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Digital Photometer

Operator's Manual



Model Numbers:
IF PM

INDUSTRIAL FIBER OPTICS

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INTRODUCTION

This manual provides information about Industrial Fiber Optics' Digital Photometer. It contains all the information you need to operate this device safely and knowledgeably, even if you are a novice to this technology. Please read the manual carefully before operating.

As soon as you receive this laser, inspect it and the shipping container for damage. If any damage is found, immediately refer to the section of this manual entitled SHIPMENT DAMAGE CLAIMS.

Industrial Fiber Optics makes every effort to incorporate state-of-the-art technology, highest quality and dependability in its products. We constantly explore new ideas and products to best serve the rapidly expanding needs of industry and education. We encourage comments that you may have about our products, and we welcome the opportunity to discuss new ideas that may better serve your needs. For more information about our company and products refer to <http://www.i-fiberoptics.com> on the Internet.

Thank you for selecting this Industrial Fiber Optics product. We hope it meets your expectations and provides many hours of productive activity.

Sincerely,

The Industrial Fiber Optics Team

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LASER CLASSIFICATIONS

All manufacturers of lasers used in the United States must conform to regulations administered by the Center for Devices and Radiological Health (CDRH), a branch of the U.S. Department of Health and Human Services. CDRH categorizes lasers as follows:

Class	Description
I	A laser or laser system, which does not present a hazard to skin or eyes for any wavelength or exposure time. Exposure varies with wavelength. For ultraviolet, 2 to 4 μm exposures is less than from 8 nW to 8 μW . Visible light exposure varies from 4 μW to 200 μW , and for near-IR, the exposure is < 200 μW . Consult CDRH regulations for specific information.
II	Any visible laser with an output less than 1 mW of power. Warning label requirements – yellow caution label stating maximum output of 1 mW. Generally used as classroom lab lasers, supermarket scanners and laser pointers
IIIa	Any visible laser with an output over 1 mW of power with a maximum output of 5 mW of power. Warning label requirements – red danger label stating maximum output of 5 mW. Also used as classroom lab lasers, in holography, laser pointers, leveling instruments, measuring devices and alignment equipment.
IIIb	Any laser with an output over 5 mW of power with a maximum output of 500 mW of power and all invisible lasers with an output up to 400 mW. Warning label requirements – red danger label stating maximum output. These lasers also require a key switch for operation and a 3.5-second delay when the laser is turned on. Used in many of the same applications as the Class IIIa when more power is required.
IV	Any laser with an output over 500 mW of power. Warning label requirements – red danger label stating maximum output. These lasers are primarily used in industrial applications such as tooling, machining, cutting and welding. Most medical laser applications also require these high-powered lasers.

BACKGROUND

The word “photometer” originates from two other words — photo, which means light, and meter, which means instrument. Together the two words mean “an instrument for measuring light.”

Photometers (or light meters) are used in many household and commercial applications, including some we may not be aware of. For example, the “night lights” in the hallway outlets of many modern homes contain a photometer. When it gets dark, a photometer sensor switches an electrical device that supplies electricity to a light source. Another common photometer is the optical sensor in many point-and-shoot cameras. It is an internal photometer combined with sophisticated electronics that control the lens opening and shutter speed necessary to produce high-quality pictures.

The Digital Photometer to which this manual applies is a simple, easy-to-use digital instrument for measuring the energy levels of visible and some near-infrared light beams.* It was designed for instructors, students and technicians. Applications of the photometer include science, physics, principles of technology and vocational technology programs. Typical experiments that teachers and students may conduct using this photometer include:

- Characterizing the polarization of light
- Monitoring solar energy
- Optical filter transmission measurements
- Demodulating a laser beam
- Measuring attenuation in fiber optic cables

For more details about the specifications and use of the photometer, continue to the next section.

Table 1. Common abbreviations used in this manual.

Abbr	Long version	Scientific Notation
mW	milliwatts	1×10^{-3} watts
μ W	microwatts	1×10^{-6} watts
nW	nanowatts	1×10^{-9} watts
mm	millimeters	1×10^{-3} meters
μ m	micrometers	1×10^{-6} meters
nm	nanometers	1×10^{-9} meters

* More information is provided on page 5, under Product Specifications.

GENERAL INFORMATION

Control / Display Unit

1. ON/OFF Switch

The ON/OFF Switch is located in the lower left portion of the Digital Photometer's face. It is a "momentary switch" that applies power to the Control/Display Unit and Detector Assembly from the internal batteries only when the switch is pressed or closed. (The switch's momentary feature prevents the user from inadvertently leaving the photometer on and draining its internal batteries.)

2. Selector Switch

The Selector Switch is located in the lower middle face of the meter. It is used to select the meter's four different power ranges: 20 microwatts (μW), 200 microwatts, 2 milliwatts (mW) and 20 milliwatts. Position of the selector switch does not control electrical power to the meter.

3. Display (LCD)

The indicator for the Digital Photometer is a liquid crystal display (LCD) with 3-1/2-digit resolution. The maximum display reading is 1999 and the minimum is 0. (When the meter displays a negative number, go to the section entitled "Zeroing" Procedure on Page 11 to correct the reading.)

4. V+ Jack

The V+ jack is an industry-standard "banana" as is the V- jack. Both are located on the middle right portion of the Display/Control Unit face. The voltage across the V+ and V- jacks is an analog equivalent to the reading on the LCD display. The jacks provide access to the internal electronics and a positive voltage corresponding to the amount of light striking the sensing element (Detector). Full-scale reading on the digital display will correspond to one volt across the V+ and V- banana jacks.

The V+ and V- banana jacks make the meter useful as a transducer to convert an optical signal to an electrical signal. The jacks can be connected to an oscilloscope, multimeter, chart recorder or a preamplifier and speaker.

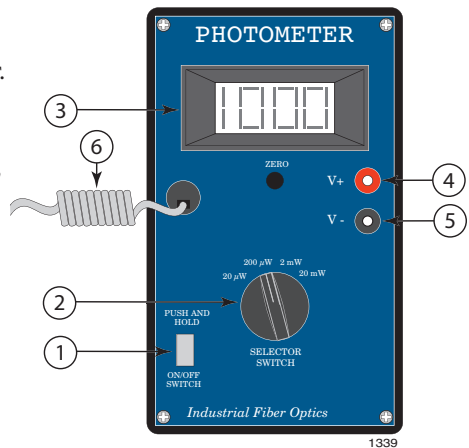


Figure 1. Photometer face.

5. V- Jack

The V- jack is also an industry-standard “banana” located in the middle right portion of the photometer face. This banana jack completes the electrical circuit for the V+ banana jack.

6. Cable

The cable electrically connects the Control/Display Unit to the Detector Assembly. Do not disassemble or remove the cable from either assembly as product warranty will be voided

7. Stand

The Digital Photometer is accompanied by a metal stand for mounting the Detector Assembly. The stand allows the Detector Assembly to be raised and lowered, which makes measurements easier, more stable and more uniform.

8. Detector Assembly

The Detector Assembly is composed of three parts: the Detector Housing, Detector (the optical sensor), and a thumb screw. The Detector

Assembly is electrically and mechanically connected to the Control/Display Unit by the Cable. It is not meant to be removed from the cable, and your product warranty will be voided if it is removed.

9. Detector

The Detector, or light sensing element, is approximately one centimeter square with a 7 mm diameter aperture in the center of the Detector Housing. See Figure 2. Always align your light source with the detector to make the most accurate measurements.

10. Thumb Screw

The thumb screw is located on the side of the Detector Housing. Loosen the screw to adjust the Detector Assembly on the stand and tighten the screw to secure the housing at the desired elevation. Tighten this screw as you would turn off a water faucet. Do not overtighten as this will damage the threads and/or detector mount.

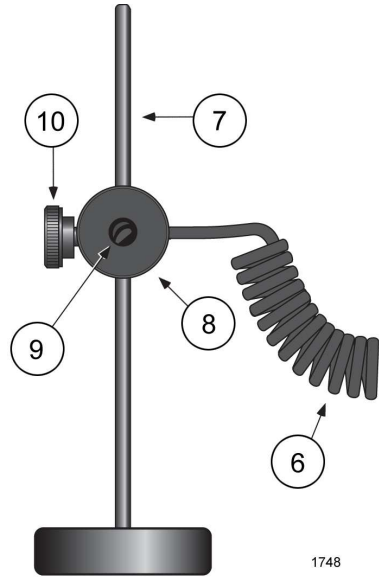


Figure 2. Front view of the Detector Assembly mounted on its stand.

11. Batteries (Not shown)

The Digital Photometer requires two 9-volt batteries (included) for operation. For shipping and storage purposes they have not been installed at the factory. To install or replace the batteries, follow the procedure in the section entitled SERVICE AND MAINTENANCE.

Battery types suggested for use with this meter include standard, heavy duty, and alkaline 9-volt batteries. Part numbers for major manufacturers are shown in Table 2. Do not use nickel-cadmium (NiCd) or lithium chemistry batteries in this instrument. They may damage your meter and/or produce inaccurate readings.

Table 2. Part numbers for popular batteries suitable for the Digital Photometer.

	Standard	Heavy-duty	Alkaline
Duracell®	Not available	M9V	MN1604
Eveready®	216	1222	522VP
Ray-o-Vac®	1604	D1604	A1604

PRODUCT SPECIFICATIONS

Table 3. Digital Photometer specifications.

Parameter	Value
Operating	
Input power	2 9-V batteries
Accuracy*	± 10%
Range (4)	19.99 μ W, 199.9 μ W, 1.999 mW, 19.99 mW
Temperature	10 to 30° C
Optical	
Detector active area	38 mm ²
Aperture	7 mm
Wavelength sensitivity	450 to 1050 nm
Maximum optical input	20 mw
Storage	
Control/Display unit	16 x 9.5 x 6.5 cm
Detector Assembly Stand	16.5 x 5 cm
Weight	750 grams
Temperature	-10 to 50° C

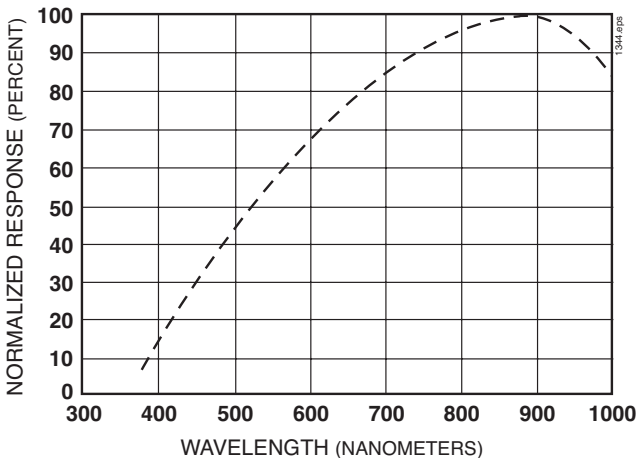


Figure 3. Typical response of Detector versus wavelength.

* Calibrated at 635 nm. Consult factory for calibration at other wavelengths.

SAFETY

Electrical

This meter is particularly safe because it operates from low voltage batteries. However, as when using any electrical device, certain safety precautions are imperative:

- Do not short-circuit the banana jacks or connect them to any high voltage.
- Do not operate this instrument while in contact with water.
- Use only recommended batteries.
- Do not modify any of the electrical circuitry in the photometer. (Modifying circuitry will also void your product warranty.)

Optical

There are no optical safety hazards associated with the Digital Photometer. However, because this instrument and others like it are often used in conjunction with lasers or other high-intensity light sources, it is necessary to be familiar with their operating procedures. If you are uncertain or unfamiliar with them, review their operating manuals or contact your instructor or safety officer.

INITIAL CHECKOUT

1. Unwrap all the components from the protective shipping packaging. Do not throw away the 12 x 6 x 4 tuck-top box, as it can be used to store the Digital Photometer.
2. Check that the Digital Photometer is complete and in good, undamaged condition. The complete meter includes the Control/Display Unit, Detector Assembly, Stand and two 9-volt batteries.
3. Install the batteries following the procedure found in the section entitled SERVICE AND MAINTENANCE.
4. Set the Stand upright, loosen the Thumbscrew at the rear of the Detector Assembly and slide the Detector Assembly over the post. Secure the Detector Assembly in place by tightening the Thumbscrew. Do not overtighten the Thumbscrew.
5. Turn the Selector Switch to 2 mW (milliwatts).
6. Turn the Control/Display Unit on by depressing the ON/OFF switch located in the lower left portion of the face. Numbers on the LCD display should now be visible.
7. Hold the ON/OFF switch in for 15 seconds. If the LCD does not read zero ($\pm .002$ mW), refer to the section entitled SERVICE AND MAINTENANCE for the procedure to “zero” the Control/Display Unit.
8. Point the Detector Assembly at a light source. Depress and hold the ON/OFF switch in. The display should read between 50 μ W and 1 mW for typical lighting.
9. Shade the detector inside the Detector Assembly from the room light and observe a reduction in the LCD display's reading.

You should have now verified that the Digital Photometer has arrived in good physical condition and is electrically/optically ready to use. Following are sample procedures using this photometer to monitor solar energy and power levels of laser beams.

OPERATING PROCEDURES

Monitoring Solar Energy

Using the Digital Photometer in solar experiments is just one of many applications for this versatile instrument. Below is a set-up procedure for monitoring solar energy.

1. Set the Selector Switch to the 20 mW position.
2. Check that the meter reads zero ($\pm .002$ mW) when the detector is covered and the On/Off Switch is closed. If not, go to the section titled “Zeroing” Procedure under Service and Maintenance.
3. Point the Detector Housing directly at the sun. (This can be done with the Detector Housing on or off the stand.)
4. Depress and hold the ON/OFF Switch in on the Control/Display Unit for 15 seconds.
5. Adjust the position of the Selector Switch so that the most sensitive position is used without “overranging” the meter.
6. Note the reading on the Control/Display Unit’s LCD.

Measuring a Laser Beam’s Power

1. Review your lab’s laser safety procedures.
2. Set the Photometer’s Selector Switch to the 20 mW position and zero the meter if necessary.
3. Set the laser up and position it so the emitted beam can not accidentally create a hazard for you or other people in the vicinity.
4. Switch the laser on and open its beam shutter.
5. Align the laser beam with the Detector inside the Detector Housing, being very conscious of safety.
6. Depress and hold in the ON/OFF Switch on the Control/Display Unit for 15 seconds.
7. Adjust the position of the Selector Switch so that the most sensitive position is used without “overranging” the meter.
8. Note the reading on the Control/Display Unit’s LCD.

TROUBLESHOOTING

LCD Remains Blank When Switch is Pressed

- On/Off Switch is not depressed fully.
- No batteries installed.
- Batteries may be weak. Replace batteries. See section entitled SERVICE AND MAINTENANCE for battery installation procedure.

LCD Display Does Not Read Zero

- Cover detector aperture.
- Zero adjustment needs to be made. See section entitled SERVICE AND MAINTENANCE for corrective procedure.
- Batteries may be weak. Replace batteries. See section entitled SERVICE AND MAINTENANCE for battery installation procedure.

No Change in Display Reading

- Light source or laser beam not striking the detector's sensitive area inside Detector Assembly. Reposition Detector Assembly or light source.
- Selector Switch is set at too high a level. Turn Selector Switch counter-clockwise one stop.
- Batteries may be weak. Replace batteries. See section entitled SERVICE AND MAINTENANCE for battery installation procedure.

No Output from Banana Jacks

- On/Off Switch is not depressed fully.
- Light source or laser beam not striking the detector's sensitive area inside Detector Assembly. Reposition Detector Assembly or light source.
- Selector Switch is set at too high a level. Turn Selector Switch counter-clockwise one step.
- Selector Switch is set at too low a level. Turn Selector Switch clockwise one step.
- Batteries may be weak. Replace batteries. See section entitled SERVICE AND MAINTENANCE for battery installation procedure.
- The electrical load of the device attached to the banana jack outputs is too low. (These outputs were not designed to drive an audio speaker.)

Do not attempt to troubleshoot the Digital Photometer beyond the steps listed above. If you believe that a problem exists within the Digital Photometer, please either contact the factory or return it for appropriate servicing to Industrial Fiber Optics, as described in the section on SERVICE AND MAINTENANCE

SERVICE AND MAINTENANCE

The only service and maintenance that the Digital Photometer should require is battery replacement and “zeroing.” Instructions for both procedures follow. All other adjustments have been made at Industrial Fiber Optics facilities.

Battery Installation

The recommended batteries for this meter are standard, heavy-duty or alkaline 9-volt batteries. See Table 2 for the part numbers of major battery manufacturers. Do not use nickel-cadmium or lithium chemistry batteries in this meter as they may cause damage or malfunctions.

1. Remove the four screws at the corners of the Control/Display Unit front panel.
2. Lift the front panel from the meter chassis and place it on a table or bench, face down.
3. Remove both batteries from the battery holders by tipping the rear portion upward and outward.
4. Remove any protective packaging from the replacement batteries.
5. Place one 9-volt battery into one of the battery holders and securely push it into place. When the battery is positioned properly it will be level with, and reside just below, the plastic battery holder sides.
6. Install the other 9-volt battery.
7. Check to ensure that the battery holder and 9-volt terminals are fully engaged.
8. Place the front panel inside the chassis.
9. Press the ON/OFF switch in to check for proper operation.
10. Replace the four screws in the corners of the front panel and tighten them.

“Zeroing” Procedure

Periodically it may become necessary to adjust the Control/Display Unit so it reads zero in the absence of light. (When the meter is on the 20 μ watt scale the display sometimes cannot be totally zeroed because of stray ambient light. In those cases, subtract the DC offset from your readings.) Zeroing the Photometer can be done using the following procedure.

1. Cover the Detector Assembly.
2. Turn the Selector Switch to the position at which you wish to zero the meter.
3. Depress and hold the ON/OFF Switch in so the meter is powered. (The LCD display should be lit.)
4. Let the meter stabilize for 15 seconds.
5. Insert a small NON-METALLIC screwdriver (standard blade type) into the hole marked Zero on the Photometer faceplate and adjust the internal potentiometer so the LCD reads as close to 0 as possible. This potentiometer turns only 3/4 of a revolution. Do not turn more than 3/4 of a turn or permanent damage to the meter will result.

Malfunctions

In the unlikely event that the meter malfunctions, you may have it repaired by doing the following:

- In writing, describe the problem, person whom we should contact, phone number and your return address.
- Pack the Control/Display Unit, Detector Assembly, Stand, manual and your letter carefully in a strong box with adequate packing material, to prevent damage in shipment.
- Ship the package to:

INDUSTRIAL FIBER OPTICS

1725 WEST 1ST STREET
TEMPE, AZ 85281-7622

WARRANTY

Industrial Fiber Optics products are warranted against defects in materials and workmanship for 90 days. The warranty will be voided if internal or external components have been damaged, mishandled, or altered by the buyer.

Warranty liability is limited to repair or replacement of any defective unit at the company's facilities, and does not include attendant or consequential damages. Repair or replacement can be made only after failure analysis at the factory. Authorized warranty repairs are made at no charge, and are guaranteed for the balance of the original warranty.

Industrial Fiber Optics will pay the return freight and insurance charges for warranty repair within the continental United States, by United Parcel Service or Parcel Post. Any other delivery means must be paid for by the customer.

The costs of return shipments for a Digital Photometer no longer under warranty must be paid by the customer. If an item is not under warranty, repairs will not be undertaken until the cost of such repairs have been prepaid by the customer. Typical repair costs range from \$50 - \$75, and completion times from two to three weeks.

When returning items for analysis and possible repair, please do the following:

- In a letter, describe the problem, person to contact, phone number and return address.
- Pack the laser, power adapter, manual and letter carefully in a strong box with adequate packing material, to prevent damage in shipment.
- Ship the package to:

INDUSTRIAL FIBER OPTICS

1725 WEST 1ST STREET
TEMPE, AZ 85281-7622

SHIPMENT DAMAGE CLAIMS

If damage to an Industrial Fiber Optics product should occur during shipping, it is imperative that it be reported immediately, both to the carrier and the distributor or salesperson from whom the item was purchased. **DO NOT CONTACT INDUSTRIAL FIBER OPTICS.**

Time is of the essence because damage claims submitted more than five days after delivery may not be honored. If shipping damage has occurred during shipment, please do the following:

- Make a note of the carrier company, the name of the carrier employee, the date and the time of the delivery.
- Keep all packing material.
- In writing, describe the nature of damage to the product.
- In cases of severe damage, do not attempt to use the product (including attaching it to a power source).
- Notify the carrier immediately of any damaged product.
- Notify the distributor from whom the purchase was made.

Rules for Laser Safety

- Lasers produce a very intense beam of light. Treat them with respect. Most educational lasers have an output of less than 3 milliwatts, and will not harm the skin.
- Never look into the laser aperture while the laser is turned on! PERMANENT EYE DAMAGE COULD RESULT.
- Never stare into the oncoming beam. Never use magnifiers (such as binoculars or telescopes) to look at the beam as it travels – or when it strikes a surface.
- Never point a laser at anyone's eyes or face, no matter how far away they are.
- When using a laser in the classroom or laboratory, always use a beam stop, or project the beam to areas, which people won't enter or pass through.
- Never leave a laser unattended while it is turned on – and always unplug it when it's not actually being used.
- Remove all shiny objects from the area in which you will be working. This includes rings, watches, metal bands, tools, and glass. Reflections from the beam can be nearly as intense as the beam itself.
- Never disassemble or try to adjust the laser's internal components. Electric shock could result.