

# OPERATOR'S MANUAL

**SPECTROLINE®**

## DMXA-Series and DMHA-Series Digital Radiometers



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Congratulations on choosing a Spectroline® DMXA-Series or DMHA-Series digital radiometer. Spectronics Corporation has designed it to provide the most desirable features, the best performance and, when used properly, years of trouble-free operation. Please read the instructions in this manual carefully before using the unit.

## SECTION I INTRODUCTION

### 1.1 GENERAL

The Spectroline DMXA-Series and DMHA-Series digital radiometers provide readings from 0-19,990  $\mu\text{W}/\text{cm}^2$  or 0-199.9  $\text{mW}/\text{cm}^2$  (0-199,900  $\mu\text{W}/\text{cm}^2$ ), respectively. They feature an easy-to-read LED display. Their overall accuracy is better than  $\pm 5\%$ .

These radiometers use high-quality interference filters that exhibit accurate and carefully controlled spectral coverage, practically eliminating unwanted meter sensitivity to infrared interference and other undesirable radiations. This allows the readings to be obtained directly instead of by calculation, a time-consuming and error-producing procedure required by certain competitive devices. The interference filters also minimize the "solarization" effect upon the response of the meters over time.

All Spectroline radiometers are calibrated to NIST standards by pyroelectric methods for maximum accuracy. They are designed with a low electrical impedance, making their linearity vastly superior to that of any other comparably priced radiometers. The sensor heads are provided with a special diffuser-sensor window that ensures accurate Lambertian or Cosine response.

The metering electronics of the DMXA-Series and DMHA-Series radiometers feature better than  $\pm 5\%$  accuracy, integrated circuitry, and solid-state LED display. Additional features of the electronics are excellent temperature and over-ranging characteristics. The DMXA-Series and DMHA-Series radiometers also have built-in autozeroing.

### 1.2 FEATURES

**1.2.1** The Spectroline DMXA-Series and DMHA-Series digital radiometers are pocket-sized, battery-operated units suitable for use in the measurement of 254nm, 300nm, 365nm or 450nm wavelengths.

**1.2.2** The radiometers feature nonrechargeable and rechargeable options. With the nonrechargeable option, the meters require four "AA" 1.5 volt, alkaline batteries. With the rechargeable option, the meters require four "AA" 1.25 volt, nickel-cadmium batteries and the Spectroline Model DM-15C0001 battery charger (separately available).

**1.2.3** The radiometers measure irradiances as specified in Table 1-1. The sensor generates electrical current proportional to the irradiance experienced at a plane defined by the face of the sensor. Amplification and current-to-voltage conversion circuitry are contained within the hand-held display unit and its integrated nature provides high reliability and accuracy in the readings.

**1.2.4** The numerical display is a light-emitting diode (LED) for precise reading in even total darkness. The numerals are 0.5 inch (12.7mm) high and in a single plane for distant and wide-angle viewing.

### **1.3 ACCESSORIES AND REPLACEMENT PARTS**

All accessories and replacement parts required for the operation of the radiometers are listed in Table 7-1.

### **1.4 TECHNICAL DATA**

Table 1-1 lists all the technical specifications for the radiometers.

#### **⚠ WARNING**

This radiometer is carefully designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, recommendations presented in this manual must be read carefully and thoroughly understood before any measurements are made. **Failure to follow directions could result in serious adverse effects.**

Also, certain models are designed for use in regions of the spectrum, notably the ultraviolet range, which may be hazardous to the eyes and/or skin of individuals. Ultraviolet protective eyewear (UVS-30 spectacles or UVG-50 goggles) and facewear (UVF-80 face shield) are obtainable from Spectronics Corporation.

## **SECTION II INSTALLATION**

### **2.1 UNPACKING AND INSPECTION**

**2.1.1** Unpack and inspect the radiometer for possible damage in shipment. Check the performance as soon as possible. If damage is noted, notify the carrier and supplier before using the instrument. Also check that all items are included.

**2.1.2** Save the shipping carton and packing materials for future storing or shipping of the radiometer.

### **2.2 POWER SOURCE REQUIREMENTS**

The radiometer is battery operated. The batteries are factory installed in the instrument.

## 2.3 INSTALLATION

The radiometer may be operated in any position without compromising accuracy. The sensor probe may also be positioned at any angle.

TABLE 1-1 TECHNICAL DATA

### 1. Readout Unit

#### Irradiance Range

|                       |  |
|-----------------------|--|
| DMXA-Series . . . . . | 0-19,990 $\mu\text{W}/\text{cm}^2$                                     |
| DMHA-Series . . . . . | 0-199.9 $\text{mW}/\text{cm}^2$ (0-199,900 $\mu\text{W}/\text{cm}^2$ ) |

#### Resolution

|                       |  |
|-----------------------|--|
| DMXA-Series . . . . . | 10 $\mu\text{W}/\text{cm}^2$                                 |
| DMHA-Series . . . . . | 0.1 $\text{mW}/\text{cm}^2$ (100 $\mu\text{W}/\text{cm}^2$ ) |

#### Display

|                       |  |
|-----------------------|--|
| DMXA-Series . . . . . | 4½ digit, 7 segment, LED<br>0.5 inch (12.7mm) high |
| DMHA-Series . . . . . | 3½ digit, 7 segment, LED<br>0.5 inch (12.7mm) high |

#### Conversion Rate

3 readings per second nominal

#### Overall Accuracy

Better than ±5%  
with reference to NIST standards

#### Temperature Coefficient

±0.025%/°C (0 to 50°C)

### 2. Sensor

#### Spectral Ranges

|                              |                         |
|------------------------------|-------------------------|
| DM-254XA, DM-254HA . . . . . | 230-280 nanometers (nm) |
| DM-300XA, DM-300HA . . . . . | 280-320 nanometers (nm) |
| DM-365XA, DM-365HA . . . . . | 320-400 nanometers (nm) |
| DM-450XA, DM-450HA . . . . . | 420-480 nanometers (nm) |

#### Temperature Coefficient

±0.20%/°C (0 to 50°C)

### 3. Power Requirements

#### Battery Operation

Four nonrechargeable "AA" size alkaline battery cells are included as standard.

Four rechargeable "AA" size nicad battery cells and a battery recharger are available as an option.

### 4. Reference Conditions . . . . .

Specified on Certificate of Calibration.

### 5. Dimensions

#### Readout Unit

|                    |                  |                  |                 |
|--------------------|------------------|------------------|-----------------|
| Length . . . . .   | 7.25 in (18.4cm) | Width . . . . .  | 3.50 in (8.9cm) |
| Thickness. . . . . | 2 in (5.1cm)     | Weight . . . . . | 1 lb (0.45kg)   |

#### Sensor

|                    |                 |                  |                 |
|--------------------|-----------------|------------------|-----------------|
| Length . . . . .   | 3 in (7.6cm)    | Width . . . . .  | 2 in (5.1cm)    |
| Thickness. . . . . | 0.70 in (1.8cm) | Weight . . . . . | 1.25 oz (35.4g) |

#### Sensor Cord Length . . . . .

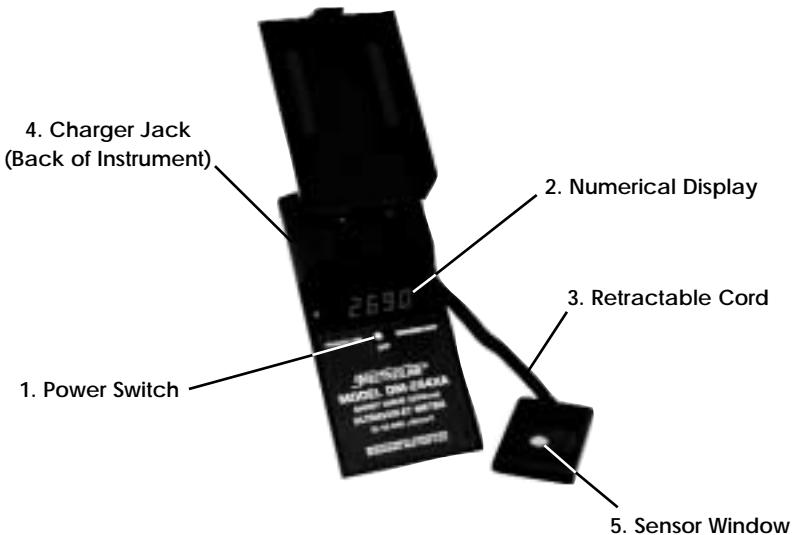
## SECTION III CONTROLS, CONNECTORS AND INDICATORS

### 3.1 GENERAL

All operating controls, connectors and indicators are described in Table 3-1. Become familiar with each item prior to operating the radiometer for the first time.

**TABLE 3-1 FRONT AND BACK PANEL DESCRIPTION**

|   |  |
|---|--|
| 1. Power Switch:                                      | With the dual-operation toggle switch flipped to the "POWER ON" position, the radiometer will remain activated until manually turned off. The meter will also operate when the switch is held in the "MOMENTARY" position, but the switch will automatically return to the "OFF" position once pressure is released. |
| 2. Numerical Display:                                 | The digital display uses LEDs and includes a "1" digit and 7-segment type 0-9 digits. The last digit is permanently set at "0." Over-range (or out-of-range) condition is indicated by a blank display, except for the most significant "1."   |
| 3. Retractable Cord:                                  | This coil cord connects the sensor to the readout unit.  |
| 4. Charger Jack:                                      | Use only with rechargeable battery cells. Any other type of cell may produce hazardous conditions and may damage the instrument.   |
| 5. Sensor Window:                                     | Sapphire diffuser to ensure good cosine response.  |
| 6. Battery Level Indicator Light<br>(Not Illustrated) | When lighted, green LED indicates that battery level is adequate.  |



## SECTION IV OPERATION

### 4.1 GENERAL

This section of the manual contains information required to use and operate the radiometer in a safe and proper manner.

### 4.2 IRRADIANCE MEASUREMENT PROCEDURE

- a. Be sure that this meter is appropriate for the spectral region of interest.
- b. Place the sensor at the point where the irradiance is to be measured.
- c. Turn on the light source.
- d. Flip the power switch to the "POWER ON" or "MOMENTARY" position as desired.
- e. The value of the irradiance over the sensitive area of the sensor will be displayed in microwatts per square centimeter (DMXA-Series) or milliwatts per square centimeter (DMHA-Series).
- f. Return the power switch to the "OFF" position and remove the sensor from the light source.

**NOTES:** The least significant digits of the measured irradiance may change as the display is being observed. The amount of variance will depend on the stability of the light source, with the change being smaller for tubular fluorescent-type lamps and larger for HID (High Intensity Discharge) lamps.

Also, interference filters are not perfect band-pass filters. Therefore, if an inappropriate measurement is attempted (for example, measurement of small amounts of UV-B from an intense UV-A radiation source or measurement of relatively small amounts of UV-A, UV-B or UV-C in sunlight), errors can be expected if appropriate corrections are not made.

#### 4.2.1 REMOTE USE OF THE SENSOR

To Remove Sensor: First, release cord from retaining slot. Then slide sensor out. Do not pull out sensor without first releasing cord, to avoid stretching of cord.

To Replace Sensor: Slide sensor up into receptacle with cord down and filter up. Wrap cord clockwise around retaining slot. *See diagram inside front cover of radiometer.*

#### ⚠ CAUTION

This radiometer is designed for intermittent use only. Do not leave the exposed sensor head under the light source any longer than necessary to take measurements. Prolonged exposure can result in premature aging and/or solarization of the sensor, necessitating more frequent recalibration to maintain accurate readings. In time, such exposure can cause permanent damage to the sensor.

## SECTION V THEORY OF OPERATION

### 5.1 OVERALL SYSTEM

The basic block diagram for the radiometer is shown in Figure 5-1.

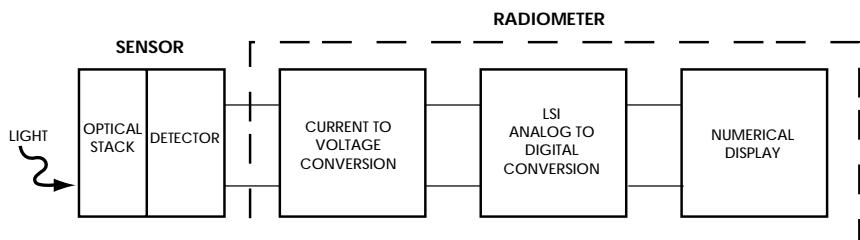


Figure 5-1 Basic System Block Diagram

#### 5.1.1 THE INPUT OPTICS

The Lambertian (Cosine) response of the sensor head is desirable for many measurement applications, especially those where the angle from the source to the detector is variable or those situations where

the angle from the source is "extended," such as in the measurement of a fluorescent lamp at distances comparable to or shorter than its length. In the latter case, the extended source provides radiation from many angles, all of which must be properly "weighted" as to their effectiveness on the plane represented by the sensor surface.

In actual practice, it is difficult to make a sensor conform to the ideal response over the entire solid angle of  $2\pi$  steradians. The sensor heads provided with the DMXA-Series and DMHA-Series radiometers minimize this problem by using a diffusing material (sapphire) having excellent transmission at the various spectral regions, which is mounted close to the surface of the sensor so that the oblique rays are not obstructed. The spectral range is selected by providing an appropriate optical interference filter before the sensor cell assembly.

### 5.1.2 THE SENSOR CELL

#### Photovoltaic Operation

When a p-n junction is operated with no externally applied voltage, it is considered to be operating in the photovoltaic mode. Under this zero applied voltage condition and low levels of incident light, the p-n junction will generate a current proportional to the light power incident on the active surface. This photon induced current, or photo-current, will divide between the diode parallel dynamic resistance and the parallel load resistance. The dynamic resistance is normally a high value and is an inverse exponential function of forward voltage. The direction of current flow will produce a voltage across the diode that opposes the band-gap potential of the photodiode junction, thus forward biasing it. As a result, the value of the diode dynamic resistance ( $R_d$ ) drops exponentially as the irradiance increases and the photogenerated voltage is a quasi-logarithmic function of diode irradiance when the external load resistance is considered. Another major disadvantage is that  $R_d$  typically has a wide spread of values over different production batches.

One way of achieving sufficiently low load resistance and eliminating the effect of the diode parallel resistance is to feed the photocurrent into the virtual ground of an operational amplifier.

The output voltage is the result of the photocurrent being driven by the amplifier through the feedback resistor and the input impedance  $R$  in  $= R_f / A$  where  $A$  is the open loop gain and  $R_f$  the feedback resistor.

This circuit has a linear response and is low noise due to the almost complete elimination of leakage current with the zero bias. This results in a proportional voltage being presented to the signal conditioning section of the electronics.

### 5.1.3 ANALOG TO DIGITAL CONVERTER SECTION

The analog-to-digital converter uses a large-scale integrated (LSI) circuit and changes the DC voltage into digital information. This digital information is decoded into 7-segment information for the LED display.

### 5.1.4 DISPLAY

The DMXA-Series radiometers feature a 4½ digit LED display that reads directly in microwatts per square centimeter ( $\mu\text{W}/\text{cm}^2$ ), while the DMHA-Series feature a 3½ digit LED display that reads directly in milliwatts per square centimeter ( $\text{mW}/\text{cm}^2$ ).

## SECTION VI OPERATOR SERVICING

### **WARNING**

The following operator servicing instructions are intended to be used by qualified personnel for limited maintenance of the radiometer. **Do not perform any servicing other than that contained in these operator instructions.** Return the unit to the factory for other maintenance not covered in this section.

### 6.1 GENERAL

The radiometer is carefully designed and constructed with high quality components. By providing reasonable care and following the instructions in this manual, the user can expect a long, useful service life from the instrument.

### 6.2 WARRANTY

The warranty policy for the DMXA-Series and DMHA-Series radiometers is provided on the Certificate of Limited Warranty enclosed separately with each unit.

**NOTE:** For assistance of any kind, contact the Customer Service Department at Spectronics Corporation. In the U.S. and Canada, call toll-free 1-800-274-8888. Give full details of the difficulty and include the model and serial numbers of the unit and the date of purchase. If return of the radiometer to the factory is deemed necessary, shipping instructions will be provided. If an estimate of charges for nonwarranty work or other service work is required, a quote will be furnished upon evaluation of the unit. Service work will not be performed without customer approval.

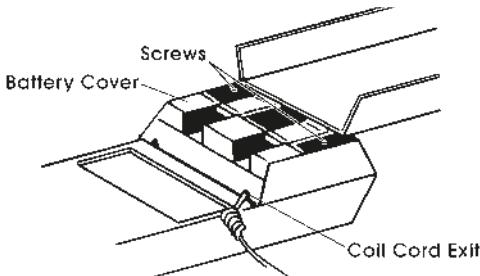
## 6.3 SHIPPING

Carefully pack the radiometer in the original shipping container and packing materials. Ship it prepaid to the factory and be sure to insure the unit for full value.

## 6.4 BATTERY COVER REMOVAL

The battery cover at the back of the radiometer can be removed for maintenance purposes by the following procedure:

- a. Disconnect the charger (if used) from the unit.
- b. Turn the two screws in the battery cover *counterclockwise* until the cover is removed.
- c. Reverse this procedure when replacing the cover.

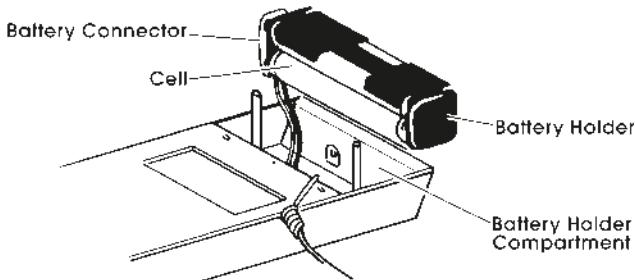


## 6.5 BATTERY INSTALLATION AND REPLACEMENT

The radiometer is provided with nonrechargeable, "AA" size alkaline cells as standard. If rechargeable nickel-cadmium batteries are used, the Spectroline DM-15C0001 bivoltage AC recharger must be used. Use of any other charger may damage the meter. Refer to the markings on the DM-15C0001 for power source requirements.

Battery cells should be replaced as follows:

- a. Lift out the battery holder from the radiometer and remove the holder from the battery connector.
- b. Take out the old cells from the holder.
- c. Insert four new cells, ensuring that the cells are installed according to the polarity designated on the battery holder. **FAILURE TO DO SO CAN DAMAGE THE RADIOMETER.**
- d. Check that the battery holder contacts are clean and making good connection.
- e. Reconnect the battery holder to the battery connector.
- f. Replace the battery holder in its compartment and replace the battery cover ensuring that the coil cord exits in the appropriate slot.



## 6.6 BATTERY CHARGING

Nickel-cadmium batteries should be recharged as follows:

- a. Be sure the radiometer is turned off.
- b. Plug the jack of the DM-15C0001 recharger into the receptacle at the back of the radiometer.
- c. Set the recharger at the proper voltage and plug it into an appropriate AC power source.
- d. Approximately 12 hours are required to fully charge the batteries.

## 6.7 RECHARGEABLE BATTERY CARE

- a. Avoid discharging rechargeable batteries completely or leaving discharged cells in the radiometer for long periods of time.
- b. Ensure that all newly purchased rechargeable cells are charged for at least 15 minutes before operating the radiometer.

## 6.8 PREVENTIVE MAINTENANCE

### 6.8.1 Daily Care

- a. Immediately clean all spilled materials from the radiometer and wipe dry. If necessary, moisten a cloth with soap and water to clean plastic surfaces and the sensor head. The sensor surface should be rinsed with ethanol to remove any residual soap and/or organic contaminants.
- b. Whenever possible, avoid exposure or usage in areas that are subject to temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes, or strong electrical or electromagnetic interference.

### WARNING

Do not attempt to clean this instrument when it is connected to the charger.

### 6.8.2 Monthly Care

Verify unit calibration by performing operational checks using known value sources. If the need for recalibration is indicated, contact the factory.

### 6.8.3 Semiannual or Annual Care

It is recommended that the radiometer be returned to the factory for a complete overall check and recalibration. Return long wave units (365nm) **at least every 12 months**. All others should be returned **at least every 6 months**. Contact the Customer Services Department for shipping instructions before returning the unit. In the U.S. and Canada, call 1-800-274-8888.

#### NOTE

The calibration potentiometer is located inside the radiometer. **Do not attempt to recalibrate this unit.** Spectronics Corporation does not guarantee the readings if the meter has been calibrated by any other facility.

### 6.8.4 Storage

When the radiometer is not in use, store it in a location free from temperature extremes, dust or corrosive fumes, and vibration or mechanical shock.

## 6.9 TROUBLESHOOTING

**6.9.1** If the radiometer does not yield satisfactory results, follow this procedure before attempting to service the unit:

- a. Review and comply with the Irradiance Measurement Procedure, listed in paragraph 4.2.
- b. Check that the irradiance intensity range being measured is within the rating of the unit.
- c. Be sure that the batteries are properly installed (refer to paragraph 6.5) and that they are charged.
- d. Ensure that the environment in which the radiometer is being used is within the unit specifications.
- e. Inspect the sensor head and readout unit for visible damage. If any damage is observed, the radiometer should be returned to the factory. Be sure to contact the Customer Service Department at Spectronics Corporation for shipping instructions before returning the radiometer. In the U.S. and Canada, call toll-free 1-800-274-8888. A quote will be furnished upon receipt and evaluation of the unit. Out-of-warranty service work will not be performed without customer approval.

**6.9.2** If the steps taken in paragraph 6.9.1 do not yield satisfaction, refer to the Troubleshooting Chart (Table 6-1). Direct all other repair and adjustment needs to the factory.

**TABLE 6-1 TROUBLESHOOTING CHART**

| Symptom                                | Probable Cause  | Cure   |
|--|---|--|
| 1. Low intensity on numerical display. | Batteries not fully charged, defective or making poor contact.  | Remove battery cover and check that batteries are making good contact. Refer to 6.5. If good contact is made check the voltage. If symptom persists replace batteries.   |
| 2. No numerical display.               | a. Batteries not installed.<br>b. Batteries installed incorrectly.<br>c. Batteries not making contact.<br>d. Batteries not charged. | a. Remove battery cover to ascertain whether batteries are present.<br>b. Remove batteries and check that polarity is correct.<br>c. Ensure that good contact is made. Check voltage. If symptom persists replace batteries.<br>d. Recharge nicad batteries or replace alkaline batteries. |

## SECTION VII ORDERING INFORMATION

TABLE 7-1

| Description                                       | Part No.   |
|---|------------|
| BATTERY, Alkaline, "AA" Size, 1.5 Volt . . . . .  | Commercial |
| (Four Required)                                   |            |
| BATTERY, Nicad Rechargeable, "AA" Size, . . . . . | DM-N4      |
| 1.25 Volt (Four Required)                         |            |
| BATTERY RECHARGER, Bivoltage . . . . .            | DM-15C0001 |
| (115V/60Hz, 230V/50Hz)                            |            |
| CARRYING CASE . . . . .                           | DR-75      |

### ACCESSORY



DR-75 Carrying Case