User's Manual

51002 Digital Illuminance Meter

YOKOGAWA
Yokogawa Meters & Instruments Corporation

RG103
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CONTENTS

Overview

Thank you very much for purchasing our Digital Illuminance Meter. Prior to its use, thoroughly read this instruction manual to observe the correct way of use.

Our digital illuminance meter is a small, lightweight meter and enables illuminance measurements with the meter separated from the light detector. The display adopts a large liquid crystal display (LCD) for ease in reading, and attention is also paid to operation key arrangement. The photoelectric element adopts a silicon photodiode for correcting the spectral luminous efficiency by combining with an optical filter in order to measure the illuminance of natural light. There is a microcomputer incorporated in this meter to realize an illuminance meter having excellent functions. There are also various functions incorporated in this meter, not found in conventional meters: a ripple measurement function which enables the illumination from a lamp to be measured even during daylight hours; a color-correction factor computation function; a timer-hold function; an average-illuminance computation function; a comparator; measurement of the totalized intensity of illumination; an automatic power-off function; and others. Refer to the text for details on these respective functions. Moreover, this illuminance meter provides recorder output and digital data output, further extending its usefulness. Thus, the range of applications of this meter is much more extensive than that of existing luxmeters (illuminance meters).

This digital illuminance meter has been designed, manufactured, and delivered under strict quality control criteria by a factory certified in the ISO 9001 Quality Standards. We hope you will be able to make sufficient use of the performance of this product, in addition to our traditional photocell luxmeters.

Please retain this instruction manual for future use in operating this product.

Prior to Use

Checking accessories

After unpacking the meter, check it for appearance and its accessories.

Accessories: Instruction manual: 1
Recorder output plug (JC017A): 1
Soft-sided case (RB037A): 1
One dry cell battery (9 V) in the meter.

Precautions on Handling

- Exercise care not to drop the meter or hit it with a hard object.
- Avoid placing the meter in a room at a temperature above 60°C or below -20°C. Also, avoid placing it in an area subject to direct sunlight or at a high humidity.
- Using the meter at low temperatures (between -10 and 0°C) causes the display response to be delayed.
- Avoid using the meter in a dirty, dusty, or salt-air area or where there are corrosive gases.
- Dirt or dust adhering to the light-detecting surface decreases measurement accuracy. Wipe the surface clean with a soft, dry cloth.
- Do not use solvent (trichloroethylene, paint thinner, benzene, alcohol, etc.), which may deform the case material or cause the print to peel off. To remove stains from the case, gently wipe them off with a soft cloth. If the instrument is badly stained, use a soft cloth moistened with a neutral detergent, then wipe off the moisture using a dry cloth.
- Do not disassemble the meter.
- Do not separate mainunit from light-detector with the power on.

Safety Summary

The CAUTION Which appear on the following page must be followed to ensure operator safety and to retain the operating condition of the Illuminance Meter,

Safety Symbol

Indicates the operator must refer to an explanation in this manual.

Calibration

Calibrate the meter once every two years in order to maintain accurate measurements.
Calibration is done by Yokogawa.
To have the meter calibrated, consult the Yokogawa sales representative from whom you purchased the instrument or the Yokogawa sales division listed on the back of this manual.

Optional Accessories

Product	Specification	Model
Light-detector extension cable	3m	910 01
	30m	910 02
Data output cable	3m	910 03
AC adaptor	120 V (DC 9V)	940 01
	220 V (DC 9V)	940 02

Note

Accessories of non-standard
Safety standard: EN 61010-1
· AC adapter Model: 94001(Input of 120 V± 10% AC)
Model: 94002(Input of 220 V± 10% AC)
EMC standard:
· Light-detector extension cable
Model: 91002(Cable length: Approx. 30 m)

⚠ CAUTION

Danger of electrical shock!
· When you use the AC adaptor, never use a power supply that is not suited to the adaptor.
· Handle the AC adaptor with care so that the adapter is not damaged. If the adaptor is damaged, do not use it.

Operation

Components

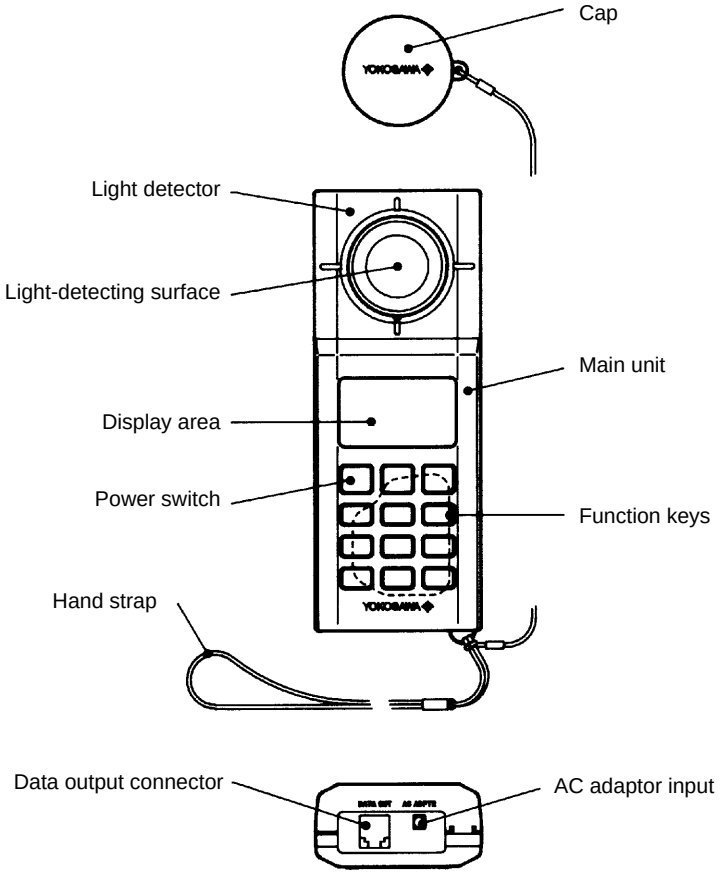
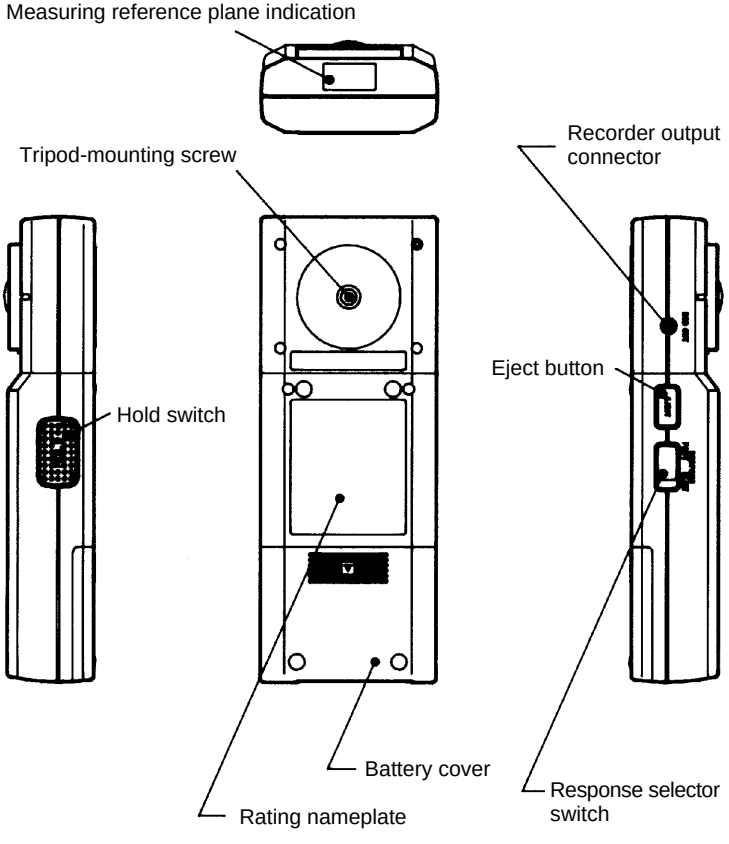


Figure 1. Components


Measuring reference plane indication
Tripod-mounting screw
Recorder output connector
Hold switch
Eject button
Battery cover
Rating nameplate
Response selector switch

Display Area

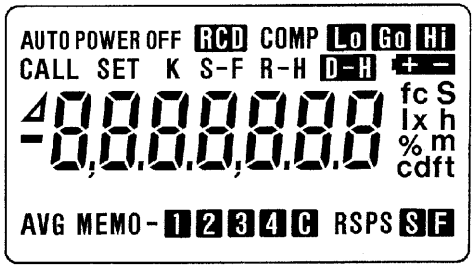


Figure 2. All Display Elements

Description of Elements in Display Area

Element	Display condition/indication
8,8.8.8,8.8.8	Digital display of measured value, calculated value, and set value
AUTO POWER OFF	Indicates meter in automatic power-off mode
Δ	Deviation
CALL	Indicates when CALL key is pressed
SET	Indicates set mode
K	Color correction factor
REC	Indicates when a plug is inserted into the recorder output connector
S–F	Ripple measurement
COMP Lo Go Hi	Indicates comparator mode
R–H	Indicates range hold
D–H	Indicates data hold and timer hold
	Indicates low battery voltage
AVG MEMO– 1 2 3 4 C	Indicates average illuminance
RSPS S F	Response setup display
S	Timer hold-time unit (sec)
lx	Unit of illuminance
fc	Unit of illuminance
h	Unit of integral time for totalized intensity of illumination
%	Deviation display (%)
m	Unit of length for distance to light source
cd	Unit of the light source; indicated upon light source luminous intensity

Prior to Operation

1. Response Time Setup

The response speed of the light detector can be selected using the response selector switch. The response speed is set as described below. Set the switch to FAST or SLOW according to its application. When FAST is set, [RSPS F] appears; when SLOW is set, [RSPS S] appears in the display area.

Switch position	Response speed	Application
FAST	Approx. 10 mS	Measurement of continuous light Daylight, interior lighting (fluorescent lamps, incandescent lamps), etc.
SLOW	Approx. 500 mS	Measurement of average illuminance such as flickering lights or variations from measuring beams such as TV screens

Note: If the recorder output is used for waveform observation, set the switch to FAST.

2. Replacement of Battery

If the battery voltage drops during operation, a [⊟] sign appears in the display area. In this case, replace the battery with a new one immediately. Check the polarity markings in the battery compartment and battery's polarity in order to avoid putting in the battery incorrectly. Use either a 6F22 9-V dry cell battery (S-006P, manganese, with approximately a 25-hour service life) or a 6LR61 9-V dry cell battery (alkaline dry cell battery with approximately a 40-hour service life).

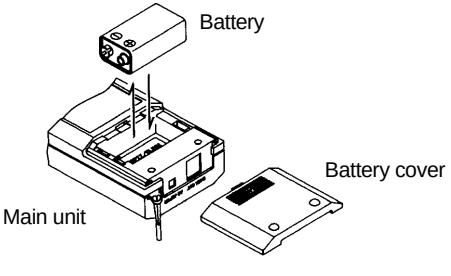


Figure 3. Replacement of Battery

3. Selection of Units of Measurement (lx, fc)

Since this illuminance meter conforms to the International System of Units (SI units), the lux (lx) is regarded as the reference unit. Some countries use the footcandle (fc) which is not an SI unit. For this reason, this illuminance meter provides a function to display readings converted to fc units with a unit selector switch. Select the desired unit, as needed, prior to measurement.

Be sure to turn off the power before selection.

Figure 4 shows the location of the lx-fc selector switch. Note that the specifications and operation description in this manual are based on the lux.

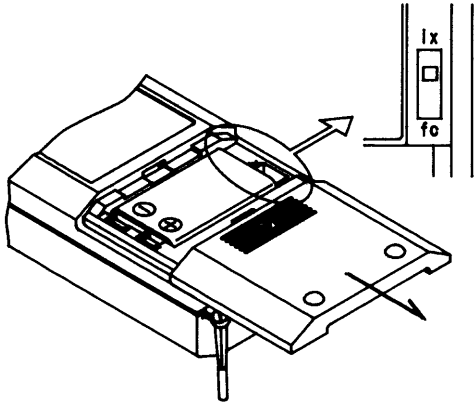


Figure 4. Location of lx-fc Selector Switch

4. Automatic Power Off (AUTO POWER OFF)

This digital illuminance meter provides an automatic power-off function in order to avoid using up the battery if you forget to turn off the power. This function turns the power off about 30 minutes after any key is last pressed. Immediately before turning the power off, the meter makes a beeping sound. If you press any of the operation keys while the beeping sound is on, this will extend the time of the automatic power-off function by 30 minutes. Whenever a plug is in the recorder output connector while the

totalized intensity of illumination and/or the comparator function is being executed, this function is automatically disabled; thus, it does not function. The function can be disabled permanently if not necessary (if the meter is used continuously). Refer to the operation procedure described in “Illuminance Measurement.” Whenever this function is operable, [AUTO POWER OFF] appears in the display area.

Notice on Making Measurements

1. Before starting measurement, as a rule, turn on the bulb five minutes beforehand and the discharge lamp 30 minutes.
2. Set the position and angle of the light-detecting surface accurately. Figure 5 shows the measuring reference plane.

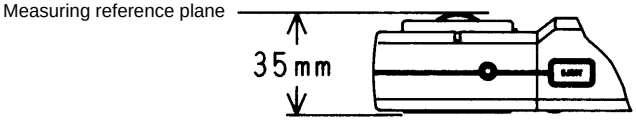


Figure 5. Measuring Reference Plane

3. Exercise care that your position or clothes do not affect illuminance measurement.
4. In the case of accurate illuminance measurement, multiply the measured value by the color correction factor corresponding to the spectral distribution of the measuring light source and the factor corresponding to the relative spectral response of this illuminance meter, respectively. This meter provides a color correction factor function which is set to a typical light source. The color correction factor multiplied by the measured value is indicated automatically.
5. The zero point may vary if the ambient temperature varies greatly over long-time meter use. In such a case, turn off the power once and then turn it on again (see “Illuminance Measurement”).

Note

- An electromagnetic interference affects the operating tolerances under EN61326-1;1997+A1; 1998 condition.

- If a high electromagnetic interference equipment exists in the near vicinity of the instrument, this may cause malfunction.

Illuminance Measurement

Operation

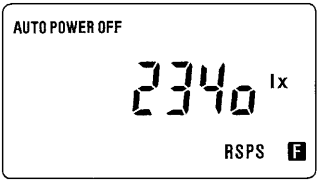
1. Cover the light-detecting surface with the cap and confirm that the HOLD switch lock is released.
2. Press the POWER switch to turn on the power. All the characters will appear in the display area. When the meter enters the automatic zero-adjustment mode, [—CAL—] appears.

Note: If [—CAP—] appears, this means that the cap is not on properly. Press on the cap until [—CAL—] appears.

3. When automatic zero adjustment is completed, [—CAL—] disappears and [0.00] appears.
4. After confirming the [0.00] display, remove the cap to start measurement.
5. After the measurement has been completed, press the POWER switch again to turn off the power, and cover the light-detecting surface with the cap for protection against stray light.

Note: If [Err] appears, check the connection between the main unit and light-detecting surface and check the cap to make sure it is on properly, and then start this operation again from the beginning. To disable the automatic power-off function, press the HOLD switch to lock the switch before turning off the power. When automatic zero adjustment is completed, press the HOLD switch to release the lock. [AUTO POWER OFF] disappears, resulting in automatic power-off being disabled.

Example of display upon illuminance measurement



Operation of Optional Functions

Notice on Operation

1. If an optional function (except for the color correction factor) has already been executed, the other optional functions cannot be used. Release the currently executed function to proceed to the next operation. Releasing the function means illuminance measurement is in progress (at power on).
2. There are some functions required in advance for the setup modes. To enter the setup mode, start from the function release status (except for the color correction factor).
3. If a numeric value is to be set in the setup mode, press the numeric value key ([^]) until the desired numeric value appears, starting from the most significant digit. When the numeral for the digit is reached, press the ([>]) key to proceed to the next digit to the right, and do the same operation as above.
4. For an operation key with which two functions are enabled, only the function necessary for operation is described. For example, description of the [RANGE / T–H] key is divided into that of the [RANGE] key and the [T-H] key.

Color Correction Factor [K] Key

A color correction factor, calculated for individual products based on the spectral distribution characteristics and relative spectral response characteristics (spectral sensitivity) corresponding to various light sources to be measured, is incorporated. Table 1 below shows the various kinds of light sources and typical values of the color correction factor. This function reads the color correction factor in advance, and displays the measured value automatically multiplied by the factor when the [K] key is pressed. Also, this function provides user areas (U1, U2, and U3) to write desired values, respectively. Once a value is written in one of the areas, the value is retained even after the power is turned off.

Light source		Color correction factor* Typical value of
Type	Indication	
Daylight fluorescent lamp White fluorescent lamp Three-way fluorescent lamp	FLd FW FL3	0.994 0.996 1.007
High-pressure mercury vapor lamp	HGL	0.993
High-pressure sodium vapor lamp	nAL	0.988
Standard light source B Standard light source C	Stb StC	0.996 0.995
Equal-energy source (400 to 760 nm)	Wt	0.997
User area 1 User area 2 User area 3	Y1 U2 U3	User-specified User-specified User-specified

* The color correction factor is calculated based on the relative spectral distribution values respectively of JIS Z 8719, JIS Z 8720, and CIE No. 53TC.2 lamps.

Table 1. Typical Values of Color Correction Factor

How to Read the Color Correction Factor

1. Press the [SET] key and then the [K] key. This causes [SET, K] to appear. The light source signal and color correction factor appear in the display area. Each time the [∧] key is pressed, a data set is called up subsequently. When the desired light source appears, stop calling up the data.
2. Press the [SET] key again to end the setup. This causes [SET, K] to disappear.

Note: Once a color correction factor is called, it is memorized even after the power is turned off.

Operation

1. Press the [K] key. This causes [K] to appear. While [K] is displayed, a factor is calculated according to the color correction factor set.
2. To confirm the color correction factor set, continue pressing the [CALL] key.

3. To release its reading, press the [K] key again. This causes [K] to disappear.

Note: The color correction factor is valid for all other optional functions; however, if an optional function has already been executed, the [K] key does not work. If a function is combined with another function, the [CALL] key does not work, either.

How to Set (Change) User Area

1. Press the [SET] key and then the [K] key. This causes [SET, K] to appear.
2. Select one of the user areas (U1, U2, or U3) using the [∧] key.
3. Enter a numeric value using the [>] and [∧] keys. The write-enabled numeric range is between 0.000 and 9.999.
4. If a factor is set to another area, press the [>] key to stop the display from blinking (next to the ones digit), and then repeat procedures 2, 3, and 4 above.
5. After completing the factor input, press the [SET] key again to end setup. This causes [SET, K] to disappear.

Data Hold [HOLD] Switch

This function holds (locks) the measured value indicated. This switch is used when it is hard to read an indication, such as measurement in a dark place.

Operation

1. Press the [HOLD] switch (lock). The measured value is held (locked) and D–H appears.
2. Read the indication, taking the meter to a bright place or turning on a light in the room.
3. To release the lock, press the [HOLD] switch again. This causes D–H to disappear.

Timer Hold [HOLD] Switch, [T–H] Key

This function holds the measured value after a time set in advance has elapsed. You must move away from the place where the meter is located so that your position or clothes do not have an influence on the measurement. Setting and holding the time so you may leave the area enable accurate measurement.

How to Set (Change) Timer

1. Press the [SET] key and then the [T–H] key. This causes [SET, D–H, S] to appear.
2. Enter a numeric value using the [∧] and [>] keys. The timer-setting range is between 000 and 999.
3. Press the [SET] key again to end the timer setting. This causes [SET, D–H, S] to disappear.

Note: The set value is retained even after the power is turned off until the value is again updated. To confirm the time set, do operation items 1 and 3.

Operation

1. Press the [HOLD] switch (lock). This causes D–H to appear.
2. Press the [T–H] key to start the timer; D–H starts blinking.
3. Move away from the place where the meter is located.
4. When the set time of the timer elapses, a beeping sound is generated, D–H stops blinking, and the measured value at that time is held (locked).
5. Read the indicated value
6. To release the lock, press the [HOLD] switch again. This causes D–H to disappear.
7. To repeat this operation, do items 2 to 5 or 1 to 6.

Range Hold [RANGE] Key

This key selects automatic range and manual range. Manual range enables an arbitrarily fixed range to be set. If measured values are known to be within a particular range response comes fast if a fixed range is used, making reading much easier.

The range configuration is as follows:

```
     0.00   to 9.99
    0.0    to 99.9
   0       to 999
  0o      to 9,99o
  0oo    to 99,9oo
 0,ooo to 999,ooo
```

o: dummy display (The o or o's indicate the number of digits)

Operation

1. Press the [RANGE] key to switch manual range; its range is fixed to the currently executing range. This causes [R-H] to appear.
2. Each time this key is pressed, the range becomes maximized subsequently. After the display reaches the most significant range, it returns to the least significant range, and repeats such action.

Note: To confirm the range, cover the light-detecting surface with the cap to make the luminous intensity zero.

3. When the display shows the setting range, stop this key operation.
4. Keep pressing this key for two seconds to return to automatic range.

Average Illuminance [AVG] Key

The average illuminance can be calculated using 4-point and 5-point methods. This digital illuminance meter provides five memory devices to retain the measured values of each measuring point. When the measurement is completed, the average illuminance can be calculated and displayed.

Operation

1. Press the [AVG] key. This causes [AVG MEMO -] to appear.
2. Save the measuring point data in memory.

· In the case of the 4-point method

Designate location keys [1] to [4] each to one of the four corners in a room by pressing the keys to allow the respective measuring point data to be retained in memory.

When the location keys are pressed, the storage-location number corresponding to the key number appears after AVG MEMO - in the display area. When the data from the four locations are retained, the display shows [AVG MEMO - 1 2 3 4].

· In the case of the 5-point method

Designate location keys [1] to [4] each to one of the four sides in a room by pressing the keys to allow the respective measuring point data to be retained in memory. Moreover, get the measurement data for the center of gravity by pressing location key [C] (the order for retention in memory can be ignored). When the location keys are pressed, the storage-location number corresponding to the key number appears after AVG MEMO - in the display area. When the data for the five locations are retained in memory, the display shows [AVG MEMO - 1 2 3 4 C].

3. After either [AVG MEMO - 1 2 3 4] or [AVG MEMO - 1 2 3 4 C] appears, press the [AVG] key again. This causes [MEMO] to disappear, and the calculated results to appear.
4. To confirm the retained value of a location, keep pressing the desired location key.
5. To release, press the [AVG] key for two seconds.

Note: To repeat a measurement, start operation from the beginning after the release operation is done once. If data are stored in a wrong location, press that location key for two seconds so the display of the storage-location disappears; then, store the data in the correct location.

Deviation Display [Δ/%] Key

This key is the deviation display function. The deviation is displayed by setting the reference luminous intensity and calculating the deviation to the set reference value. The display is twofold:

(1) Deviation value display Δ

Δ = (measured value) - (reference value)

(2) Percent display

% = (Δ/reference value) x 100

Operation

1. Measure the reference luminous intensity and then press the [Δ/%] key. The measured value at that time is retained in memory as a reference value.

   This causes [Δ, R-H] to appear and the measured range is fixed. After that, the deviation value is displayed.

2. Press the [Δ/%] key again to change to the percent display. This causes [%] to appear. Each time this key is pressed, these two appear alternately.

3. To confirm the reference value, keep pressing the [CALL] key.

4. To release, press the [Δ/%] key for two seconds.

Note: If the measured value exceeds the measuring range, [OL] appears.

Light Source Luminous Intensity [cd] Key

If a single light source is used and is regarded as a single-point light source, the luminous intensity of the light source can be calculated and displayed, by setting the distance from the light source to the measuring point.

Luminous intensity (cd) = illuminance (lx) × distance $(m)^2$

Set the distance to the measuring light source in advance.

How to Set (Change) Distance

1. Press the [SET] key and then the [**cd**] key. This causes [SET, m] to appear.
2. Enter the distance between the light source to be measured and the reference plane of the illuminance meter using the [∧] and [>] keys. The unit is m.
3. Press the [SET] key again. This causes [SET, m] to disappear, resulting in ending the setting.

Operation

1. Press the [**cd**] key. This causes [cd] to appear.
2. Face the light-detecting surface of the illuminance meter towards the light source. Set the distance correctly to the input value showing the distance between the light-detecting surface and the light source. To confirm the distance input, keep pressing the [CALL] key.
3. Read the display.
4. To release, press the [**cd**] key again. This causes [cd] to disappear.

Totalized Intensity of Illumination [ACC] Key

This key calculates and displays the totalized intensity of illumination and integral time. The maximum value of the totalized intensity of illumination is 9,990,000,000 lx-h (effective value: 3 digits), and that of the integral time is 10,000 hours. Also, a comparator function (hold function) is incorporated in this function. When the totalized intensity of illumination reaches the previously set value, the totalization stops at that value to enable the integral time at a totalization stop to be read. If this function is used, set the comparator limit value in advance.

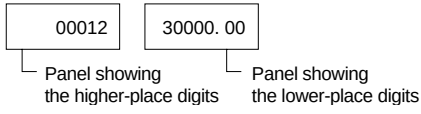
Note: If the battery voltage drops while long-time totalization is executing, a totalization error occurs during that time. Thus, it is recommended that an AC adaptor be used.

How to Set Comparator (only in cases where comparator is used)

The number of digits available to be set is 12 maximum (including up to the second decimal place), consisting of three digits for the effective value and 0's in the remaining digits' places. The input should be set, dividing the digits into the higher-place digits (5 digits) and the lower-place digits (7).

1. Press the [SET] key and then the [ACC] key. This causes [SET, lx-h] to appear.
2. The panel displayed first is for determining the higher digits (5 digits). Use the [∧] and [>] keys to input a number subsequently. When the higher-place digit input is completed, press the [>] key to proceed to the next panel for determining the lower-place digits. Use the [∧] and [>] keys to input a number subsequently.

   Example: Setting of "1230000"

3. When the input is completed, press the [SET] key. This causes [SET] to disappear, resulting in ending the setting.

Operation

1. Press the [ACC] key. This causes [lx-h] to appear, resulting in the start of totalization. Also, this causes [AUTO POWER OFF] to disappear, resulting in release of automatic power off.

· If the comparator function is used, press the [COMP] key. This causes [COMP, Go] to appear. "Go" means totalization is in progress.

2. Each time this key is pressed, the integral time and totalized value are displayed alternately. In the case of the integral time, the display shows [h].
3. To stop totalization (integration), press the [HOLD] switch (lock). This causes [D-H] to appear, momentarily stopping the integration of illuminance and time. To continue totalization (integration), press the

HOLD switch again (lock release).

- If the comparator function is used, when the value reaches the set totalized value, the display shows [D-H, Hi], notifying you that totalization (integration) has stopped. The value indicated at that time stands for the integral time.

4. To confirm the comparator set value, keep pressing the CALL key. If the number of digits exceeds 7, the higher digits are displayed alternately with the lower ones.

5. To release, press the ACC key for two seconds.

Note: If either the totalized intensity of illumination or integral time reaches the maximum value, the integral function stops. This causes [D–H] to appear, notifying you that this function has stopped.

Comparator COMP Key

The comparator is available upon illuminance measurement. Set the limit of the comparator in advance. The Lo and Hi levels can be set for the limit values. Executing this function indicates the results in the display area and enables comparator output to be taken from the data output connector. Table 2 shows the display and output.

Table 2. Data Output Table

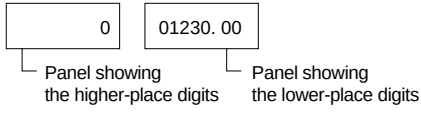
Conditions	Display	Comparator output	
		Lo	Hi
LO set value > indicated value	Lo	H	L
LO set value ≦ indicated value ≦ HI set value	Go	L	L
Indicated value > HI set value	Hi	L	H

The number of digits available to be set is 8 maximum (including up to the second decimal place), consisting of three digits for the effective value and 0's for the remaining digits' places.

How to Set (Change) Comparator

1. Press the [SET] key and then the [COMP] key. This causes [SET COMP Lo] to appear. Lo stands for the low side.
2. Each time this key is pressed, Hi and Lo are displayed alternately. Here, stop the alternation at the Lo side.
3. The panel displayed first is for determining the higher-place digit. Use the [∧] key to input a number. When higher-place digit input is completed, press the [>] key to proceed to the next panel for determining the lower-place digits. Use the [∧] and [>] keys to input a number subsequently.

Example: Setting of "1230"



4. Press the [COMP] key to change the indication from Lo to Hi and do the same operation as in item 2.
5. Confirmation of set values is possible by pressing the [COMP] and [>] keys.
6. After the input is completed, press the [SET] key. This causes [SET] to disappear.

Operation

1. Confirm that illuminance measurement (including the color correction factor function) is in progress.
2. Press the [COMP] key. The comparator function is executed with [COMP] appearing along with either Lo, Go, or Hi. The comparator output signal is generated.
3. To confirm set values, keep pressing the [CALL] key. The set values for Lo and Hi can be confirmed at 1.5-second intervals.
4. To release, press the [COMP] key for two seconds, and the display

disappears, causing signal output to stop.

Ripple Measurement S–F Key

Illuminance Measurement During Daylight Hours

This function measures easily the intensity of illumination of fluorescent lamps during daylight hours. If the illumination is to be measured during the daytime, stray sunlight influences the measurement. During daylight hours, measurement is done by turning on the fluorescent lamp first, and then turning off the lamp to measure the stray light, and finally subtracting this stray light. However, this method makes it necessary to repeat turning the lamp on/off for each measuring point and to wait for stabilization of the intensity of illumination after the lamp is turned on; thus, this results in taking much time and placing a heavy burden on the operator if there are many measuring points.

Another method is where the intensity of illumination of each measuring point is measured with the fluorescent lamp turned on, and then the lamp is turned off to measure the stray light at the same point and collectively subtracting this stray light. However, this method has disadvantages, such as difficulty in ensuring the same place and elevation when the lamp is turned on and off, and errors caused by variations in the stray light. Clearly, the intensity of illumination should be measured at night in general.

Measurement Principle

This illuminance meter can calculate the illuminance by using the characteristic where the AC compound included in the radiation of a fluorescent lamp lit with a commercial power frequency has a constant ratio (ripple ratio) to the DC compound (average value), and by measuring the AC compound. The ripple ratio should be calculated prior to measurement.

According to Figure 6, the ripple ratio is:

$$\text{Ripple ratio} = \frac{\text{(DC compound Ld)}}{\text{(AC compound Lr)}} = \frac{\{\text{(Total room illuminance)} - \text{(Stray light Lg)}\}}{\text{(AC compound Lr)}}$$

The illuminance to be obtained is:
Illuminance = (AC compound Lr) x (ripple ratio)

The illuminance can be calculated by measuring the AC compound.

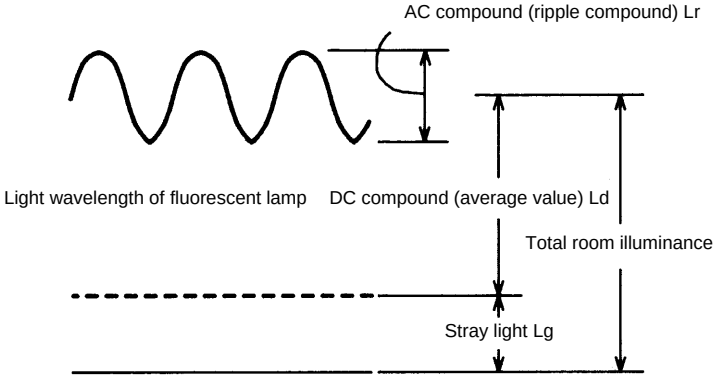


Figure 6. Measurement Principle Diagram

How to Set Ripple Ratio

The ripple ratio should be set in advance, prior to ripple measurement. Once the ripple ratio is set, illuminance can be measured under the same conditions (the same kind of fluorescent lamp). Immediately after the fluorescent lamp is turned on, the light source is not stable; thus, set the ripple ratio 30 minutes after the lamp is turned on. Select a location in the room where there is little stray light, and set the ripple ratio under the fluorescent lamp.

Never move the illuminance meter during the setting operation.

1. Face the light-detecting surface of the illuminance meter towards the light source to be measured, and then press the SET and S–F keys. A [———] display appears for approximately five seconds. For the moment, total illuminance and ripple are measured.

2. When the display shows [L-OFF] (light is off), turn off all fluorescent lamps.

3. Press the SET key. A [———] display appears for three seconds. When the setting computation is completed, this returns to normal measurement. (The stray light is measured and the ripple ratio is computed.)

Note: If "Err" appears, the ripple ratio is not set. Press the SET key to release the error, and change the location before restarting. "Err" appears in the following cases:

- If the stray light is greater than or equal to that from the fluorescent lamp
- If the ratio of the AC compound to the illuminance to be calculated is considerably small

The set ripple ratio is retained in memory even after the power is turned off until the setting is next updated.

Operation (Ripple Measurement)

1. Press the S–F key. The display [S-F] appears.

2. Start measurement.

3. To confirm the ripple ratio, keep pressing the CALL key.

4. To release ripple measurement, press the [S-F] key again, and the display disappears.

Data Output

Digital data output and comparator output can be transferred out through the data output connector. The output data are illuminance measurement data (the luminous intensity is included if the light source's luminous intensity is set; correction computation is included if the color correction factor is set; and the ripple measurement value is included if the ripple is measured), which are transmitted as BCD serial data conforming to our standard format, regardless of function key settings.

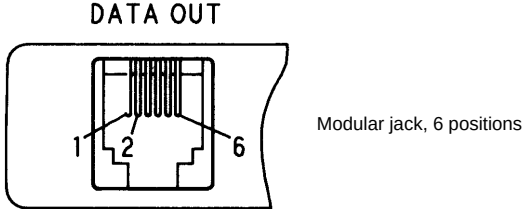


Figure 7. Connector Pin Arrangement

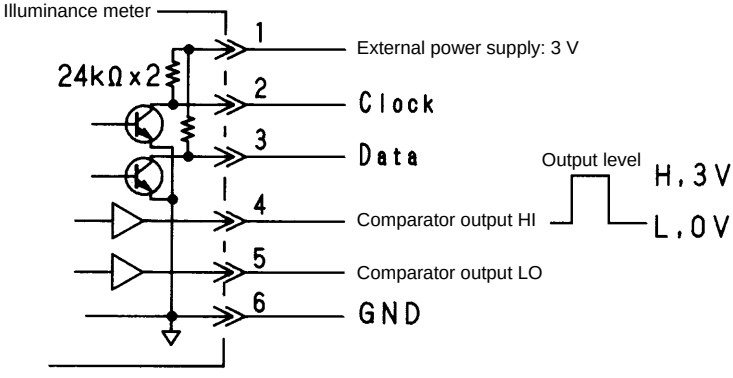


Figure 8. Connection Circuit

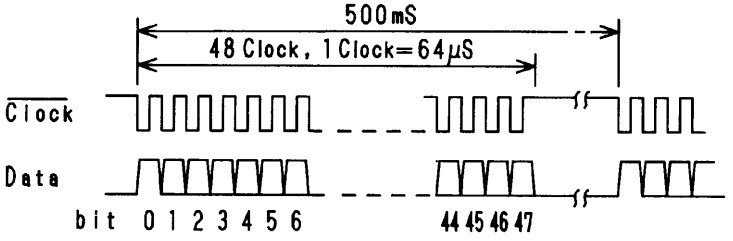


Figure 9. Timing Chart

Table 3. Contents of Data

Bit	Data	Bit Output
0	Start bit	H
1	Measurement data overflow	
2	Function-setting data hold	
3	Measurement data sign (-)	
4	Error	
5	Lo batt (low battery voltage)	
6	Data length (48 bits)	L
7		L
8	Model code (illuminance meter)	L
9		L
10		H
11		H
12	Measurement data decimal point dp1	
13	dp2	
14	dp3	
15	Unused	L
16	Unused	L
17		L
18		L
19		L
20	Measurement data 10^2 8	
21	4	
22	2	
23	1	

Bit	Data	Bit Output
24	Measurement data 10^1 8	
25	4	
26	2	
27	1	
28	Measurement data 10^0 8	
29	4	
30	2	
31	1	
32	Unused	L
33		L
34		L
35		L
36		L
37		L
38		L
39		L
40	Measurement data exponent 10^{-6}	
41	10^{-3}	
42	10^{-3}	
43	10^{-6}	
44	Display of unit lx	
45	Unused	L
46	2Display of unit cd	
47	Unused	L

The levels of L and H in bit output are fixed.

Note

- The application of this accessory could affect the immunity performance of the product and such items should be used with this consideration.
- Interconnection with other apparatus is not recommended.

Recorder Output (Analog Output)

Recorder output is connected to observation equipment (recorder, oscilloscope, etc.), and records of illuminance variation or a light source waveform can be observed.

Specifications: 999mV ±5% (range fixed for full scale of each range) Load resistance of 100 kΩ or more

1. Prepare a coated single-core shielded wire and solder it to the attached recorder output plug as shown in Figure 10. Connect another shielded wire to the input connector of the observation equipment.

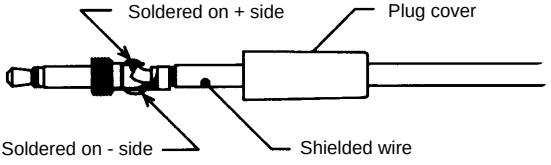


Figure 10. Shielded Wire Connection Diagram

2. Turn on the power to the illuminance meter and insert the plug into the recorder output connector of the light detector. The display [REC , R-H] appears, and the range is fixed (manual range).
3. Set the response selector switch to FAST.
4. The output voltage is 1 mV for one numeral of the least significant digit of the effective display (3 digits). Confirm the range according to the illuminance-measuring range. Use the RANGE key for range setting.
5. Cover the light detector with the cap to adjust the zero level of the observation equipment.
6. Remove the cap from the light detector to start observation.

Note

- The application of this accessory could affect the immunity performance of the product and such items should be used with this consideration.
- Interconnection with other apparatus is not recommended.

Separation of Light Detector

This illuminance meter can be used with the light detector and main unit separated. Prepare a dedicated connection cable (an accessory sold separately).

1. Turn off the power.
2. Press the eject button and the release lock to separate the light detector from the main unit.
3. Insert the plug (the plug with the eject pins) of the connection cable into the main unit and confirm that the connection is locked.
4. Connect the other end of the connection cable (the plug with the YOKOGAWA logo) to the light detector and confirm that the detector is locked to the connector.
5. Turn on the power to start measurement.
6. To disconnect the connection cable, press the eject buttons both on the plug connected to the light detector and on the main unit to release the two locks.

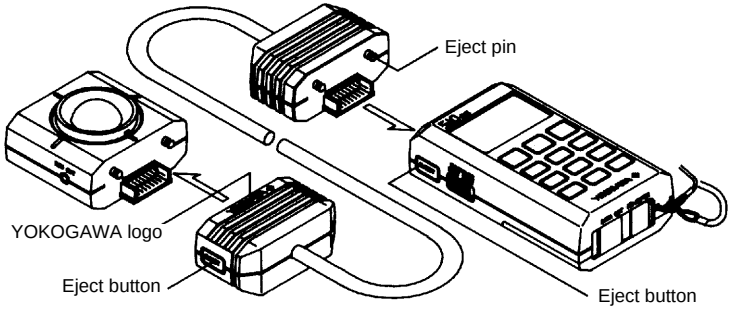


Figure 11. Connection with Separated Light Detector

Note

- The application of this accessory could affect the immunity performance of the product and such items should be used with this consideration.
- Interconnection with other apparatus is not recommended.

Use of AC Adaptor

In order to maintain correct operation, always use accessories (sold separately).

Model: 940 01
Rating: Input of 120 V ±10% AC
Output of 9 V 100 mA DC
Model: 940 02
Rating: Input of 220 V ±10% AC
Output of 9 V 100 mA DC

Note

- The application of this accessory could affect the immunity performance of the product and such items should be used with this consideration.
- Interconnection with other apparatus is not recommended.

After-sales Servicing

If repair work is necessary because of incorrect operation, consult the Yokogawa sales representative from whom you purchased the instrument or the Yokogawa sales division listed on the back of this manual.

Error Massage

When “Err.1” or “Err.2” massage is indicated on the display, repair work is necessary.

Specifications

Class: Conformance to Class AA in JIS C 1609-1: 2006
Photoelectric element: Silicon photodiode
Display: Liquid crystal display (numbers up to 7 digits); with function and unit display provided; maximum effective display: 999 + (0 or 0's to indicate the number of digit places)
Overrange [OL]
Low battery voltage [⊟]
Measurement cycle: Twice per second
Measuring ranges: 0.00 to 9.99/99.9/999/9,990/99,900/999,000 lx
Automatic/manual selection of range
Accuracy: At 23°C±2°C
If the reading is 3000 lx or less:± 2% of reading ±1 (effective minimum digit)
If the reading is greater than 3000 lx: ± 3% of reading ±1 (effective minimum digit)
Response time: Automatic range: 5 sec; manual range: 2 sec
Characteristics of oblique incident light:

Angle of:	Deviation from the cosine law
10°	±1%
30°	±2%
50°	±6%
60°	±7%
80°	±25%

Characteristics of relative visible-spectrum response:
Deviation from the standard spectrum luminous efficiency fs (JIS C 1609-1): within 6%
Ripple measurement: Illuminance measurement of fluorescent lamp (except for high-frequency lighting) during daylight hours
Measuring range: 100 to 3000 lx
Accuracy: at 23°C ± 2°C; ± 7% of reading ±1 (effective minimum digit)
Temperature characteristics: ±3% at 23°C reference and a range of -10 to 40°C
Humidity characteristics: ±3%
Recorder output: 1 V ±5% (fixed range, for each range)
Load resistance: 100 kΩ or more

Automatic power-off:	Except when the integral function is working or the recorder (data) output plug is connected. After the last key has been pressed, the time set up for automatic power-off can be prolonged for approximately 30 minutes. This function can be disabled.
Operating temperature:	Between -10 and 40°C
Operating humidity:	80% R.H. or less; no moisture condensation
EMC standards:	EN55011: 1998 Group 1 Class B EN61326-1; 1997+A1; 1998 EN61000-3-2; 1995 EN61000-3-3; 1995
Effect of radiation immunity:	Accuracy range of reading: [Rated accuracy+10% of range] for the strength of a radio-frequency electromagnetic field of 3 V/m
Power supply:	9-V dry cell battery 6F22 (S-006P)/6LR61 or an AC adaptor (optional)
Dimensions:	Approx. 67 (W) x 177 (H) x 38 (D) mm
Weight:	Approx. 260 g

Note

If a high electromagnetic interference equipment exists in the near vicinity of the instrument, this may cause malfunction.

Characteristics of Relative Visible-spectrum Response

The visible spectrum of light to which human beings are considered sensitive has an extremely narrow range: 360 to 830 nm. Within this range, sensitivity differs greatly depending on the wavelength. This phenomenon is called standard spectrum luminous efficiency, indicated by V (λ).

An illuminance meter is used to measure the luminous intensity, and the characteristics of relative visible-spectrum response plays an important role in illuminance measurement. This meter, rather than the human eye, brings these characteristics to the same degree of brightness as V (λ). These characteristics are standardized to the engineering standards of a legally certified luxmeter and to JIS C 1609 standards. The relative spectrum response of an illuminance meter S (λ) is measured in 95 wavelengths at 5-nm intervals to calculate the deviation from V (λ) (fs). This method of evaluation adopts the performance evaluation of the Commission Internationale de l'Eclairage (International Commission on Illumination) (CIE). Moreover, there are various light sources such as white light, fluorescent lamps, mercury-vapor lamps, and others on the market. The ideal would be for the relative spectrum response of the illuminance meter and V (λ) to match absolutely; however, there is a subtle deviation between them. Thus, a subtle indication error occurs if the illuminance of a light source having a different spectrum distribution from that upon calibration is measured. To correct this error, color correction factors are provided. To make an accurate measurement, it is recommended that color be corrected by multiplying the color correction factor of the measuring light source by the indicated value on the illuminance meter. Figure 12 shows the characteristics of the relative spectrum response:

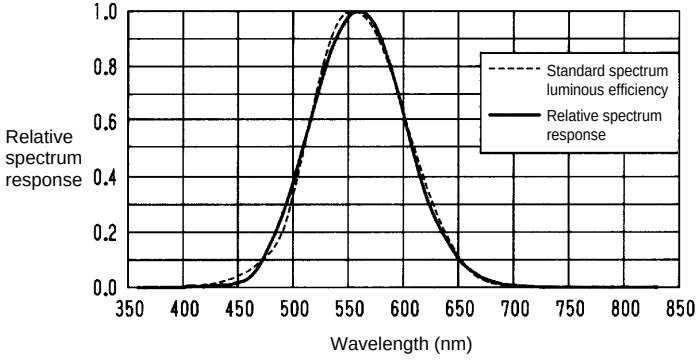


Figure 12. Characteristics of Relative Visible-spectrum Response

Characteristic of Oblique Incident Light

When reading a book at night, you will find that the brightness differs between reading under a lamp or light and reading a little farther from the light. At that time, you can see that the words are more legible if you turn the book toward the light. Oblique incident light has the characteristic that when the angle between the tangential line of an illuminated surface and the direction of incidence is supposed to be θ, the illuminance of the surface is proportional to cos θ. This characteristic is also standardized. If the cosine law did not hold true, the intensity of illumination from a light source in an oblique direction could not be measured accurately. Figure 13 shows the characteristic of oblique incident light.

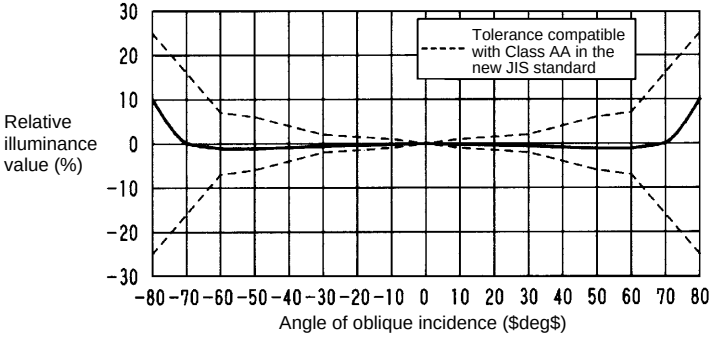


Figure 13. Characteristic of Oblique Incident Light

Illuminance Measurements for Lighting Installations

(Extract from JIS C 7612 standards)

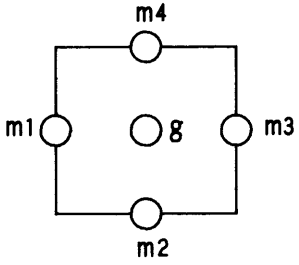
For general lighting, the horizontal angle of light shall be measured to obtain an average value. Unless otherwise specified, the height of the measuring surface shall be within 85 cm from the floor, 40 cm from the tatami floor in the case of a Japanese-style room, or nearly on the surface of the floor or ground in the case of a corridor or the outdoors (If it is difficult to measure the illuminance on the floor or ground, the height shall be within 15 cm from the floor or ground).

The location for measurement shall be divided into equal areas by vertical and horizontal partitioning lines, and the average illuminance for each area shall be calculated. The calculated average of the areas shall be the average illuminance of the total area measured. According to the 5-point method given in Figure 14, the middle of each side (the m point) and the center of gravity (the g point) shall be measured to obtain the average illuminance for each area according to the following expression:

$$\overline{E}_0 = \frac{1}{6}(E_{m1} + E_{m2} + E_{m3} + E_{m4} + 2E_g) = \frac{1}{6}(\sum E_m + 2E_g)$$

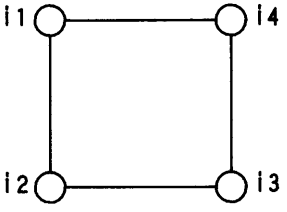
If the variation of the illuminance is small, the illuminance may be measured according to the 4-point method given in Figure 15 after measuring the illuminance (Ei) of the four corners (the i point):

$$\overline{E}_0 = \frac{1}{4}(E_{i1} + E_{i2} + E_{i3} + E_{i4}) = \frac{1}{4}\sum E_i$$



$$\bar{E}_0 = \frac{1}{6}\left(\Sigma^4 Em + 2E_g\right)$$

Figure 14. 5-point Method



$$\bar{E}_0 = \frac{1}{4}\Sigma^4 E_i$$

Figure 15. 4-point Method

This illuminance meter has the function where measurement according to the 4- or 5-point method is easy (see the item, “Average Illuminance”). Also there is the method where the average illuminance of multiple divided areas is obtained directly. For details, refer to JIS C 7612.

MEMO

Waste Electrical and Electronic Equipment (WEEE), Directive 2002/96/EC

This Product complies with the WEEE Directive (2002/96/EC) marking requirement. The affixed product label (see below) indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category

With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a “Monitoring and Control instrumentation” product.

To return unwanted products within the EU area, contact your local Yokogawa Europe B. V. office.
Do not dispose in domestic household waste.

YOKOGAWA

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