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Measuring methods of photodiodes for fiber optic transmission

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently, JIS C 5991 : 1988 has been revised and replaced with this Standard. In this revision, conformance of provisions between JIS and International Standard was taken into consideration.

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Measuring methods of photodiodes for fiber optic transmission

Introduction Users should note that at application of this Standard, the normative references to this Standard shall be referred at the same time. Further, it is often necessary to carry out comparison with and study on the similar standard(s), if any.

This is a Japanese Industrial Standard prepared based on **IEC 747-5 Semiconductor devices. Discrete devices and integrated circuits—Part 5 : Optoelectronic devices** issued in 1992, and **IEC 747-5 Amendment 1** issued in 1994, without any modification in technical contents.

1 Scope This Japanese Industrial Standard specifies measuring methods of photodiodes for fiber optic transmission (excluding ones accommodated in electronic circuits; hereafter referred to as “photodiodes”).

Remarks : The International Standards corresponding to this Standard are shown below.

IEC 747-5 (1992) *Semiconductor devices. Discrete devices and integrated circuits—Part 5 : Optoelectronic devices (Second edition)*

IEC 747-5 (1994) *Amendment 1*

2 Normative references The following normative references contain provisions which, through reference in this Standard constitute provisions of this Standard. The most recent editions of the normative references shall apply.

JIS C 1102 *Electrical indicating instruments*

JIS C 5001 *General rules for electronic components*

JIS C 5990 *General rules of photodiodes for fiber optic transmission*

3 Definitions For the purpose of this Standard, the definitions specified in **JIS C 5990** apply.

4 Atmospheric conditions for measurement

4.1 Standard conditions Unless otherwise specified, the measurements shall be carried out under the standard conditions (temperature 15 °C to 35 °C, relative humidity 25% to 85% and air pressure 860 hPa to 1 060 hPa) specified in **4.1** of **JIS C 5001**. If any doubt arises on the decision of measured values under this standard conditions or if specially required, the measurements shall be carried out under the conditions of **4.3**.

If conversion to reference conditions is necessary, the conditions of **4.2** shall be employed.

If the measurement under the standard conditions is difficult, the measurement may be carried out under the conditions other than the standard conditions unless doubt arises on the decision.

4.2 Reference conditions The reference conditions shall be such that the temperature is 25 °C, relative humidity is 45 % and air pressure is 860 hPa to 1 060 hPa given in the reference conditions specified in 4.2 of **JIS C 5001**. However, only the temperature may be employed as the reference condition.

4.3 Referee conditions The referee conditions shall be the referee conditions of temperature grade and relative humidity grade 2 {temperature (25±2) °C, relative humidity 45 % to 55 % and air pressure 860 hPa to 1 060 hPa} specified in 4.3 of **JIS C 5001**.

5 Measuring apparatus and equipment

5.1 Measuring 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 harmonic content not exceeding 5 %. However, in the case of commercial frequency, the harmonic content shall not exceed 10 %.

In a kind of test which requires the measurements of a.c. output especially the ripple content of d.c. power supply, harmonic content of a.c. power supply and the a.c. impedance of d.c. power supply through which an a.c. current flows shall be made small not to influence the measurements.

Further, enough protective means shall be provided against incoming of any surge.

5.2 Instrument and measuring apparatus Unless otherwise specified, the instrument shall be that of class index 0.5 specified in **JIS C 1102** and the measuring apparatus shall have at least equivalent accuracy, and their input impedances shall be such that the influence on the measuring system is negligible.

Remarks : If there is no instrument of class index 0.5 or better, or measuring apparatus of equivalent accuracy as the standard, the provision of 5.2 does not apply.

6 Precautions for measurement

6.1 Observance of maximum ratings The photodiode under test shall not exceed its maximum ratings in any case including transient state.

6.2 Precaution for attaching and detaching specimen The photodiode under test shall not be attached to or detached from the test circuit while the voltage is applied.

6.3 Precaution for damage due to electrostatic charge For photodiodes which may be damaged by electrostatic charge, the following precautions shall be observed.

- a) Electrostatic charging shall be prevented by means of electrostatic conductive materials, antistatic agent, etc. at transport, storage and leaving of photodiodes.
- b) The measurements shall be carried out in a place where no electrostatic charge is generated. It is preferable that the relative humidity is about 50 %.

To prevent generation of electrostatic charge, it is necessary to make the potentials of the operator, tools and instruments equal to the potential of photodiode under measurement.

6.4 Precaution for stain of optical component Take care so that optical parts of optical components including photodiodes will not be stained. If stained, remove the stain by cleaning with alcohol or the like.

6.5 Temperature stabilization (thermal equilibrium) conditions When the measured value changes with the lapse of time due to heat generation of the photodiode under test, carry out the measurement after the temperature has been stabilized or previously determine the timing of measurement (time interval up to initiation of measurement).

Informative reference : If a change exceeding anticipated error does not appear in the measured value, when the timing of measurement is doubled, consider that the temperature is stabilized.

6.6 Measuring circuit The measuring circuit illustrated in this Standard shows an example of the circuit to be used for the measurement. Accordingly an alternative circuit may be used providing that the equivalent results are obtained.

7 Measuring methods of electrical and optical characteristics

7.1 Measurement of dark current

7.1.1 Purpose The purpose is to measure the dark current of photodiodes under specified conditions.

7.1.2 Measuring circuit Carry out the measurement of dark current in the circuit of Fig. 1, in accordance with the method stated below.

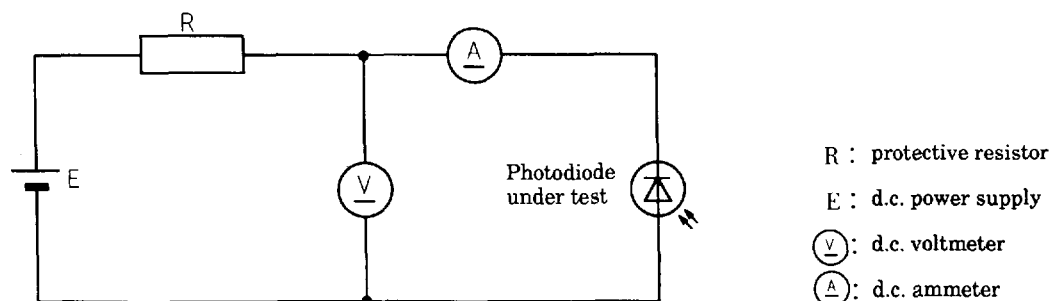


Fig. 1 Measurement of dark current

7.1.3 Measuring method Apply the specified reverse voltage across electrode terminals of the photodiode without optical input, and measure the dark current at that state.

7.1.4 Items to be specified in detail specifications

- a) Operating temperature
- b) Reverse voltage

7.2 Measurement of responsivity

7.2.1 Purpose The purpose is to measure the responsivity of photodiodes under specified conditions.

7.2.2 Measuring circuit Carry out the measurement of responsivity in the circuit of Fig. 2, in accordance with the method stated below.

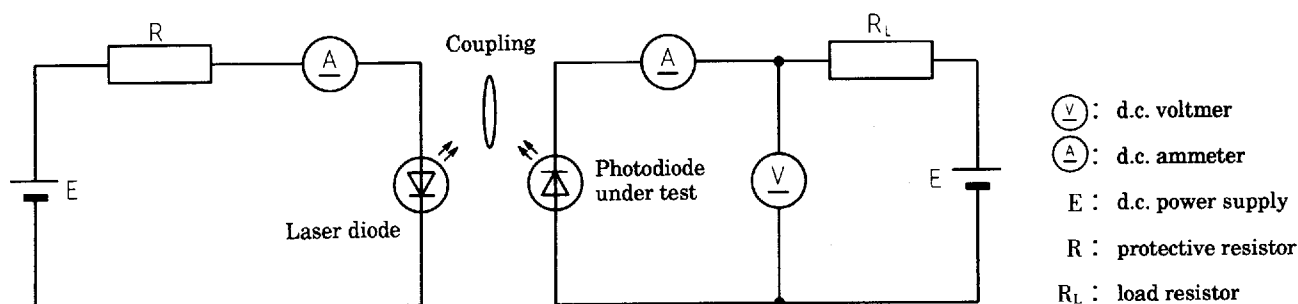


Fig. 2 Measurement of responsivity

7.2.3 Measuring method Apply the specified reverse voltage to the photodiode under test, and irradiate the diode with the light of input optical power P by using a light source of the specified wavelength and spectrum bandwidth. Measure the current which flows through the circuit at the said procedure, calculate the photocurrent I_{P0} by subtracting the dark current from the current so measured, and calculate the responsivity by means of formula (1).

$$S(\text{A/W}) = I_{P0}/P \dots\dots\dots (1)$$

where, S : responsivity (A/W)
 P : input optical power (W)
 I_{P0} : photocurrent (A)

Fig. 2 is an example of measuring circuit employing a laser diode as the light source, however, a combination of white light source and spectroscope may be used as the light source.

7.2.4 Precaution for measurement At the measurement pay attention on the following:

- For photodiodes other than optical fiber pigtail type and optical connector type, the diameter of the optical input beam shall be smaller than the diameter of photo-receptive plane of the photodiode under test.
- Use an optical power which falls in the region where the photocurrent of photodiode shows linearity, as the input optical power.

7.2.5 Items to be specified in detail specifications

- Operating temperature
- Reverse voltage
- Wavelength and spectral width of light source