INSTRUCTION MANUAL

OPTICAL PROBE

MODEL OPR10

KIKUSUI ELECTRONICS CORPORATION

Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.
(Revision should be applied to items indicated by a check mark ☑.)

☐ Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

☐ Input fuse

The rating of this product's input fuse is _____A, _____VAC, and _____.

WARNING

- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

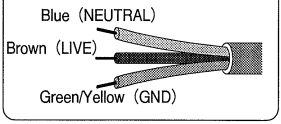
☐ AC power cable

The product is porvided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

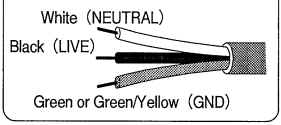
WARNING

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.

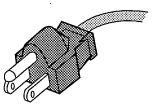
☐ Without a power plug



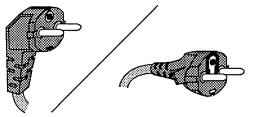
☐ Without a power plug



☐ Plugs for USA



☐ Plugs for Europe



☐ Provided by Kikusui agents

Kikusui agents can provide you with suitable AC power cable.
For further information, contact your Kikusui agent.

☐ Another Cable _____

 Kikusui Part No. Z9-000-027 IB001681

KIKUSUI

TABLE OF CONTENTS

1. GENERAL

1.1 Description

Model OPR10 Optical Probe is used being directly connected to a 20 - 200 MHz band oscilloscope or a digital voltmeter. The OPR converts an optical signal (the optical output of an LED, laser, optical fiber or other device) into an electrical signal, which can be directly measured in the mW or μW unit on the CRT screen or can be observed as a modulated output waveform.

1.2 Features

(1) A modulated optical signal waveform can be displayed on a CRT.

(2) Calibrated oprical-to-electrical conversion can be made.
(Conversion of optical output μW into electrical output mV)

(3) Wide measuring range with optical range selection (4 ranges)

(4) Power level calibration at two points--850 nm and 660 nm

(5) Compact, light, and excellent operability

2. SPECIFICATIONS

Calibration wavelengths: 660 nm and 850 nm (selectable), calibrated in terms of power level

Measurable Wavelength Range: 500 nm to 1050 nm

Optical Power Measuring Range: -55 dBm to +0 dBm

Range	Frequency Response (-3 dB)	Rise/Fall time (typical)	Noise Level (p-p value)	Maximum Measurable Optical Power
1 mV/μW	DC to 100MHz	5ns	5μW	1mW
10mV/μW	DC to 20MHz	20ns	500nW	100μW
100mV/μW	DC to 2 MHz	200ns	40nW	10μW
1000mV/μW	DC to 200kHz	2μS	4nW	1μW

(at 850 nm)

Measuring Accuracy: ±5% (after ZERO adjustment, at 850 nm, -10 dBm, non-modulated)

±10% (after ZERO adjustment, at 660 nm, -20 dBm, non-modulated)

Light Receiving Area: 2 mm dia., FC connector adaptor type

Maximum core diameter of optical fiber: 1.0 mm, NA0.5

Optical-to-electrical Converting Element: SI PIN photodiode

Output Connector: BNC connector
Output level is calibrated by connecting a 50-ohm external terminator.

Band limit: 10 MHz (ON/OFF selector provided)

Ambient Temerature and Humidity: 5 to 35 deg. C (41 to 95 deg. F), 85% RH

Power Supply: With AC adaptor (Standard type: Nominal 100 V)

Overall Dimensions

Excluding Extrusions:	90 W × 30 H × 50 D mm (3.54 W × 1.18 H × 1.97 D in.)
Including Extrusions:	125 W × 35 H × 55 D mm (4.92 W × 1.34 H × 2.17 D in.)
Weight:	Approx. 140 grams (5 oz)

Accessories:

AC Adaptor	1
TM01-OPR P-P Terminator	1
TM02-OPR P-J Terminator	1
BNC Cable (1 meter long)	1
Instruction Manual	1

Options:

OA02-OPR Type D4 Optical Input Adaptor
FB01-OPR Optical Fiber Cable (1 m), Type FC
FB02-OPR Optical Fiber Cable (1 m), Type D4

3. NOTES AND PRECAUTIONS

3.1 Inspection or Transportation Damage

Upon receipt of the device, immediately unpack and inspect it for any signs of damage which might have been sustained when in transportation. If any signs of damage are found, immediately notify the transportation compacy and/or your dealer.

3.2 Environments

The normally operating temperature range of the probe is 5 to 35 deg. C (41 to 95 deg. F). Do not use, or store for a long period, the probe in high temperature and high humidity lest the probe should be adversely affected. It is unrecommendable to use the probe in a strong electric or electromagnetic field since such will degrade the measuring accuracy.

3.3 Absolute Maximum Allowable Optical Input Level

The absolute maximum allowable optical input level of the probe is 10 mW (+10 dBm). Note that the probe can be damaged if an optical power higher than the above level is applied to the probe.

3.4 AC Adaptor

For the probe, use the AC adaptor which has been specifically designed and accompanies the probe. No other adaptor can be used for the probe.

4. OPERATING INSTRUCTIONS

4.1 Description of Front Panel Items

The front panel items of the probe are described below, referring to Figure 4-1.

① POWER Switch: Main Power switch. When on, LED ② illuminates.

○ RANGE SELECT Switches

③ 1 (mV/μW): When the switch is ON (▲), optical power is converted into electrical voltage at a rate of 1 mV per 1 μW.

④ 10 (mV/μW): When the switch is ON (▲), optical power is converted into electrical voltage at a rate of 10 mV per 1 μW.
(Set ohter RANGE SELECT switches (③, ⑤, ⑥) in the OFF state.)

⑤ 100 (mV/μW): When the switch is ON (▲), optical power is converted into electrical voltage at a rate of 100 mV per 1 μW.
(Set other RANGE SELECT switches (③, ④, ⑥) in the OFF state.)

⑥ 1000 (mV/μW): When the switch is ON (▲), optical power is converted into electrical voltage at a rate of 1000 mV per 1μW.
(Set other RANGE SELECT switches (③, ④, ⑤) in the OFF state.)

⑦ 660 nm/850 nm: The switch selects the input light wavelength for 660 nm or 850 nm.
When the wavelength in neither 660 nm nor 850 nm, set the switch to the state for the nearer one.
In this case, the measured value is non-calibrated and requires correction as described in Section 4.4.

⑧ BWL: The switch is to apply a bandwidth limit of approximately 10 MHz in order to eliminate undesirable highre frequencies. (The ▲direction is for BWL ON.)

⑨ Conversion Table: The table indicates the combinations of RANGE SELECT (mV/μW) switches (③, ④, ⑤, ⑥) and SCOPE (mV/DIV) switch, allowing to read the optical power in terms of the corresponding μW per 1 graticule division of the oscilloscope [READING (μW/DIV)].

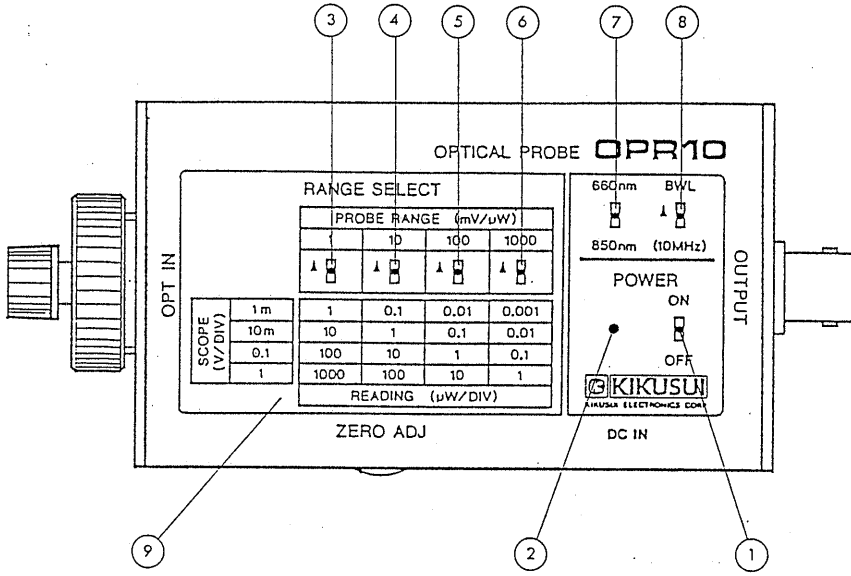


Figure 4-1. Front Panel of Optical Probe OPR10

4.2 Side Panel Items and Others

The side panel items and others are described below, referring to Figures 4-2 and 4-3.

⑩ ZERO ADJ knob: To adjust the zero input level.

⑪ DC IN Connector: The input connector accepts the output of the AC Adaptor which accompanies the probe.

⑫ OUTPUT Connector: The connector (BNC type) delivers the electrical output signal.

⑬ OPT IN Adaptor: The adaptor accepts an optical input. Type FC Optical Input Adaptor is installed as a standard device. Type D4 optical Input Adaptor (optional) may be installed instead.

⑭ TM01-OPR P-P Terminator: The terminator allows to connect the probe directly to the oscilloscope. The terminator has a 50-ohm terminating resistor.

⑮ TM02-OPR P-J Terminator: The terminator allows to connect the probe to the oscilloscope via the 1-meter cable (which accompanies the probe). The terminator has a 50-ohm terminating resistor.

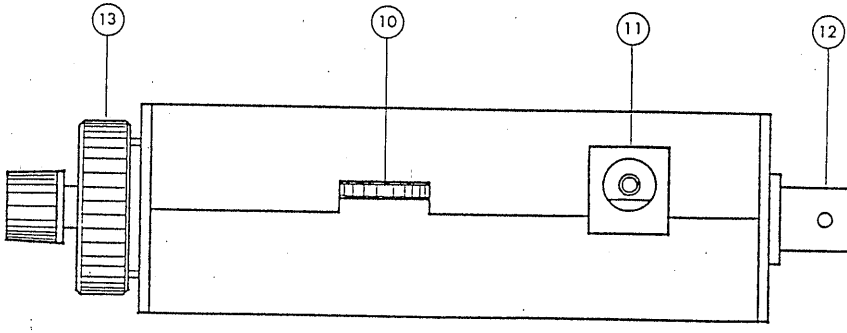
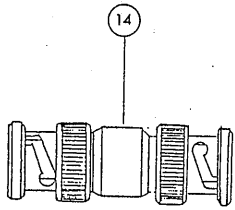
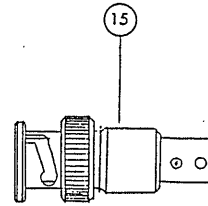


Figure 4-2. Side Panel of Optical Probe OPR10



TM01-OPR
P-P Terminator



TM02-OPR
P-J Terminator

Figure 4-3. Terminators

4.3 Initial Operating Procedure

When connecting the optical probe to the oscilloscope without using the cable, connect the P-P Terminator ⑭ to the probe and then connect it to the oscilloscope. When connecting the probe to the oscilloscope using the cable, connect the cable to the probe and then connect the cable to the oscilloscope by terminating the cable end with the P-J Terminator ⑮.

After making sure that the POWER switch is off, connect the AC Adaptor output plug to the DC IN connector ⑪ of the probe. Connect the AC Adaptor input plug to an AC line and then proceed as follows:

(1) Turn on the POWER switch and confirm that the POWER lamp (LED) illuminates.

(2) Make ZERO adjustment as follows (ZERO adjustment must be made each time any one or both of the RANGE SELECT and 660nm/850nm switches is or are changed):

① Shut off the input light of the optical input adaptor of the probe with the shut-off cap.

② Adjust the ZERO ADJ knob of the probe so that the zero level of the probe conforms with the ground level of the oscilloscope.

4.4 Optical Power Measurement

For optical power measurement, proceed as follows:

(1) Set the 660nm/850nm switch to the 660nm or 850nm state in conformity with the measured optical signal wavelength. (When the wavelength is neither one of the above, set the switch to the nearer one. In this case, the measured value must be corrected as described in Step (4).)

(2) Set the PROBE RANGE (mV/μW) switches of the RANGE SELECT section in formity with the measured optical power level.

Range	Measuring Range (μW)	Measuring Range(dBm)
1 mV/μW	1μW to 1mW	-30dBm to 0dBm
10 mV/μW	0.1μW to 100μW	-40dBm to -10dBm
100 mV/μW	0.01μW to 10μW	-50dBm to -20dBm
1000 mV/μW	0.001μW to 1μW	-60dBm* to -30dBm

*: The minimum measurable level is -55 dBm.

The ranges are selectable in 10-time steps. Within each range, optical power can be measured with a 1000-time dynamic range, thereby well covering the spans between ranges. When selecting a range, pay attention to the maximum measurable level of the range.

(3) Set the oscilloscope sensitivity at 1 mV/DIV, 10 mV/DIV, 0.1 V/DIV or 1 V/DIV for the "SCOPE* (V/DIV)" item of the RANGE SELECT Table on the front panel of the probe. With the combination of this item and the "PROBE RANGE (mV/μW)" item, optical power per 1 division of the CRT graticule can be directly read as indicated by the "READING (μW/DIV)" tiem.

*: The term "SCOPE" denotes the vertical deflection sensitivity of the oscilloscope.

For example, when the PROBE RANGE (mV/μW) is 10 (mV/μW) and the SCOPE (V/DIV) is 0.1 (V/DIV), the READING (μW/DIV) is 10 μW/DIV. This means that one division of the CRT graticule represents 10 μW of optical power.

The optical power in the μW unit can be converted into that in the dBm unit as described in Section 4.5.

Some different combinations of PROBE RANGE values and SCOPE sensitivities are possible for the same READING rate. They apt to your discretion. Select an appropriate combination taking into consideration the frequency bandwidth and noise level which may differ by the range.

(4) The sensitivity of the optical detector element differs by the wavelength of the light. Therefore, the measured value should be corrected as follows: The correction factors are as obtained by employing typical values. As the wavelength of the light measured becomes apart from that of the light with which the optical detector element has been calibrated, errors will increase.

① When the 660nm/850nm switch is set at 660nm:
Find the correction factor for the wavelength of the input light in the chart shown in Figure 4-4, and multiply the measured value by the correction factor.

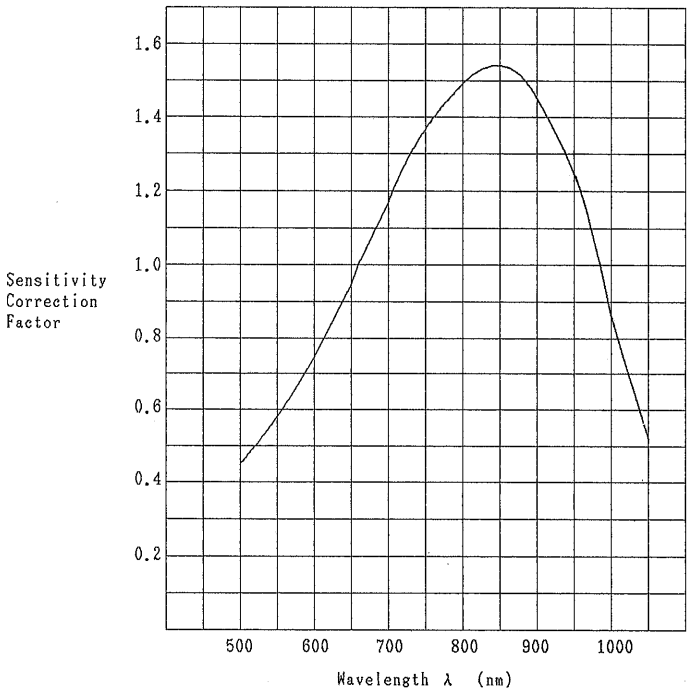
Example: Assume that the wavelength of the input light is 700 nm and the measured optical power is 100 μW. The correction factor is found to be 0.85 in Figure 4-4. Therefore, the actual optical input power is calculated to be
100 μW × 0.85 = 85 μW.

② When the 660nm/850nm switch is set at 850nm:

Find the correction factor for the wavelength of the input light in the chart shown in Figure 4-5, and multiply the measured value by the correction factor.

Example: Assume that the wavelength of the input light is 750 nm and the measured optical power is 100 μW. The correction factor is found to be 1.12 in Figure 4-5. Therefore, the actual optical input power is calculated to be
100 μW × 1.12 = 112 μW.

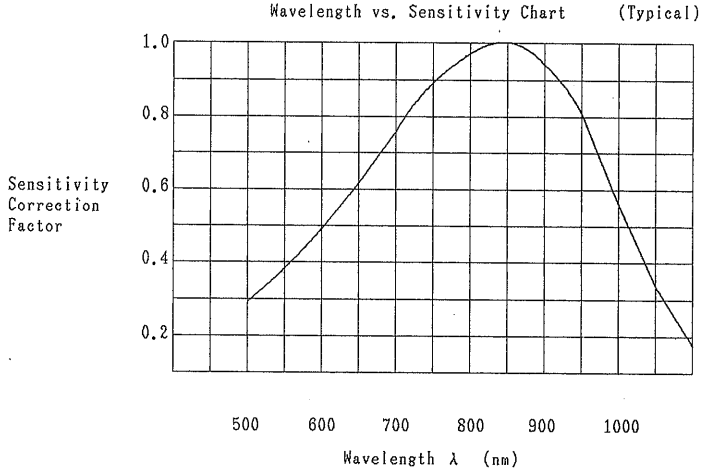
Wavelength vs. Sensitivity Chart (Typical)



Wavelength λ (nm)	Relative Sensitivity	Correction Factor*
500	0.45	2.22
550	0.58	1.72
600	0.75	1.33
650	0.95	1.05
700	1.17	0.85
750	1.37	0.73
800	1.49	0.67
850	1.54	0.65
900	1.45	0.69
950	1.25	0.80
1000	0.86	1.16
1050	0.52	1.72

*: The correction factor is a calculated reciprocal of the relative sensitivity.

Figure 4-4. Wavelength vs. Sensitivity Chart for 660nm Switch Setting



Wavelength λ (nm)	Relative Sensitivity	Correction Factor *
500	0.29	3.45
550	0.38	2.63
600	0.49	2.04
650	0.62	1.61
700	0.76	1.32
750	0.89	1.12
800	0.97	1.03
850	1.00	1.00
900	0.94	1.06
950	0.81	1.23
1000	0.56	1.79
1050	0.34	2.94

*: The correction factor is a calculated reciprocal of the relative sensitivity.

Figure 4-5. Wavelength vs. Sensitivity Chart for 850nm Switch Setting

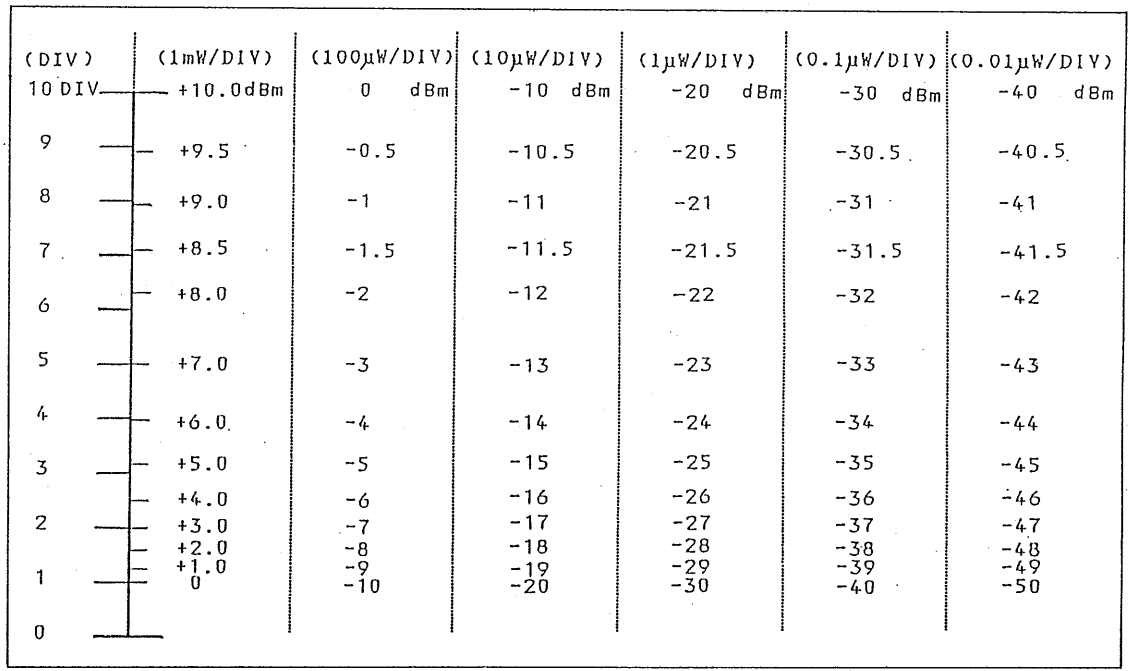


Figure 4-6. μW-dBm Conversion Chart

4.5 μW-dBm Conversion

An optical power expressed in terms of μW or mV can be converted into that expressed in terms of dBm, with reference to 1 mW = 0 dBm, using the following formula:

$$dBm = 10 \log \left(\frac{\chi}{1\ mW}\right)$$

where, χ : Optical power to be converted into dBm term

Values calculated employing the above formula for signal deflection amplitude (CRT graticule divisions) on the oscilloscope are shown in the chart in Figure 4-6. The chart allows to find readily the optical power in terms of dBm. The combination of PROBE RANGE value and SCOPE sensitivity gives the READING rate of the optical power per one graticule division. Referring to this READING rate is 10 μW/DIV and the signal amplitude on the CRT graticule is 4 DIV, the optical power level is found to be -14 dBm.

4.6 Notes for Output Impedance

The output circuit of the probe is as shown in Figure 4-7. For the output impedance, note the following:

① Be sure to terminate the output with 50 ohms. Note that errors may be introduced if it is terminated with other resistances.

② When using a coaxial cable, its impedance must be 50 ohms and its length must be within 1 meter.

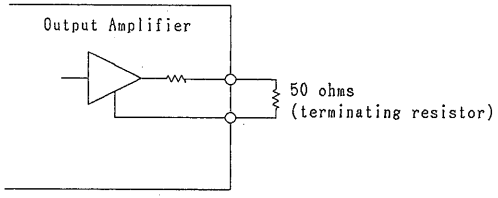


Figure 4-7

5. OPERATING PRINCIPLE

5.1 Operating Principle

The optical probe is comprised of an optical to electrical converter, an amplifier, and a power supply as shown in Figure 5-1. The optical input applied to the OPT IN section is detected into an electrical current signal by a photodiode and then into an electrical voltage signal. The voltage signal is amplified by the amplifier and then delivered to the output circuit.

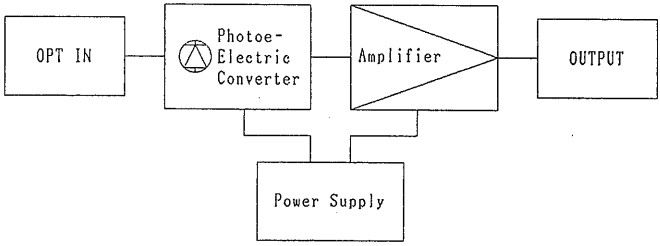


Figure 5-1. Block Diagram of Optical Probe OPR10

6. MAINTENANCE

6.1 Maintenance

The measuring accuracy will be degraded if the light receiving surface of the sensor of the probe collects dust. Pay attention so that no dust is collected on the light receiving surface. Whenever the probe is not in use, install the optical input adaptor and put on the cap to guard against dust.

Exercise care so that no unreasonably large shocks are applied to the probe when handling it.

6.2 Repair

The probe is a high precision device. Never attempt to repair it for yourself. For any repair service, order your Kikusui agent.