BS 7920:2005

Luminance meters — Requirements and test methods

ICS 17.180.20; 29.140.40

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British Standards

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Foreword

This British Standard has been prepared by Subcommittee CPL/34/5. Together with BS EN 13032-1:2004, it supersedes BS 7920:1998, which is withdrawn.

Luminance meters are used for measurements relating to many varied applications, such as:

— road lighting;

— road tunnel entrances;

— cathode ray tubes and other display screens;

— light boxes for examining X-ray and other transparencies;

— road and advertising signs;

— signal lamps such as traffic lights.

In many of these applications luminance levels are specified.

The approach of this standard is similar to that used for BS 667:2005 on illuminance meters. This British Standard specifies the requirements for two types of luminance meter: Type L: laboratory instruments and Type F: field instruments. The error tolerances have been considered in a similar manner to that used in CIE Publication 69 [1], and the definitions are based on CIE Publication 17.4 [2].

Error tolerances for Type L meters have been aligned with those given in BS EN 13032-1:2004, Table 4.

BS EN 13032-1 specifies laboratory luminance meters for testing luminaires only. It does not cover luminance meters for other laboratory purposes or for field use.

This new edition of BS 7920 incorporates changes necessitated by the publication of BS EN 13032-1:2004. It does not reflect a full review or revision of the standard which will be undertaken in due course.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages 1 to 15 and a back cover.

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Introduction

As lighting levels reduce, the response characteristics of the human eye change from photopic during the day through an intermediate mesopic region at dusk to a scotopic response at night time.

At present, eye response functions have not been defined in the mesopic region; research work is still in progress on this subject. Although photopic measurements are generally only applicable at lighting levels above about 2 $cd \cdot m^{-2}$, in practice lighting levels for installations are specified at values significantly below this. It is therefore necessary to make luminance measurements with known accuracy at these lower levels to check performance against such specifications whilst accepting that the measurements do not accurately represent the visual response.

Photometric measurements, even under laboratory conditions, are more difficult to determine precisely than many other kinds of physical measurement, and in the case of luminance meters, liability to error is increased by the fact that many of the essential components of such instruments are susceptible to variation with time and use. These errors can be minimized by care in the design of the instrument as a whole, and also by the user in not exposing it to deleterious conditions of temperature, illumination or atmosphere.

1 Scope

This British Standard specifies performance requirements for luminance meters for the measurement of photopic luminance for applications other than the measurement of luminaires. It specifies the performance requirements for two types of luminance meter, Type L (laboratory instruments) and Type F (field instruments). This standard is intended for use by meter manufacturers and users.

NOTE The requirements specified for a Type L meter in this standard are identical to the requirements specified for a luminance meter in BS EN 13032-1. However, BS EN 13032-1 specifies additional requirements which are not specified in this standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS ISO 10526:1999, *CIE standard illuminants for colorimetry.*

PD 6461-3:1995, *General metrology — Part 3: Guide to the expression of uncertainty in measurement (GUM).*

CIE Publication 18.2:1983, *The basis of physical photometry*. Second edition.

3 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply.

3.1
luminance
(in a given direction, at a given point of a real or imaginary surface) (L_v; L)
quantity defined by the formula:

$$L_v = \frac{d\Phi_v}{dA \cdot \cos\theta \cdot d\Omega}$$

where

$d\Phi_v$	is the luminous flux transmitted by an elementary beam passing through the given point and propagating in the solid angle $d\Omega$ containing the given direction;
dA	is the area of a section of that beam containing the given point;
θ	is the angle between the normal to that section and the direction of the beam;
unit:	$cd \cdot m^{-2} = lm \cdot m^{-2} \cdot sr^{-1}$

[CIE 17.4:1987, definition 845-01-35]

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3.2
luminance meter
instrument for measuring luminance

3.3
photoelectric detector
detector of optical radiation in which the absorption of photons results in the generation of an electric current or voltage, or causes a change in electrical resistance

NOTE 1 Referred to in the text as a "detector".

NOTE 2 The term "photoelectric cell" is also in use.

3.4
selective or coloured filter
medium which changes the spectral distribution of radiation by transmission

3.5
colour temperature
temperature of the full radiator which emits radiation of the same (or nearly the same) chromaticity as the radiation considered

3.6
photometer head
photoelectric detector the spectral response of which is weighted (usually by means of coloured filters) to approximate the CIE spectral luminous efficiency function $V(\lambda)$ of the human eye for photopic vision, as defined in CIE 18.2; with either a variable-focus optical system or a fixed focus system in front of the detector

NOTE More information on the spectral response is given in **C.2**.

3.7
measurement field
projected area of the object being measured, from which light is received by the detector

NOTE 1 The measurement field is generally circular. It can, however, have other shapes (e.g. trapezoidal, square or irregular).

NOTE 2 For circular fields, the measurement field is determined by the measurement field angle (see **3.8**). Differently shaped measurement fields can have the measurement field angle expressed in various ways.

3.8
measurement field angle
angle subtended by the measurement field at the optical centre of the luminance meter (see Figure 1)

NOTE The measurement field angle corresponds to the ten percent measurement angle (see **3.11**).

3.9
effective range
that portion of the range over which the instrument conforms to the accuracy requirements of this specification

3.10
field of view
area seen through the eyepiece of the photometer head

3.11
fifty percent, ten percent and one percent measurement angles, of a photometer head
($\varepsilon_{1/2}$, $\varepsilon_{1/10}$ and $\varepsilon_{1/100}$)
angles measured in a plane through the optical axis of the photometer head at the optical centre, within which the responsivity of the luminance meter is equal to or greater than one-half, one-tenth, or one-hundredth, respectively, of the responsivity to incident light in the direction of the optical axis

NOTE Further definitions related to photometry are given in CIE Publication 17.4 [2].

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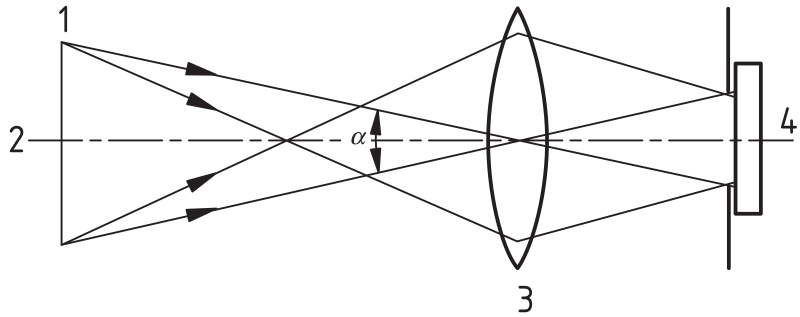

Key
1 Source
2 Optical axis
3 Lens
4 Detector
α Measurement field angle

Figure 1 — Diagram showing characteristic ray paths in a luminance meter

4 Classification

Luminance meters are of two types:

a) *Laboratory luminance meters designated Type L.*

These are generally high precision instruments, retained in a laboratory or standardizing area. It is against these instruments that other equipment may be calibrated. Such meters may not be suitable for site or field measurements.

b) *Field luminance meters designated Type F.*

These are for use in the field, on site and in the working environment. Some accuracy may have to be sacrificed in the interests of the ease of use, robustness, portability and versatility of field meters.

NOTE Before using an instrument in a humid or dusty environment the user should consult the manufacturer.

5 Digital ranges and readouts

NOTE 1 Many luminance meters are provided with a digital readout, either with the ranges selected by the user or with the range automatically selected by the instrument (auto-ranging).

The display shall read either directly in candelas per square metre, or indicate a value to be multiplied or divided by a factor (typically 10, 100 or 1 000). The appropriate factor shall be marked on the instrument. The display shall show a minimum of three digits.

NOTE 2 The use of three digits allows a factor of 10 between ranges, whilst still allowing the resolution to be within ±1 % at the lower end of the range. Extra digits, such as a display reading up to 1999, are useful either to give an overlap between the ranges, or to give greater sensitivity. Moving decimal points, and fixed zeros are helpful particularly to less experienced users when covering a number of ranges, as they enable direct readings in candelas per square metre to be made. However, final dancing digits, which vary in a random manner, should be avoided.

The digits themselves should be large and clear enough to be easily read. Liquid crystal displays (LCDs) are frequently used because of their low power consumption compared with light emitting diodes (LEDs). For meters with LCDs covering low lighting levels, a built-in lamp is useful to enable it to be read. It is essential that care is taken, both with this lamp, and with an LED display, that the reading is not affected by stray light reaching the sensor.

NOTE 3 A “hold” facility for the display can be useful, enabling extra light to be switched on, or the instrument to be moved, without altering the reading.

NOTE 4 The meter may be self-zeroing or fitted with a zero adjustment.

NOTE 5 Guidance on choice of meter range is given in Annex A.

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6 Analogue scales

For multi-range analogue luminance meters the factor between adjacent ranges shall not exceed four.

The scales of the luminance meters shall be marked in candelas per square metre or multiples of candelas per square metre with bold graduations and so figured as to minimize the chance of error in reading, even in a poor light.

NOTE 1 As with the digital display, a built-in lamp is useful for reading the scale in poor illumination, but care needs to be taken to ensure that this light does not affect the readings.

NOTE 2 BS 3693 gives recommendations for scale marking and figuring.

NOTE 3 The part of the scale below the effective range of the luminance meter may be unmarked.

7 Calibration and testing temperature

The calibration and testing of luminance meters shall be performed in an ambient temperature of 20 °C ± 2 °C unless otherwise specified by the manufacturer of the instrument.

NOTE Care should be taken when calibrating or using the luminance meters at high levels of luminance, in order to minimize the effect of high temperature.

8 Power supply

For battery-operated instruments, a battery check or other warning shall be provided to show when the battery should be replaced to ensure accuracy.

Mains-powered instruments shall conform to Clause **9** within the range 207 V to 253 V.

9 Performance requirements for laboratory and field luminance meters

When calibrated and tested in accordance with the clauses listed in Table 1, the meter reading error due to each factor shall not be greater than the relevant value specified in Table 2.

NOTE It is recommended that luminance meters should be returned to the manufacturer, or a competent photometric testing authority, at intervals as recommended by the manufacturer for recalibration and, if necessary, adjustment.

Table 1 — Test and calibration methods

Source of error	Clause
Calibration uncertainty	Annex B
Non-linearity	**C.1** or method of comparable accuracy
Spectral correction	**C.2**
Infra-red response	**C.3**
Ultraviolet response	**C.4**
Directional response	**C.5**
Effect from the surrounding field	**C.6**
Fatigue	**C.7**
Errors of focus	**C.8**
Temperature change	**C.9**
Range change	**C.10**

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Table 2 — Error tolerances for luminance meters

Source of error (Terms in parentheses are corresponding terms used in BS EN 13032-1, where these differ)	Maximum acceptable error over effective range % of reading	
	Type L Laboratory meter	Type F Field meter
Calibration uncertainty[a] in the range:		
Less than 1 000 $cd \cdot m^{-2}$	1.5	3.0
1 000 $cd \cdot m^{-2}$ to 10 000 $cd \cdot m^{-2}$	1.5	3.5
Non-linearity (Linearity) in the range:		
Less than 1 000 $cd \cdot m^{-2}$	0.2	0.5
1 000 $cd \cdot m^{-2}$ to 10 000 $cd \cdot m^{-2}$	0.2	1.0
Spectral correction [$V(\lambda)$ match]	2.0	4.0
Infra-red response	0.2	0.2
Ultraviolet response	0.2	0.2
Directional response	2.0	4.0
Effect from the surrounding field (Surrounding field)	1.0	1.0
Fatigue	0.1	0.4
Errors of focus (Focusing distance)	0.4	0.6
Temperature change (Temperature dependence)	0.2[b]	0.2[b]
Range change	0.1	0.6

[a] The standard used and errors involved should be stated.
[b] Percent per kelvin.

NOTE 1 For digital displays displaying three significant digits there is a tolerance of ±1 on the least significant digit, which corresponds to 1 % for a reading of 100 and 0.2 % for a reading of 500.

NOTE 2 A meter which just meets the requirements of this standard would have a best measurement capability of ±5 % (Type L) or ±7 % (Type F). For highly coloured sources, such as light emitting diodes (LEDs), larger uncertainties would apply in practice.

10 Marking

The following information shall be distinctly and durably marked on the luminance meter:

a) mark of origin (this may take the form of a trade mark, the manufacturer's identification mark or the name of the vendor);

b) the number of this British Standard, i.e. BS 7920:2005[1)];

c) type, i.e. L or F;

d) instrument identification number;

e) for instruments with a fixed circular measurement field the 10 % measurement field angle.

To ensure proper use and maintenance, the following additional particulars shall be marked on the luminance meter or otherwise made available to the purchaser:

1) spectral correction error;

2) the calibration and testing temperature;

3) correction factor for differences between the ambient temperature and testing temperature;

4) the date and source of the last calibration and the recommended date of the next calibration.

Where the photometer head can be disconnected from the indicating instrument they both shall be marked to ensure that the correct combination of photometer head and indicating instrument are used together.

NOTE Correction factors for specified non-Plankian light sources may also be given, see **C.11**.

[1)] Marking BS 7920:2005 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a claim is not to be confused with third party certification of conformity.

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Annex A (informative) Guidance on choice of meter range

A.1 General

Most luminance meters cover more than one range; there is usually a small, but sometimes significant, difference between the readings made at the top of the lower range and the bottom of the next higher range. This applies to both analogue and digital meters, but the effect is generally more obvious with digital meters because the lower figure is usually read more easily with greater precision, and it is not seen in comparison with the full scale as with an analogue meter.

A.2 Choice of range

Sometimes use can be made of the overlap between the ranges, or it may be worth working in a higher range to avoid the problem of making range change corrections. However, where practical, the lower range should be used, as it is more sensitive, and the maximum reading in the range is frequently taken as the calibration point; zero and linearity errors tend to increase towards the minimum reading in the range.

Annex B (normative) Calibration

B.1 General

Meters shall be calibrated using one of the methods given in **B.2**.

NOTE Calibration results may be used to maintain a calibration history of the meter.

B.2 Calibration methods

B.2.1 *Calibration using a reference luminance source*

B.2.1.1 *Apparatus*

B.2.1.1.1 *Reference source*, comprising a source of uniform luminance, the calibration of which shall be traceable to national or international standards of measurement which, in the UK, are the responsibility of the National Physical Laboratory (NPL). The source shall consist of a tungsten filament lamp and a white (spectrally non-selective) reflecting or transmitting diffuser, or of a tungsten lamp and an integrating sphere. It shall be calibrated for luminance in a specified direction and for a specified angle of view and have a colour temperature of 2 856 K ± 50 K. The source shall have a facility for adjusting the luminance to give a range of calibrated values.

NOTE A simple means by which to achieve this is to use a calibrated luminous intensity standard lamp and a calibrated matt white diffusing plate. By adjusting the distance between the lamp and the plate a range of known luminance levels can be generated.

B.2.1.2 *Procedure*

Before calibration, adjust the position of the luminance meter so that light from the reference source is reaching it at the correct calibration angle as given for the reference source by the calibration laboratory, and adjust the field of view to meet the required calibration conditions as given for the reference source by the calibration laboratory.

Before calibration, adjust the meter to indicate zero with zero luminance at the photometer head.

Adjust the luminance source to achieve a series of luminance values, at least one for each meter range.

For each luminance value expose the luminance meter to light from the reference source for sufficient time for the reading to stabilize. Then record the reading on the luminance meter. Cover the photometer head between successive readings. Calculate the calibration uncertainty of the meter using the method given in PD 6461-3:1995.

B.2.2 *Calibration using a reference meter*

B.2.2.1 *Principle*

The meter to be calibrated is compared with a reference meter when each in turn is exposed to the same luminance from a tungsten lamp-based comparison source, operating at a colour temperature of 2 856 K ± 50 K.

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B.2.2.2 *Apparatus*

B.2.2.2.1 *Comparison source*, comprising a stable source of uniform luminance. The source shall consist of a tungsten filament lamp and a white (spectrally non-selective) reflecting or transmitting diffuser, or of a tungsten lamp and an integrating sphere, and shall have a colour temperature of 2 856 K ± 50 K.

B.2.2.2.2 *Reference meter*, the calibration of which shall be traceable to national or international standards of measurement which, in the UK, are the responsibility of the National Physical Laboratory (NPL); and which has been calibrated using a tungsten lamp-based reference source (**B.2.1.1.1**), operating at a colour temperature of 2 856 K ± 50 K.

B.2.2.3 *Procedure*

Before calibration, adjust the position of each luminance meter so that light from the comparison source is reaching it at the correct calibration angle as given for the reference meter by the calibration laboratory, and adjust the field of view to meet the required calibration conditions as given for the reference meter by the calibration laboratory.

Before calibration, adjust each meter to indicate zero with zero luminance at the photometer head.

Adjust the comparison luminance source to achieve a suitable luminance value on the reference luminance meter and record this luminance value. Replace the reference meter with the meter to be calibrated and record the luminance value indicated.

Repeat this process at a series of luminance values, at least one for each meter range.

Cover the photometer head of each luminance meter between taking measurements at each successive point of calibration and expose the head to the source for a sufficient time for the reading to settle before making a measurement.

Compare the reading of the meter to be calibrated with that of the reference meter at each luminance level and record the results of this calibration.

Calculate the calibration uncertainty of the meter using the method given in PD 6461-3:1995.

Annex C (normative) Test methods

C.1 Test for linearity

C.1.1 ***Principle***

The most accurate method for measuring the linearity of luminance meters uses the principle of additivity of radiant fluxes. The luminance meter is focused on an opal diffuser or diffuse reflector material which is illuminated by a number of sources, the light from which can be selectively blocked.

The luminance meter is exposed to a luminance close to the value at which the meter being checked was calibrated. Then the meter is exposed to a series of luminances covering each range of the meter.

C.1.2 ***Apparatus***

C.1.2.1 *Opal diffuser*, or diffuse reflector material (e.g. barium sulfate).

C.1.2.2 *A number of stable light sources*, (for example, six tungsten filament lamps) with facilities for blocking the light.

C.1.3 ***Procedure***

After calibrating in accordance with Annex B, focus the luminance meter on the diffuser. Illuminate the diffuser by means of the luminance sources, both separately and in combination to give a series of luminance values covering each range of the meter; at least five luminance values per range. Take a reading on the meter for each luminance value. (These are the luminance values at the check points.)

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C.1.4 ***Calculation of non-linearity***

Calculate the non-linearity, N, as a percentage, from the following equation:

$$N = \left| 1 - \frac{A}{C} \times \frac{B}{D} \right| \times 100$$

where

A	is the meter reading at each check point;
C	is the meter reading when exposed to a luminance close to the calibration point;
B/D	is the ratio of luminance close to the calibration point to the luminance at each check point.

C.2 Calculation of spectral correction error

The spectral correction error is a measure of the departure of the actual spectral responsivity of the meter from the spectral luminous efficiency of the human eye. The percentage spectral correction error f_1' is given by the following equation:

$$f_1' = \frac{\sum_{380}^{780} \left| s*(\lambda)_{\text{rel}} - V(\lambda) \right|}{\sum_{380}^{780} V(\lambda)} \times 100$$

where

$s*(\lambda)_{\text{rel}}$ is the normalized relative spectral responsivity as given by the following equation:

$$s*(\lambda)_{\text{rel}} = \frac{\sum_{380}^{780} S(\lambda)_{\text{A}} V(\lambda)}{\sum_{380}^{780} S(\lambda)_{\text{A}} s(\lambda)_{\text{rel}}} s(\lambda)_{\text{rel}}$$

$S(\lambda)_{\text{A}}$	is the spectral distribution of the illuminant used in the calibration (standard illuminant A in accordance with BS ISO 10526:1999);
$s(\lambda)_{\text{rel}}$	is the relative spectral responsivity normalized at an arbitrary wavelength;
$V(\lambda)$	is the spectral luminous efficiency of the human eye for photopic vision, as defined in CIE 18.2.

C.3 Infra-red response test

C.3.1 ***Apparatus***

C.3.1.1 *Light source*, based on a tungsten filament lamp operating at a colour temperature of 2 856 K ± 50 K.

C.3.1.2 *Infra-red transmitting filter*, which excludes visible radiation[2)].

C.3.2 ***Procedure***

Set up the luminance meter facing the light source with the infra-red transmitting filter between the photometer head and the light source. Record the luminance reading, L_1. Remove the filter and record the luminance reading, L_2.

[2)] For information on the availability of infra-red transmitting, visible radiation absorbing filters contact BSI Customer Services, British Standards House, 389 Chiswick High Road London W4 4AL.

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C.3.3 ***Expression of results***

Express the infra-red response as the ratio of the luminance recorded when the filter was placed between the photometer head and the light source to that recorded without the filter, i.e. L_1/L_2.

Calculate the percentage error, E, due to the infra-red response, from the following equation:

$$E = \frac{L_1}{L_2} \times 100$$

C.4 Ultraviolet response test

C.4.1 ***Apparatus***

C.4.1.1 *Light source*, comprising a low pressure mercury discharge lamp.

C.4.1.2 *A 365 nm interference filter*, or other UV transmitting, visible radiation absorbing filter[3)].

C.4.2 ***Procedure***

Set up the luminance meter facing the light source with the UV transmitting filter between the photometer head and the light source. Record the luminance reading, L_1. Remove the filter and record the luminance reading, L_2.

C.4.3 ***Expression of results***

Express the ultraviolet response as the ratio of the luminance recorded when the filter was placed between the photometer head and the light source to that recorded without the filter i.e. L_1/L_2.

Calculate the percentage error, E, due to the ultraviolet response, from the following equation:

$$E = \frac{L_1}{L_2} \times 100$$

NOTE It should be noted that misleading results are obtained if a medium/high pressure mercury lamp or fluorescent lamp is used, or if the UV filter transmits significant visible radiation. The latter can be checked using a light source based on a tungsten filament lamp operating at a colour temperature of 2 856 K ± 50 K; zero luminance should be recorded when the UV filter is placed between the photometer head and the source.

C.5 Directional response test

C.5.1 ***General***

Luminance meters should evaluate the luminance of the assessed surface, luminous areas outside the measurement field should not influence the measurement results. The directional response function can be used to describe the directionally dependant evaluation and the influence of the surrounding luminance outside the measurement field. The response of the luminance meter is a function of the incidence angle. The directional response function (evaluation of the incidence light as a function of the angle of incidence) is determined by the geometrical optics, construction of the photometer head and stray light in the optical system. Special directional response functions can be generated by fitting the photometer head with special lenses or other such accessories (e.g., interchangeable objectives). One example is for the measurement of equivalent veiling luminance.

C.5.2 ***Procedure for measurement of directional response***

Position a light source at a sufficiently large distance from the luminance meter to ensure that the extent of the luminous area of the light source is not greater than 5 % of the measurement field angle. For focusing luminance meters focus the meter on the light source. For non-focusing luminance meters carry out the measurement at a distance of at least 10 m or at a distance recommended by the manufacturer. Rotate the luminance meter around the optical centre. Alternatively the same result may be achieved by moving the light source so that it remains at a constant distance from and facing the optical centre of the photometer head, keeping the photometer head fixed. Obtain a measurement of the meter reading as a function of the angle of incidence, characterized by ε and φ as shown in Figure C.1 in at least four equally spaced directions. Ensure that stray light is prevented from falling on the luminance meter.

[3)] For information on the availability of UV transmitting, visible radiation absorbing filters contact BSI Customer Services, British Standards House, 389 Chiswick High Road, London W4 4AL.

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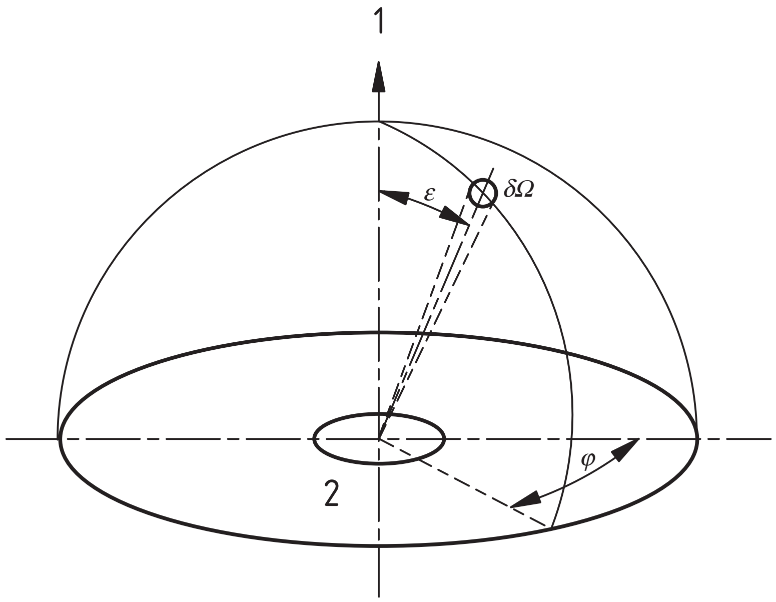
C.5.3 ***Calculation***

Calculate the directional response of the luminance meter in terms of the directional response function $f_2(\varepsilon,\varphi)$, using the following equation:

$$f_2(\varepsilon,\varphi) = \frac{Y(\varepsilon,\varphi)}{Y(\varepsilon = 0)} \times 100$$

where

- $Y(\varepsilon,\varphi)$ is the meter reading at angle of incidence ε,φ (see Figure C.1);
- $Y(\varepsilon = 0)$ is the meter reading for light incident in the direction of the optical axis of the photometer head.



Key

1 Optical axis

2 Entrance pupil

ε Angle of incidence, measured from the optical axis

φ Azimuth angle

Figure C.1 — Co-ordinates for calculation of the directional response function $f_2(\varepsilon,\varphi)$

Calculate the percentage uniformity error, $f_2(g)$, due to the directional response over the measurement field, using the following equation:

$$f_2(g) = \left(1 - \frac{Y_{min}}{Y_{max}}\right) \times 100$$

where

- Y_{min} is the smallest meter reading for an angle of incidence within 90 % of the measurement field angle;
- Y_{max} is the largest meter reading for an angle of incidence within 90 % of the measurement field angle.

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C.6 Surrounding field luminance (veiling glare) test

C.6.1 *Apparatus*

C.6.1.1 *Uniform luminous surface*, (in the direction of the entrance pupil) at least ten times as large as the measurement field, with a luminance at least 10 times the maximum luminance meter reading on the most sensitive range.

C.6.1.2 *Gloss trap*, with a black surface of negligibly small luminance, and with an area 10 % larger than the measurement field in the image plane (see Figure C.2).

Key
1 Measurement field, diameter *d*
2 Gloss trap, diameter 1.1*d*

a) Gloss trap for circular field

Key
1 Measurement field
2 Gloss trap

b) Gloss trap for trapezoidal field

Figure C.2 — Diagram showing gloss traps for determining surrounding field error

C.6.2 *Procedure*

Set up the luminance meter under test facing the luminous surface and record the reading, Y_{total}. Put the gloss trap in front of the luminous surface and record the meter reading again, $Y_{surround}$.

C.6.3 *Expression of results*

Calculate the percentage error, *E*, due to the surround, using the following equation:

$$E = \frac{Y_{surround}}{Y_{total} - Y_{surround}} \times 100$$

C.7 Test for fatigue

Keep the photometer head unexposed for a period of not less than 1 h. Then expose the photometer head to a luminance equal to 90 % of the maximum value for which the luminance meter is calibrated. Record the luminance meter reading, L_1. Continue to expose the photometer head to the luminance for 10 min. Record the luminance meter reading again, L_2. Calculate the percentage error, *E*, due to fatigue, using the following equation:

$$E = \frac{L_1 - L_2}{L_1} \times 100$$

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C.8 Focus error test

C.8.1 *General*

Luminance meters with a focusing photometer head focused on a constant luminance in the measurement field, can change their reading with a change in the distance from the luminance source.

C.8.2 *Apparatus*

C.8.2.1 *Luminance source*, with a luminous surface which is larger than the measurement field and the acceptance area of the photometer head.

C.8.3 *Procedure*

Position the luminance source a short distance (approximately 10 cm) in front of the entrance aperture of the luminance meter. Set the luminance of the source to a level that results in a meter reading approximately 90 % of the full-scale reading on an arbitrarily selected range. Adjust the focus of the meter to the longest focusing distance specified by the manufacturer, and record the meter reading. Then readjust the focus of the meter to the shortest focusing distance specified by the manufacturer, and record the meter reading.

C.8.4 *Calculation*

Calculate the percentage error, E, due to a change in the focusing distance, using the following equation:

$$E = \left| 1 - \frac{Y_1}{Y_2} \right| \times 100$$

where

Y_1 is the meter reading focused at the shortest distance;

Y_2 is the meter reading focused at the longest distance.

C.9 Test for error due to temperature change

Vary the temperature of the whole equipment from 0 °C to +40 °C and record the change in luminance reading. The meter should be kept at each test temperature until a stable reading is obtained. Record the luminance at +20 °C. Express the error as a percentage of the luminance at 20 °C.

C.10 Test for error due to range change

Adjust the luminance of the source to give a reading at least 95 % of the true maximum in the lower range. Switch the instrument to the next higher range and take a reading with the same source luminance.

Calculate the percentage range change error, R, for each pair of ranges, using the following equation:

$$R = \frac{H - L}{L} \times 100$$

where

L is the reading on the lower range;

H is the reading on the higher range.

C.11 Calculation of spectral correction factors

C.11.1 *Principle*

A source based on a tungsten lamp, with a colour temperature of 2 856 K ± 50 K has been adopted as the reference against which the luminance meter is calibrated. When the luminance meter is to be used for measurements with other light sources, then it may be necessary to provide a multiplying factor or other suitable means to correct the meter reading. The magnitude of the correction which is required depends upon the difference between the spectral power distributions of the calibration source and the other light source in question, and upon the relative spectral responsivity of the photometer head [i.e. the degree of deviation from the $V(\lambda)$ curve].

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C.11.2 ***Calculation***

Calculate the spectral correction factors using the following data, obtained either by measurement or from the manufacturer:

a) the relative spectral responsivity of the luminance meter (including the lens), $s(\lambda)$;

b) the spectral power distribution of the reference source used to calibrate the luminance meter $S_r(\lambda)$;

c) the spectral power distribution of the source to be measured $S_t(\lambda)$;

d) the CIE photopic spectral luminous efficiency function $V(\lambda)$, as defined in CIE 18.2.

Calculate the spectral correction factor, F, from the following equation:

$$F = \frac{\sum_{380}^{780} S_t(\lambda) V(\lambda) \times \sum_{380}^{780} S_r(\lambda) s(\lambda)}{\sum_{380}^{780} S_t(\lambda) s(\lambda) \times \sum_{380}^{780} S_r(\lambda) V(\lambda)}$$

Carry out the summations over the range 380 nm to 780 nm in maximum steps of 10 nm.

Calculate the percentage error, E, using the following equation:

$$E = |1 - F| \times 100$$

C.11.3 ***Example of calculation of correction factor for high pressure sodium lamp***

Example data for the calculation of the correction factor for a high pressure sodium lamp are given in Table C.1.

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Table C.1 — Example of calculation of correction factor for a high pressure sodium lamp

Wavelength	$V(\lambda)$	$s(\lambda)$	$S_r(\lambda)$	$S_t(\lambda)$	$S_t(\lambda)V(\lambda)$	$S_r(\lambda)s(\lambda)$	$S_t(\lambda)s(\lambda)$	$S_r(\lambda)V(\lambda)$
380	0.000 0	0.000 0	0.098	0.010 7	0.000 0	0.000 0	0.000 0	0.000 0
390	0.000 1	0.000 0	0.121	0.013 9	0.000 0	0.000 0	0.000 0	0.000 0
400	0.000 4	0.000 0	0.147	0.018 6	0.000 0	0.000 0	0.000 1	0.000 0
410	0.001 2	0.000 1	0.177	0.022 7	0.000 0	0.000 0	0.000 0	0.000 2
420	0.004 0	0.000 2	0.210	0.027 5	0.000 1	0.000 0	0.000 0	0.000 8
430	0.011 6	0.001 1	0.247	0.034 4	0.000 4	0.000 3	0.000 0	0.002 9
440	0.023 0	0.003 8	0.287	0.041 8	0.001 0	0.001 1	0.000 2	0.006 6
450	0.038 0	0.005 8	0.331	0.058 3	0.002 2	0.001 9	0.000 3	0.012 6
460	0.060 0	0.025 2	0.378	0.033 8	0.002 0	0.009 5	0.000 9	0.022 7
470	0.091 0	0.066 3	0.429	0.961 0	0.087 5	0.028 4	0.063 7	0.039 0
480	0.139 0	0.136 2	0.482	0.017 8	0.002 5	0.065 6	0.002 4	0.067 0
490	0.208 0	0.214 5	0.539	0.020 1	0.004 2	0.115 6	0.004 3	0.112 1
500	0.323 0	0.382 4	0.599	0.221 0	0.071 4	0.229 1	0.084 5	0.193 5
510	0.503 0	0.544 2	0.661	0.025 8	0.013 0	0.359 7	0.014 0	0.332 5
520	0.710 0	0.732 5	0.725	0.037 1	0.026 3	0.531 1	0.027 2	0.514 8
530	0.862 0	0.896 7	0.791	0.012 3	0.010 6	0.709 3	0.011 0	0.681 8
540	0.954 0	0.969 3	0.859	0.016 6	0.015 8	0.832 6	0.016 1	0.819 5
550	0.995 0	1.002 0	0.929	0.061 7	0.061 4	0.930 9	0.061 8	0.924 4
560	0.995 0	0.964 3	1.000	0.137 1	0.136 4	0.964 3	0.132v2	0.995 0
570	0.952 0	0.905 8	1.072	0.839 0	0.798 7	0.971 0	0.760 0	1.020 5
580	0.870 0	0.834 7	1.144	0.665 9	0.579 3	0.954 9	0.555 8	0.995 3
590	0.757 0	0.721 1	1.217	0.997 6	0.755 2	0.877 6	0.719 4	0.921 3
600	0.631 0	0.583 2	1.290	1.000 0	0.631 0	0.752 3	0.583 2	0.814 0
610	0.503 0	0.464 2	1.363	0.478 5	0.240 7	0.632 7	0.222 1	0.685 6
620	0.381 0	0.339 9	1.436	0.343 4	0.130 8	0.488 1	0.116 7	0.547 1
630	0.265 0	0.235 5	1.508	0.175 1	0.046 4	0.355 1	0.041 2	0.399 6
640	0.175 0	0.158 2	1.580	0.135 4	0.023 7	0.250 0	0.021 4	0.276 5
650	0.107 0	0.099 2	1.650	0.110 7	0.011 8	0.163 7	0.011 0	0.176 6
660	0.061 0	0.058 9	1.720	0.095 9	0.005 8	0.101 3	0.005 6	0.104 9
670	0.032 0	0.033 8	1.788	0.095 9	0.003 1	0.060 4	0.003 2	0.057 2
680	0.017 0	0.018 2	1.854	0.074 9	0.001 3	0.033 7	0.001 4	0.031 5
690	0.008 2	0.009 1	1.919	0.046 8	0.000 4	0.017 5	0.000 4	0.015 7
700	0.004 1	0.004 5	1.983	0.038 6	0.000 2	0.008 9	0.000 2	0.008 1
710	0.002 1	0.002 1	2.044	0.035 9	0.000 1	0.004 3	0.000 1	0.004 3
720	0.001 0	0.001 0	2.104	0.033 8	0.000 0	0.002 1	0.000 0	0.002 1
730	0.000 5	0.000 4	2.161	0.032 5	0.000 0	0.000 9	0.000 0	0.001 1
740	0.000 2	0.000 2	2.217	0.032 0	0.000 0	0.000 4	0.000 0	0.000 4
750	0.000 1	0.000 1	2.270	0.034 4	0.000 0	0.000 2	0.000 0	0.000 2
760	0.000 1	0.000 0	2.321	0.043 1	0.000 0	0.000 0	0.000 0	0.000 2
770	0.000 0	0.000 0	2.370	0.780 0	0.000 0	0.000 0	0.000 0	0.000 0
780	0.000 0	0.000 0	2.417	0.034 9	0.000 0	0.000 0	0.000 0	0.000 0
Sum =					3.663	10.455	3.461	10.788
Correction factor = (3.663 × 10.455)/(3.461 × 10.788) = 1.026 (2.6 %)								

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