

JIS

JAPANESE INDUSTRIAL STANDARD

Test methods of optical power meters for laser beam

JIS C 6182—1991

Translated and Published

by

Japanese Standards Association

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

1. Scope

This Japanese Industrial Standard specifies test methods of optical power meters equipped with a detector to measure optical power and/or the optical energy of a laser beam.

Remarks 1. The following Standards are cited in this Standard:

JIS C 1002-Glossary of Terms Used in Electronic Measuring Apparatus

JIS C 1003-Testing Methods for Digital Voltmeters

JIS Z 8103-Glossary of Terms Used in Instrumentation

JIS Z 8120-Glossary of Optical Terms

2. Corresponding international standard is given below.

IEC 1040: 1990-Power and energy measuring detectors, instruments and equipment for laser radiation

2. Definitions

For the purpose of this Standard, in addition to the definitions given in JIS C 1002, JIS Z 8103 and JIS Z 8120, the following principal definitions shall apply:

- (1) detector A device which transduces the optical power and/or optical energy of laser output into an electrical output.
- (2) sensitive area Input part of a detector which is the area effective for detection of laser output.
- (3) size of effective sensitive area The size of sensitive area effective for detection of laser output. It is not the size of mechanical aperture of a detector.
- (4) beam diameter The largest distance between two points, in the cross section of a beam, at which the optical power density becomes e^{-2} ($=0.1353$) of the maximum value in the beam.

Remarks: The " e^{-2} ($=0.1353$)" in (4) may be replaced by " e^{-1} ($=0.3679$)", since the diameter is defined as the largest distance between two points at which the optical power density becomes e^{-1} ($=0.3679$) of the maximum value in the beam, in IEC 1040.

3. Standard test conditions

Unless otherwise specified, the standard conditions for testing optical power meters for laser beam (hereafter referred to as the "specimen") shall be as stated below. If it is difficult to carry out the tests under the standard test conditions, the conditions under which the test has been carried out and the influence of conditions shall be recorded in the test results.

- (1) Temperature One of the following temperatures shall be chosen.
 $20 \pm 2^\circ\text{C}$, $23 \pm 2^\circ\text{C}$, $25 \pm 2^\circ\text{C}$
- (2) Relative humidity One of the following relative humidities shall be chosen.
 $(50 \pm 10) \%$, $(65 \pm 10) \%$
- (3) Positioning of detector The mechanical center of detector aperture shall be aligned with the center of beam.
- (4) Angle of incidence The light shall be introduced vertically to the sensitive area of detector, or aligning with the optical axis specified in the detector.
- (5) State of incident ray A parallel ray with beam profile of Gaussian distribution.
- (6) Central wavelength The central wavelength specified in the specimen.
- (7) Optical power level The optical power level specified in the specimen.
- (8) Polarization The linearly polarized light.

4. Calibration

The calibration shall be carried out under the standard test conditions. It shall be carried out at the wavelength and power level specified in the specimen by means of relative measurement with a standard instrument. The standard instrument means one of the instruments given below.

- (1) An instrument calibrated by means of national standard instrument.
- (2) An instrument calibrated by an official organization which carries out calibration work.
- (3) An instrument calibrated by using the instrument of (1) or (2).

The partial error shall be obtained in % indication from each test of 6. and the calibration error shall be calculated from the formula given below. However, if the standard instrument is that given in (2) above the test accuracy (% indication) at confidence coefficient of 95 % assured by the official organization shall be used as the limit of error of the standard instrument.

$$\epsilon_{cx} = \pm 2 \sqrt{\sum_{i=1}^m \epsilon_{ci}^2 + \epsilon_{cs}^2 + \left(\frac{\epsilon_{sx}}{2}\right)^2}$$

where,

- ϵ_{cx} : calibration error
- ϵ_{ci}^2 : dispersion of partial error $\left[\frac{(\epsilon_{cui} - \epsilon_{cli})^2}{12} \right]$
- ϵ_{cui} : upper limit of partial error (%)
- ϵ_{cli} : lower limit of partial error (%)
- i : subscript for each partial error
- m : number of partial errors
- ϵ_{cs} : standard deviation of dispersion in relative measurement
- ϵ_{sx} : limit of error of standard instrument after correction of deviation (twice the standard deviation at confidence coefficient of 95 %)

5. Accuracy

The calibration error of 4. and the partial error in each test of 6. shall be obtained in % indication, the limit of operating error shall be calculated from the appropriate formula given below and the value so obtained shall be taken as the accuracy of the specimen.

- (1) When correction of deviation ($\sum_{i=1}^p \bar{\epsilon}_{ti}$) is not possible.

$$\left. \begin{array}{l} \epsilon_{tu} \\ \epsilon_{tl} \end{array} \right\} = \sum_{i=1}^p \bar{\epsilon}_{ti} \pm \epsilon_{tx}$$

- (2) When correction of deviation ($\sum_{i=1}^p \bar{\epsilon}_{ti}$) is possible,

$$\left. \begin{array}{l} \epsilon_{tu} \\ \epsilon_{tl} \end{array} \right\} = \pm \epsilon_{tx} = \pm 2 \sqrt{\sum_{i=1}^p \epsilon_{ti}^2 + \epsilon_{te}^2 + \left(\frac{\epsilon_{cx}}{2} \right)^2}$$

where,

- ϵ_{tu} : upper limit of operating error
- ϵ_{tl} : lower limit of operating error
- $\bar{\epsilon}_{ti}$: mean value of upper limit and lower limit of partial error $\left(\frac{\epsilon_{tui} + \epsilon_{tli}}{2} \right)$
- ϵ_{ti}^2 : dispersion of partial error $\left[\frac{(\epsilon_{tui} - \epsilon_{tli})^2}{12} \right]$
- ϵ_{tx} : limit of error of specimen after correction of deviation
- ϵ_{tui} : upper limit of partial error
- ϵ_{tli} : lower limit of partial error
- i : subscript for each partial error
- p : number of partial errors
- ϵ_{te} : standard deviation of dispersion of measured values (see 6.2.8)
- ϵ_{cx} : calibration error

Remarks: It is desired to record the individual partial error in each test as the test results not only the accuracy of the specimen.