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**Photometry of white light emitting
diode for general lighting—Part 1:
LED packages**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Lighting Manufacturers Association (JLMA)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied *mutatis mutandis* pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS C 8152-1**: 2014), which has been technically revised.

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JIS C 8152 series consists of the following 3 parts under the general title *Photometry of white light emitting diode for general lighting*:

Part 1: LED packages

Part 2: LED modules and LED light engines

Part 3: measurement methods for lumen maintenance

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Photometry of white light emitting diode for general lighting—Part 1: LED packages

Introduction

This Japanese Industrial Standard was established in 2012, and has gone through two revisions including this one. The last revision was made in 2014, and the revision at this time is to respond to the progress in LED luminaire products and the advances in photometric technology.

No corresponding International Standard has been established at this point.

1 Scope

This Standard specifies the method for obtaining the luminous quantities such as CIE averaged LED intensity and total luminous flux, and the quantities concerning the light source colour of white light emitting diode (LED) packages for general lighting.

The photometry of light sources for general lighting (including bulb-type LED lamps) shall be in accordance with **JIS C 7801**. Furthermore, see **JIS C 8152-2** for the photometry of LED modules and LED light engines, and **JIS C 8105-5** for the photometry of LED luminaires etc. using a light distribution measurement device.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS C 1609-1 *Illuminance meters Part 1: General measuring instruments*

JIS C 62504 *General lighting—Light emitting diode (LED) products and related equipment—Terms and definitions*

JIS Z 8103 *Glossary of terms used in measurement*

JIS Z 8113 *Lighting vocabulary*

JIS Z 8724 *Methods of colour measurement—Light-source colour*

JIS Z 8725 *Methods for determining distribution temperature and colour temperature or correlated colour temperature of light sources*

JIS Z 8726 *Method of specifying colour rendering properties of light sources*

JIS Z 8781-1 *Colorimetry—Part 1: CIE standard colorimetric observers*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS Z 8103**, **JIS Z 8113** and **JIS C 62504**, and the following apply.

3.1

LED light engine

light source unit of an LED luminaire consisting of LED packages or LED modules arranged in planar or steric alignment together with a lighting device, and also of multiple mechanical, electrical/electronic and optical components

Some are without a lighting device.

3.2

bulb-type LED lamp

LED device of such a structure that one or more LEDs, controlgears and Type E, Type B or Type GX53 cap are integrated

NOTE It may be referred to as a retrofit LED lamp.

3.3

standard LED

LED of which CIE averaged LED intensity, total luminous flux, etc. have been calibrated, used as a reference for comparison in photometry

3.4

centroid wavelength

in a measurement device in which a selective response is shown to a specific wavelength range, wavelength that represents the selective response

The centroid wavelength is expressed by the following formula.

$$\lambda_g = \frac{\int_0^{\infty} \lambda \times R(\lambda) d\lambda}{\int_0^{\infty} R(\lambda) d\lambda}$$

where, λ_g : centroid wavelength (nm)

λ : wavelength (nm)

$R(\lambda)$: relative spectral responsivity of photometer

3.5

polychromator

device that makes parallel detection of spectral components of emission, with the aid of light-receiving elements arranged in an array placed on the image-formation face of a spectrum distributed by a diffraction grating, etc.

3.6

spectral slit width

one of the quantities representing the transmitted wavelength band characteristics of a spectrophotometer, which indicates the effective wavelength width of the transmitted wavelength band of spectrophotometer

The spectral slit width is either the spectral entrance slit width or the spectral exit slit width. The spectral entrance slit width is expressed by the following formula.

$$b_i = \frac{w_i}{f_i \times \frac{d\theta_i}{d\lambda}}$$

where, b_i : spectral entrance slit width (nm)
 w_i : mechanical width of entrance slit (mm)
 $\frac{d\theta_i}{d\lambda}$: angular dispersion in entrance side (rad · nm⁻¹)
 f_i : focal distance of collimator (mm)

The spectral exit slit width is expressed by the following formula. If the spectrophotometer is a polychromator, the width in the dispersion direction in the light-receiving surface of one of the light-receiving elements arranged in an array is regarded as the mechanical width of an exit slit.

$$b_o = \frac{w_o}{f_o \times \frac{d\theta_o}{d\lambda}}$$

where, b_o : spectral exit slit width (nm)
 w_o : mechanical width of exit slit (mm)
 $\frac{d\theta_o}{d\lambda}$: angular dispersion in exit side (rad · nm⁻¹)
 f_o : optical focal distance of formation of dispersed image on the exit slit when the spectrophotometer is a monochromator (mm)
 optical focal distance of formation of dispersed image on the light-receiving element when the spectrophotometer is a polychromator (mm)

The transmitted wavelength band characteristics of the spectrophotometer with the spectral entrance slit width b_i and the spectral exit slit width b_o show the shape of a trapezoid of which the lower base ($b_i + b_o$) touches the wavelength axis and the upper base becomes $|b_i - b_o|$. The spectral slit width of a monochromator uses b_i or b_o , whichever is larger.

3.7

self-absorption correction factor

factor used for correction of the integrating sphere efficiency, which is defined as the rate of the total luminous flux of a lit light source transmitted to the photodetector, and which varies depending on the installation/removal of a light source, lighting jig, etc. inside the integrating sphere

In the measurement of the total luminous flux, this factor corrects the variation of the photodetector output between the measurement with the standard LED installed and the measurement with the LED under test installed.

4 Standard LED

4.1 General

A standard LED that meets the conditions specified in 4.2 to 4.4 shall be used. Specifications are given respectively for a standard LED for luminous intensity and that for total luminous flux.

For the graduation of the standard LED, traceability to national standards shall be established.

NOTE Traceability to national standards should be established through receiving calibration undertaken by a calibration organization (registered undertaker) that satisfies the requirements of Japan Calibration Service System (JCSS) based on the Measurement Act.

4.2 Structure

The standard LED shall have a structure that conforms to the following requirements.

- a) The light-emitting part of an LED package shall be fixed to the unbiased position with respect to the mechanical central axis of the LED package so that there is no hindrance to photometry.
- b) The sealing part from which light is emitted shall be free from any defects interfering with photometry such as bubbles, flaws and chips that are detrimental to use. The terminal part, the bottom face of the sealing part, etc. that come into contact with the fixing jig for measurement shall be free from any contour abnormalities that may easily change the photometry direction during use.
- c) For the total luminous flux standard LED of an LED having backward emission, the backward emission shall not be absorbed by a lighting jig, etc.

NOTE 1 An example of luminous intensity standard LEDs is a white LED for general lighting using an InGaN system LED chip and YAG (yttrium aluminium garnet) phosphor, which is a shell-shaped LED package having a sealing part made of epoxy resin containing diffusing agents and a conductive terminal made of copper alloy.

NOTE 2 An example of total luminous flux standard LEDs having no backward emission is a white LED for general lighting using an InGaN system LED chip and YAG phosphor, of which the sealing part body is made of iron alloy for shielding light emission to the LED back (terminal side) and the window on the front face of the sealing part is made of transparent hard glass.

4.3 Performance and reproducibility

The standard LED shall meet the following characteristics requirements when its emission spectrum and light distribution characteristics are close to those of the LED under test and it is lit at the specific ambient temperature with the fluctuation kept within 2 K and at the specified current.

- a) The light distribution characteristics of luminous intensity standard LED shall ensure uniformity of light, and variation of luminous intensity not exceeding $\pm 5 \%$ and variation of chromaticity in the xy chromaticity diagram not exceeding (± 0.003 , ± 0.003) in the angular range of $\pm 5^\circ$ with respect to the mechanical central axis.
- b) The light distribution characteristics of total luminous flux standard LED shall ensure uniformity of light, and the direction of light emitted from an LED shall be taken as the measurement angle range.
- c) The reproducibility of photometric values when lit twice shall be $\pm 0.5 \%$.
- d) The maintenance rate of a graduation when continuously lit for 100 h shall be $\pm 3 \%$ to the initial value.

Examples of a luminous intensity standard LED and a total luminous flux standard LED are shown in Table 1, Figure 1 and Figure 2.

The measurement angle range of the light distribution of a total luminous flux standard LED may be regulated using a lighting jig, etc.

Table 1 Example of standard LED (types, dimensions and performances of LED package)

	Type of LED package	Outside diameter of sealing part mm	Overall length mm	CIE averaged LED intensity (nominal value) I_v mcd	Total luminous flux (nominal value) Φ_v lm	Input voltage (nominal value) V_f V
Luminous intensity standard LED	Shell-shaped type	5.0 ± 0.2	30.6 ± 1.0	500	—	3.2
Total luminous flux standard LED	Type TO-18	4.7 ± 0.2	18.1 ± 1.0	—	1 200	3.2

NOTE The values of LED input voltage, CIE averaged LED intensity and total luminous flux assume the lighting at an ambient temperature of 25 °C and at an LED input current of 20 mA.

Unit: mm

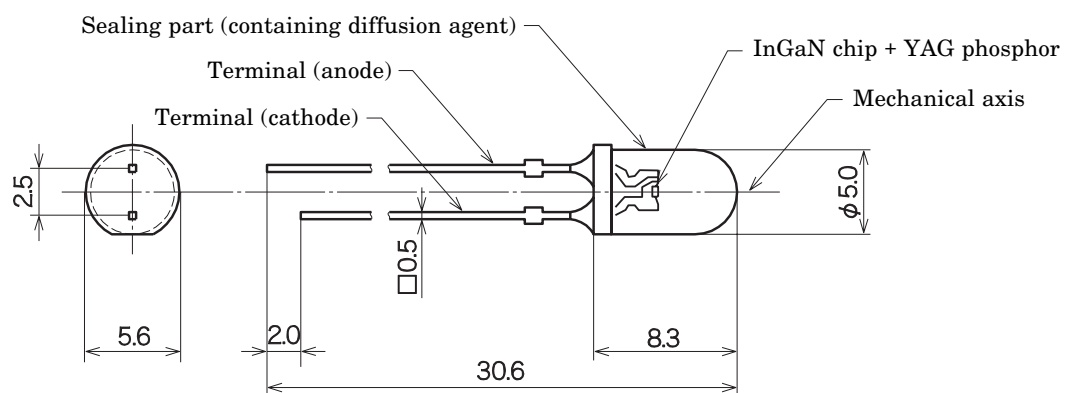


Figure 1 Example of luminous intensity standard LED ($\phi 5$ mm shell-shaped type package)

Unit: mm

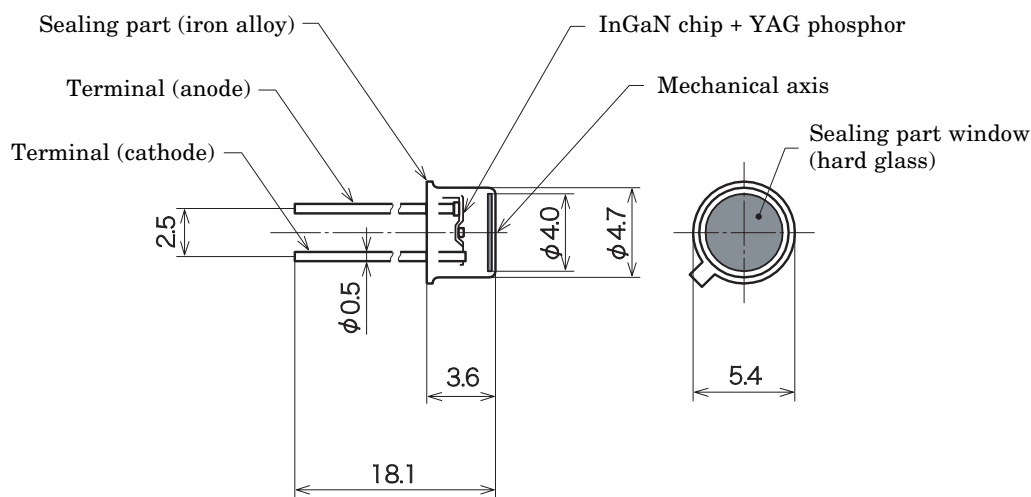


Figure 2 Example of total luminous flux standard LED (TO-18 metal can type package)

4.4 Lighting conditions of standard LED

The lighting conditions of standard LED shall be as follows.

- a) The lighting method shall be in accordance with Annex A. Prior to measurement, the standard LED shall be lit for a specified time until the temperature (junction temperature) of the LED chip has become constant, and it is ensured that its electric characteristics and optical output have stabilized¹⁾.

Note ¹⁾ The stabilization time should be 5 min or longer.

- b) The characteristics of an LED, which is a semiconductor, vary according to temperature and input current. In order to keep the optical output constant by minimizing the fluctuation of the temperature (junction temperature) of the LED chip during the measurement, lighting shall be performed under the constant current condition (e.g. 20 mA) with the fluctuation of ambient temperature kept within 2 K. It is also necessary to take notice that light colour changes easily due to temperature and current. Also, the LED shall not be directly exposed to wind during lighting.
- c) When the manufacturer or the like has specified lighting conditions for ensuring reproducibility and stability of lighting, those conditions shall be used. An example of the temperature control socket (lighting jig with a temperature control function of an LED chip) that can stably hold an LED thermally and spatially is shown in Annex B.

4.5 Precautions for handling of standard LED

In order to avoid an initial fluctuation, an LED which has been aged for 100 h or longer at a constant current (e.g. 20 mA) shall be used.

5 Photodetector

5.1 General

General matters of a photodetector (photometer) used for measurement shall be in accordance with **JIS C 1609-1**.

5.2 Performance

The performance of a photodetector used for measurement shall be in accordance with either of the following. When the spectra of a standard LED and an LED under test differ, as necessary, correction shall be made by multiplying a measured value by a colour correction factor (see Annex C).

- a) General class AA illuminance meter specified in **JIS C 1609-1**.
- b) Special illuminance measuring instrument in which the linearity and the visible region relative spectral responsivity characteristics are equivalent to those of the General class AA illuminance meter of **JIS C 1609-1**, or spectrophotometer that has a performance equivalent to this and meets requirements of **JIS Z 8724**.

For the evaluation of characteristics of a photodetector, each evaluation method of the uniformity of response of the light-receiving base surface or the light-receiving surface of the light-receiving part of the illuminance meter specified in **JIS C 1609-1** may be used.

6 Lighting conditions of LED under test

The lighting conditions of LED under test shall be as follows.

- a) The lighting method shall be in accordance with Annex A. Prior to measurement, the LED under test shall be lit for a specified time until the temperature (junction temperature) of the LED chip has become constant, and it is ensured that its electric characteristics and optical output have stabilized ¹⁾.
- b) The LED under test shall be lit under the specified current condition (e.g. 20 mA) with the fluctuation of ambient temperature kept within 2 K. Also, the LED shall not be directly exposed to wind during lighting.
- c) When the manufacturer or the like has specified lighting conditions for ensuring reproducibility and stability of lighting, those conditions shall be used.
- d) When lit under the specified current condition, the LED input voltage (forward voltage) and the ambient temperature shall be recorded.

7 Measurement of luminous intensity

7.1 General

For the measurement of luminous intensity, the CIE averaged LED intensity shall be used. The luminous intensity of the LED under test shall be obtained by the comparison with the standard LED of which the CIE averaged LED intensity is calibrated, lit at the same position as the LED under test.