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**Measuring methods of laser diodes
used for recording and playback**

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In the event of any doubts arising as to the contents,
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Foreword

This translation has been made based on the original Japanese Industrial Standard 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 Optoelectronics Industry and Technology Development Association (OITDA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS C 5943** : 1997 is replaced with this Standard.

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Measuring methods of laser diodes used for recording and playback

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **IEC 60747-5-4** published in 2006 with some addition, modification and deletion of the technical contents due to the limitation of the scope to the laser diodes used for recording and playback.

The portions given sidelines or dotted underlines are the matters in which the contents of the original International Standard have been modified. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the measuring methods of the electrical and optical characteristics of laser diodes for recording and playback used as the optical source (excluding those accommodated in electronic circuit or those accommodated in optical element; hereafter referred to as “laser diodes”).

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

IEC 60747-5-4 : 2006 *Semiconductor devices—Discrete devices—Part 5-4 : Optoelectronic devices—Semiconductor lasers* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

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 1102-1 *Direct acting indicating analogue electrical measuring instruments and their accessories—Part 1 : Definitions and general requirements common to all parts*

JIS C 5942 *General rules of laser diodes used for recording and playback*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS C 5942** apply.

4 Apparatus

4.1 Power supply

The d.c. power supply shall be of a ripple content not exceeding 3 %, and the a.c. power supply shall be of a higher harmonic content not exceeding 5 %. When using the power frequency, the higher harmonic content shall be not exceeding 10 %.

Especially, in the test in which the a.c. output is measured, the ripple content of d.c. power supply, the higher harmonic content of a.c. power supply and the a.c. impedance of the d.c. power supply circuit through which a.c. flows shall be made small to avoid the influence on the measurements. Further, enough protective means shall be provided against the entry of surges.

4.2 Instruments

Unless otherwise specified, the instrument shall be that of class index 0.5 specified in **JIS C 1102-1** or superior, and the input impedance shall be such that the influence on the measuring system is negligible.

NOTE : If the instrument of class index 0.5 or superior is not available as the standard product, the provisions of **4.2** need not apply.

4.3 Optical power meter

The optical power meter to be used for measurements shall be calibrated at the appropriate wavelength, and shall have sufficiently flat sensitivity profile on its photo-receptive plane.

4.4 Optical spectrum analyzer

The optical spectrum analyzer to be used for measurements shall have, at the appropriate wavelength, enough dynamic range (enough low stray light), accuracy on abscissa (wavelength) and ordinate (level), and resolving power to separate the emission spectrum.

5 Measuring methods of electrical and optical characteristics

5.1 Forward current (I_f)

5.1.1 Purpose

The purpose is to measure the forward current under specified conditions.

5.1.2 Measuring circuit

The measuring circuit of the forward current shall be in accordance with figure 1. Although figure 1 shows the case of d.c. operation, in the case of the modulation operation including pulse operation, the power supply and measuring devices which correspond to it shall be prepared.

5.1.3 Measuring method

The laser diode is made to emit the specified radiant power P_o by applying the specified forward voltage V_f , and the forward current I_f at that time shall be measured. This measurement may be carried out by such a method that a current-voltage waveform is plotted on the display of oscilloscope by using the a.c. power supply not exceeding 1 kHz.

If the laser diode consumes fairly large power and the temperature rise of the junction due to this largely affects the measured values, the measurement shall be carried out by either of the following methods, and the method shall be clearly stated.

- By using d.c., the measurement shall be carried out after the thermal equilibrium has been achieved. If the thermal equilibrium is not achieved, the measurement shall be carried out after a prescribed time from initiation of application of the specified voltage.
- Pulses shall be used, or the measurement shall be carried out in a short time so that the temperature rise of the junction is negligible. When pulses are used, the pulse width, duty cycle and bias conditions shall be clearly stated.

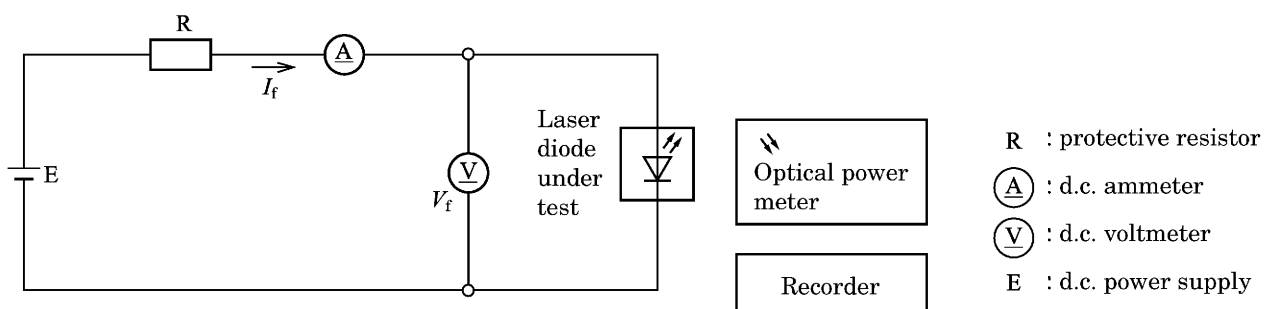
5.1.4 Precaution for measurement

The photo-receptive plane of the optical power meter shall have enough size to receive total quantity of light to be emitted. Or the quantity of light returning from the photo-receiver of optical power meter to the laser diode shall be minimized. A measuring system employing an integrating sphere (figure 2) may be used instead of the optical power meter. Care shall be taken so that the radiant power P_o of the laser diode caused by application of the forward voltage does not exceed the absolute maximum ratings.

5.1.5 Measurement conditions

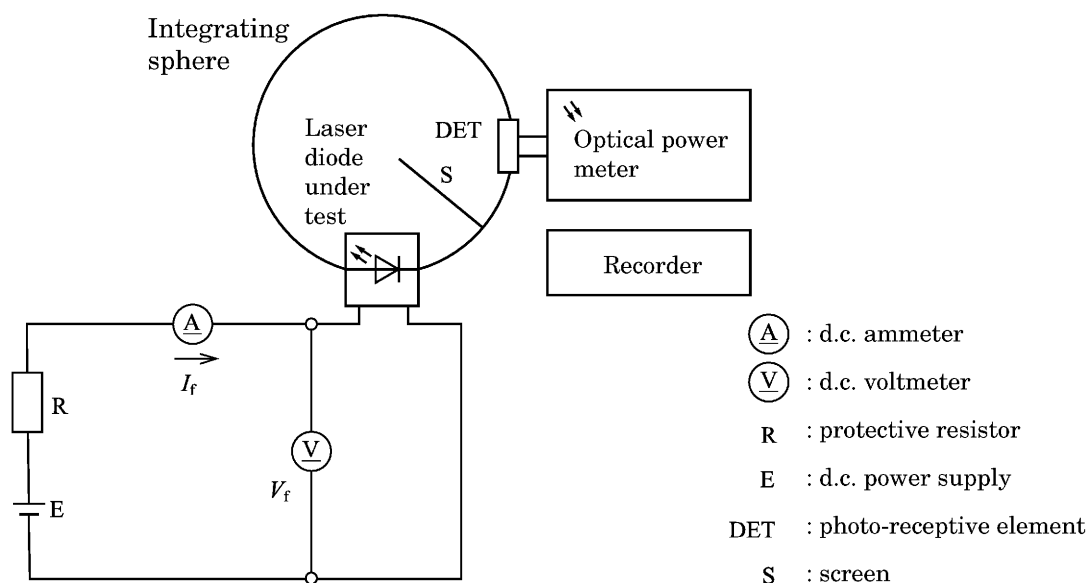
The following measurement conditions shall be specified.

- Operating temperature (T_{amb} or T_{case})
- Forward voltage V_f or radiant power P_o
- Pulse width, duty cycle and bias condition in the case of the pulse operation



The internal resistance of d.c. voltmeter shall be sufficiently large as compared with the resistance of the laser diode so that the measured values are not influenced.

Figure 1 Measurement of forward current, forward voltage, radiant power, threshold current, radiant power at threshold and differential efficiency



The internal resistance of d.c. voltmeter shall be sufficiently large as compared with the resistance of the laser diode so that the measured values are not influenced. The measuring device and the aperture shall be sufficiently small as compared with the surface area of integrating sphere. The inside surface of integrating sphere and the screen shall be coated with a paint with a constant diffusion reflectivity (0.8 or more).

Figure 2 Measurement of forward current, forward voltage, radiant power, threshold current, radiant power at threshold and differential efficiency using integrating sphere

5.2 Forward voltage (V_f)

5.2.1 Purpose

The purpose is to measure the forward voltage under specified conditions.

5.2.2 Measuring circuit

The measuring circuit of the forward voltage shall be in accordance with figure 1. Although figure 1 shows the case of d.c. operation, in the case of the modulation operation including pulse operation, the power supply and measuring devices which correspond to it shall be prepared.

5.2.3 Measuring method

The laser diode is made to emit the specified radiant power P_0 by applying the specified forward current I_f , and the forward voltage V_f at that time shall be measured. This measurement may be carried out by such a method that a current-voltage waveform is plotted on the display of oscilloscope by using the a.c. power supply not exceeding 1 kHz.

If the laser diode consumes fairly large power and the temperature rise of the junction due to this largely affects the measured values, the measurement shall be carried out by either of the following methods, and the method shall be clearly stated.

- a) By using d.c., the measurement shall be carried out after the thermal equilibrium has been achieved. If the thermal equilibrium is not achieved, the measurement shall be carried out after a prescribed time from initiation of application of the specified radiant power.
- b) Pulses shall be used, or the measurement shall be carried out in a short time so that the temperature rise of the junction is negligible. When pulses are used, the pulse width, duty cycle and bias conditions shall be clearly stated.

5.2.4 Precaution for measurement

The photo-receptive plane of the optical power meter shall have enough size to receive total quantity of light to be emitted. Or the quantity of light returning from the photo-receiver of optical power meter to the laser diode shall be minimized. A measuring system employing an integrating sphere (figure 2) may be used instead of the optical power meter. Care shall be taken so that the radiant power P_o of the laser diode caused by application of the forward current does not exceed the absolute maximum ratings.

5.2.5 Measurement conditions

The following measurement conditions shall be specified.

- a) Operating temperature (T_{amb} or T_{case})
- b) Forward current I_f or radiant power P_o
- c) Pulse width, duty cycle and bias condition in the case of the pulse operation

5.3 Reverse voltage (V_r)

5.3.1 Purpose

The purpose is to measure the reverse voltage under specified conditions.

5.3.2 Measuring circuit

The measuring circuit of the reverse voltage shall be in accordance with figure 3. Although figure 3 shows the case of d.c. operation, in the case of the modulation operation including pulse operation, the power supply and measuring devices which correspond to it shall be prepared.

5.3.3 Measuring method

The specified reverse current I_r shall be passed through the laser diode, and the reverse voltage V_r at that time shall be measured. This measurement may be carried out by such a method that a current-voltage waveform is plotted on the display of oscilloscope by using the a.c. power supply not exceeding 1 kHz.

If the laser diode consumes fairly large power and the temperature rise of the junction due to this largely affects the measured values, the measurement shall be carried out by either of the following methods, and the method shall be clearly stated.

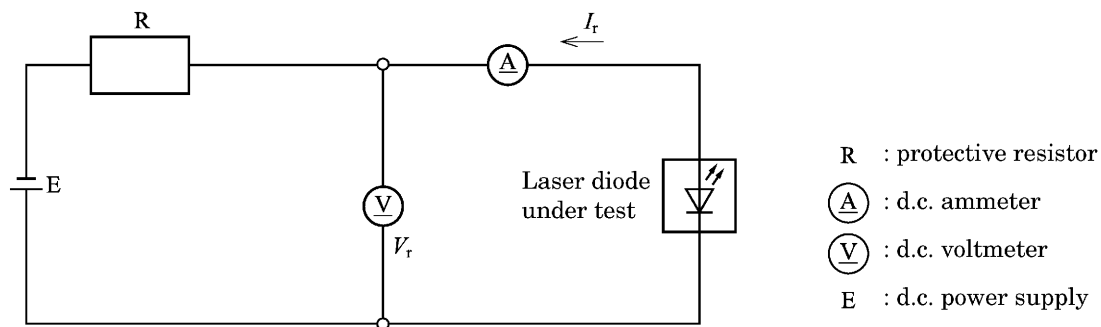
- a) By using d.c., the measurement shall be carried out after the thermal equilibrium has been achieved. If the thermal equilibrium is not achieved, the measurement shall be carried out after a prescribed time from initiation of application of the specified current.

- b) Pulses shall be used, or the measurement shall be carried out in a short time so that the temperature rise of the junction is negligible. When pulses are used, the pulse width, duty cycle and bias conditions shall be clearly stated.

5.3.4 Measurement conditions

The following measurement conditions shall be specified.

- a) Operating temperature (T_{amb} or T_{case})
b) Reverse current I_r
c) Pulse width, duty cycle and bias condition in the case of the pulse operation



The internal resistance of d.c. voltmeter shall be sufficiently large as compared with the resistance of the laser diode so that the measured values are not influenced.

Figure 3 Measurement of reverse voltage

5.4 Radiant power (P_o)

5.4.1 Purpose

The purpose is to measure the radiant power under specified conditions.

5.4.2 Measuring circuit

The measuring circuit of the radiant power shall be in accordance with figure 1. Although figure 1 shows the case of d.c. operation, in the case of the modulation operation including pulse operation, the power supply and measuring devices which correspond to it shall be prepared.

5.4.3 Measuring method

The specified forward current I_f shall be applied to the laser diode, and the radiant power P_o shall be measured. The radiant power shall be the output from one facet.

5.4.4 Precaution for measurement

The photo-receptive plane of the optical power meter shall have enough size to receive total quantity of light to be emitted. Or the quantity of light returning from the photo-receiver of optical power meter to the laser diode shall be minimized. A measuring system employing an integrating sphere (figure 2) may be used instead of the optical power meter. Care shall be taken so that the radiant power does not exceed the absolute maximum ratings.

5.4.5 Measurement conditions

The following measurement conditions shall be specified.

- Operating temperature (T_{amb} or T_{case})
- Forward current I_f
- Pulse width, duty cycle and bias condition in the case of the pulse operation

5.5 Threshold current (I_{th})

5.5.1 Purpose

The purpose is to measure the threshold current under specified conditions.

5.5.2 Measuring circuit

The measuring circuit of the threshold current shall be in accordance with figure 1. Although figure 1 shows the case of d.c. operation, in the case of the modulation operation including pulse operation, the power supply and measuring devices which correspond to it shall be prepared.

5.5.3 Measuring method

The forward current I_f and the radiant power P_o shall be recorded by the recorder such as an X-Y recorder and oscilloscope while changing I_f passed through the laser diode, and the threshold current shall be calculated by using any of the following a) to c).

The method used for the calculation shall be clearly stated.

- Method 1** The portions of two straight lines on the record of I_f - P_o curve shall be extended as shown in figure 4, the current at the intersection of the above lines shall be obtained, and it shall be taken as the threshold current I_{th} .
- Method 2** If application of the method of a) is difficult because the change in I_f - P_o curve is gradual, the portion of the straight line corresponding to the laser emission power shall be extended, the current at the intersection of the above straight line and X axis shall be obtained as shown in figure 5, and it shall be taken as the threshold current I_{th} .
- Method 3** The quadratic differential of I_f - P_o curve shall be obtained, the smallest current corresponding to the peak of the quadratic differential shall be obtained as shown in figure 6, and this current shall be taken as the threshold current I_{th} .

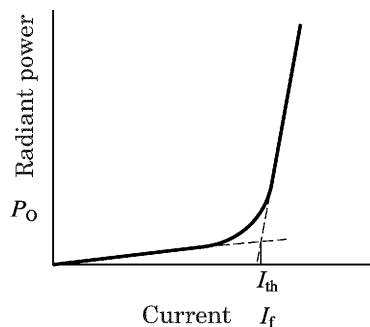


Figure 4 I_f - P_o curve
(method 1)

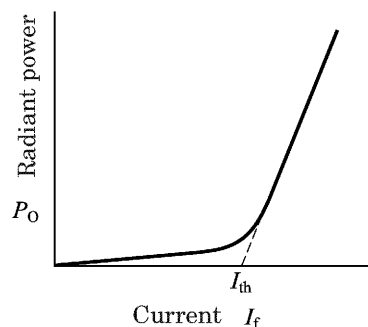


Figure 5 I_f - P_o curve
(method 2)

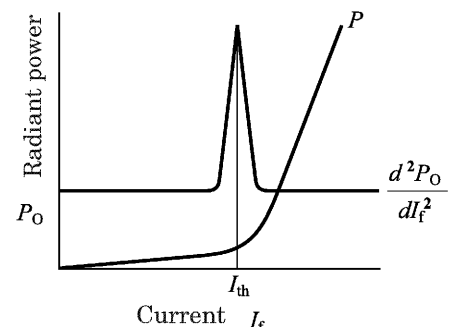


Figure 6 I_f - P_o curve
(method 3)