2.0	Measurement results can be acquired and measurement can be controlled from the included PC application software or library software.
Digital I/O	Input: $\overline{\text{TRIG}}$ Optocoupler-isolated no-voltage contact inputs L voltage (assert): 0 to 1 V (3 mA input current) H voltage (de-assert): OPEN or 5 to 30 V Output: $\overline{\text{INDEX}}$, $\overline{\text{EOM}}$, $\overline{\text{JUDGE}}$, $\overline{\text{HI1}}$, $\overline{\text{IN1}}$, $\overline{\text{LO1}}$, $\overline{\text{HI2}}$, $\overline{\text{IN2}}$, $\overline{\text{LO2}}$ Optocoupler-isolated npn open-collector 30 VDC, 50 mADC max/ch Residual voltage: 1.5 V or less (50 mA) 1 V or less (10 mA) External power output (internal power supply) 4.5 to 5 VDC, 100 mADC max Insulating from protective ground potential and measurement circuit

Corrected value backup

Storage of corrected reference values	Corrected reference values can be stored on the PC.

5.3 General Specifications

Operating temperature and humidity	5 to 35°C (41 to 95°F), 80%RH or less (non-condensing)
Storage temperature and humidity	-10 to 50°C (14 to 122°F), 80%RH or less (non-condensing)
Operating environment	Indoors, up to 2,000 m (6562-ft.) ASL
Power source	9418-15 AC Adapter (12 VDC±5% drive) AC Adapter Rated supply voltage : 100 to 240 VAC (Voltage fluctuations of ±10% from the rated supply voltage are taken into account) AC Adapter Rated supply frequency : 50/60 Hz Maximum rated power : 6 VA
Dimensions • Mass	Sensor Unit : Approx. 70W × 39.5H × 172D (2.76"W × 1.56"H × 6.77"D) (without protrusions), Approx. 550 g (19.4 oz.) Main Unit : Approx. 210W × 30H × 135D (8.27"W × 1.18"H × 5.31"D) (without protrusions), Approx. 1 kg (35.3 oz.)
Accessories	9418-15 AC Adapter .....1 USB Cable .....1 Main unit/sensor unit connection cable.....1 Cap .....1 Connecting port connecting screws.....4 Ferrite cores .....3 Rubber feet.....4 TM6101 Instruction Manual .....1 CD .....1 • PC application software (TM6101 Utility) • Library software (TM6101 measuring library) • TM6101 Utility Instruction Manual • TM6101 measuring library Instruction Manual • TM6101 Instruction Manual

5.4 PC Software Specifications

Basic Specifications

System requirements	PC capable of running supported operating systems 1 GHz or better CPU, 1 GB or more memory Video functionality capable of displaying at least 256 colors at a resolution of at least 1920 × 1080 USB 2.0 interface CD-ROM drive (for software installation) 100 MB free hard disk space
Supported operating systems	Windows 7 (32bit/ 64bit), Windows 8 (32bit/ 64bit), Windows 10 (32bit/ 64bit) (Japanese or English)
Supported measuring instruments	TM6101 only (connected to PC via USB) Up to 4 instruments can be connected simultaneously. (Only 1 instrument can be connected when using the PC application software.)
Software	PC application software, Library software

PC application software

Measuring instrument control Start/stop measurement	Measurement start by either internal or external trigger
Measurements and calculations	As described in "5.1 Basic Specifications" "Measurement items" (p.53)
Auto range function	Auto-ranging can be performed at the start of measurement.
Setting items	Switchable between measurement count specification and continuous measurement (normal measurement mode only) Trigger delay : 0 to 1000 ms (Resolution: 1 ms) (external trigger only) Sensitivity range : High, Low (normal measurement mode only) Integration time : 0.1 (low sensitivity only), 0.5, 1.0, 2.0, 4.0, 8.0, 10.0, 16.666, 20.0, 33.333, 40.0 ms (normal measurement mode only) Average times : 1 to 100 Measurement mode : Normal measurement mode, AC measurement mode Measurement range : 1 to 3 (AC measurement mode only) Commercial power supply frequency : 50/60 Hz (AC measurement mode only) Luminous intensity measurement range : 10 to 10,000 mm
Display items	Measurement results : As described in "5.2 Functions" "Display" (p.54) Graph display : Plotting of measured color values on XY chromaticity coordinates Detection level : Display of detection level as %f.s.
Data storage	Saving of measurement results as a CSV file Saved data as described in "5.2 Functions" "Display" (p.54) Support for automatic saving of data
Reference value correction functions	As described in "5.2 Functions" "Correction Functions" (p.54)

Library software

Supported development environments	Visual Studio® 2017, 2019 (Visual C++®, Visual Basic® , Visual C#®)
Measuring instrument control	Supported operations as described in "PC application software"
Acquisition of measurement results	Data can be acquired after completion of measurement. Data: Illuminance, luminous flux, chromaticity, color rendering index, correlated color temperature, Δuv, dominant wavelength, excitation purity
Reference value correction functions	As described in "5.2 Functions" "Correction Functions" (p.54)

Chapter 6 Maintenance and Service

6.1 Troubleshooting

Inspection and Repair

WARNING **Do not attempt to modify, disassemble or repair the instrument; as fire, electric shock and injury could result.**

NOTE

- If the instrument seems to be malfunctioning, check the "3.1 Pre-Operation Inspection" (p.35) before contacting your dealer or Hioki representative.
- Getting the instrument wet or letting oil or dust enter inside its casing will certainly damage it, nd is quite likely to cause an electric shock accident or a dangerous conflagration. If the instrument has gotten seriously wet, oily, or dusty, stop using it and send it for service at an approved Hioki calibration facility.

Transporting

- Place the sensor unit into a zipper-sealed vinyl bag with a desiccant such as silica gel. Remove any air and zip the bag closed.
- When transporting the instrument, use the original packing materials in which it was shipped, and pack in a double carton. Damage occurring during transportation is not covered by warranty.
- Pack the instrument so that it will not sustain damage during shipping, and include a description of existing damage. We do not take any responsibility for damage incurred during shipping.

USB cable

Use the USB cable that shipped with the instrument or the following equivalent product (commercially a vailable). Proper operation is not guaranteed if any othe cables are used.

- USB cable equivalent
  MUSBAB-2, MISUMI Inc.

6.2 Cleaning

Cleaning the main unit

NOTE

To clean the main unit, wipe it gently with a soft cloth moistened with water or mild detergent. Never use solvents such as benzene, alcohol, acetone, ether, ketones, thinners or gasoline, as they can deform and discolor the case.

Cleaning the sensor unit's detector window

⚠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.
- Do not use organic solvents other than ethyl alcohol to clean the detector window. Doing so may cause the detector window's performance to deteriorate.
- 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.

1 **Remove the sensor unit's cap.**
(Take care not to lose the cap.)

2 **Gently wipe the detector window with a material that produces little dust, for example a piece of lens cleaning paper.**
If there are any fibers left on the detector window, blow them off with a lens dust cleaner or similar tool.
If the detector window is dirty, loosen the tip of a cotton swab so that it resembles a brush, moisten it with ethyl alcohol, and lightly wipe away the dirt.

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

User's License Agreement

Important

Please read the following agreement carefully. This user's license agreement (hereafter referred to as Agreement) is a legal contract between the software user (individual or institution) and HIOKI E. E. CORPORATION (hereafter referred to as HIOKI). The term "software" includes any related electronic documentation and computer software and media, as well as any printed matter (such as the Instruction Manual).
By installing, reproducing, or using the software, you, the Licensee, agree to accept the license terms set forth in this Agreement.

This software is protected by copyright laws, international copyright agreements, as well as non-corporate laws. The software is a licensed product, and is not sold to the user.

1. License

This Agreement grants you, the Licensee, a license to install a single copy of the software on a specified computer system.

2. Explanation of other rights and restrictions

-1. Restrictions on reverse engineering, decompiling, and disassembling:

You may not reverse engineer, decompile, or disassemble the software.

-2. Separation of components:

This software is licensed for use as a single product. You may not separate the components for use on multiple computer systems.

-3. Loaning:

You may not loan or lease the software.

-4. Transfer of software:

You may transfer full rights in accordance with this Agreement. However, if you do so, you may not retain any copy of the software, but must transfer the software in its entirety (all components, media, related documentation such as the Instruction Manual, and this Agreement), and must ensure that the receiver of the software agrees with the terms set forth in this Agreement.

-5. Cancellation:

In the event that the terms and conditions set forth in this Agreement are violated, HIOKI retains the right to cancel this Agreement without compromise of any of its other rights. In this event, you must destroy all copies of the software and its components.

3. Copyright

The title and copyright rights concerning the software's related documentation, such as the Instruction Manual and copies of the software, are the property of HIOKI and other licensors, and are protected by copyright laws and international agreement regulations. Accordingly, you must treat the software as you would any other copyrighted document. However, you are permitted to make copies as indicated in (A) and (B) below provided such copies are not intended for use other than back-up purposes.

(A) You may make a single copy of the software.

(B) You may install this software on a single computer.

However, you may not reproduce the documentation supplied with the software, such as the Instruction Manual.

4. Dual media software

You may receive the same software on more than one type of media. However, regardless of the type and size of media provided, you may only use one media type and only on a single computer. You must not use or install the other media on any other computer. Furthermore, except when transferring the software as stipulated above, you may not loan, lease, or transfer the other media to any other user.

5. Warranty

-1. HIOKI reserves the right to make changes to the software specifications without any prior warning.

-2. If the software does not operate in accordance with the supplied Instruction Manual, or the software media or Instruction Manual are damaged in any way, you have one year from the date of purchase to apply for either an exchange or repair at HIOKI's discretion.

-3. In no event will HIOKI be liable for any damages resulting from fire, earthquake, or actions of a third party under the conditions stated in item number 2 above, or for any damage caused as a result of your using the software incorrectly or under unusual circumstances. Further, the warranty is invalid if the following occurs:

(A) Damage incurred through transport, moving, droppage, or any other kind of impact after you purchased the software.

(B) Damage incurred through any form of alteration, unwarranted servicing, or any other type of mistreatment.

-4. In the event that the software is exchanged or repaired, the period of warranty expires on the latest occurring date out of the day stated in the original warranty, and exactly 6 months from the day the exchanged/repaired software is returned to you.

-5. Regardless of the grounds for making a legal claim, HIOKI and its licensors will not be liable for any damage incurred (including, but not limited to: lost profits, suspension of business, loss of data or lost savings) unstated in the warranty terms for the use of this software. This is true even if HIOKI is notified of the possibility of such damages. In any event, HIOKI's liability shall be limited only to replacing defective software with software that is not defective.

HIOKI

http://www.hioki.com

All regional contact information

HEADQUARTERS
81 Koizumi
Ueda, Nagano 386-1192 Japan

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

1906 EN

Edited and published by HIOKI E.E. CORPORATION
Printed in Japan