
OPERATOR'S MANUAL
SPECTRO-UV®

AccuMAX™ Meter Series
XRP-3000
Radiometer/Photometer Kit



SPECTRO-UV®

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1. INTRODUCTION

1.1 GENERAL

The AccuMAX™ XRP-3000 advanced digital radiometer/ photometer features a microprocessor-controlled readout unit with a dual-sensor detector to accurately measure both ultraviolet and visible light. It is specially engineered for nondestructive testing (NDT) applications. The UV-A/VIS sensor connects directly to the readout unit or via a USB cable with a water-resistant sensor adapter. A visible luminance sensor is available as an optional accessory.

The XRP-3000 provides black light (long wave UV) readings from 0-100 mW/cm², and visible light readings from 0-5,300 lux, (0-500 fc). See Table 2-2 for specifications. The XRP-3000 has an overall accuracy of better than ±5% with reference to NIST standards and conforms to black light and visible light MIL and ASTM specs for FPI and MPI in NDT applications.

The sensors are loaded with low electrical impedance, making their linearity vastly superior to that of any other comparably priced radiometers. The sensors are provided with a special diffuser-sensor window that helps prevent filter degradation and ensures accurate lambertian or cosine response.

The XR-1000 readout unit has a maximum 4-digit autoranging, monochrome LCD display and is protected by a rugged rubber boot. Additional features of the electronics include excellent temperature coefficient and over-ranging characteristics and built-in autozeroing.

1.2 FEATURES

The XRP-3000 is compact, lightweight and battery-operated for convenient use in the factory, field or any other location where measurements need to be taken. A slide-out panel allows easy replacement of the unit's 9-volt batteries.

- Menu-driven functions provide multifaceted light-level readings.
- Functional features embedded within operational modes further clarify the type of data desired.
- SETTINGS buttons provide user-selectable display parameters at any operational level.
- Intuitive screen prompts provide main operational functions (normal, autozeroing and integration).
- BACK button repeats information from previous screen.

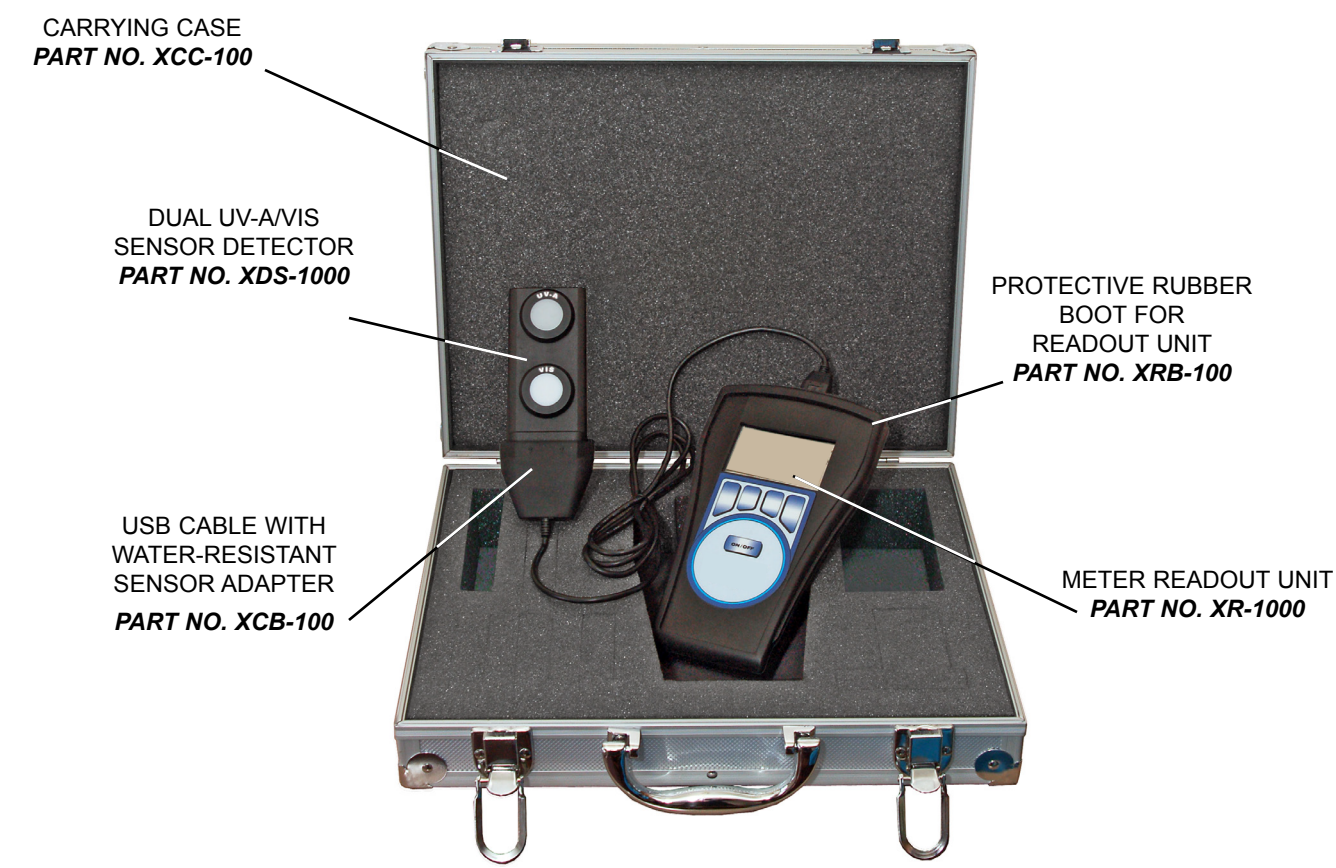
- Microprocessor-controlled readout unit with dual-wavelength sensor detector.
- Superior band-pass interference filter.
- Choice of direct connection or USB cable with water-resistant adapter between sensor detector and readout unit. Standard, commercially available USB cables can also be used.
- Excellent cosine response.
- Automatic shutoff.
- Large, easy to read LCD screen.
- Sealed sensor housing.
- Press and hold ON/OFF button prevents accidental shutoff.

1.3 PRECAUTIONS

- This radiometer is carefully designed to prevent accidental shock to the operator when used properly. However, no engineering design can render safe an instrument that 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.**
- The UV-A sensor is 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 and facewear are available from Spectro-UV for instances when UV exposure is unavoidable.
- 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 of the sensor, necessitating more frequent recalibration to maintain accurate readings.
- See Section 10, Warranty, Maintenance and Battery Replacement, for more information.

2. GENERAL SPECIFICATIONS

2.1 UNPACKING AND INSPECTION OF XRP-3000 NDT METER KIT



Component Check List

| Product Description | Part Number |
|---|-------------|
| METER READOUT UNIT | XR-1000 |
| DUAL UV-A/VIS SENSOR DETECTOR | XDS-1000 |
| USB CABLE WITH WATER-RESISTANT SENSOR ADAPTER | XCB-100 |
| RUBBER BOOT FOR READOUT UNIT | XRB-100 |
| CARRYING CASE | XCC-100 |

- Unpack and inspect the AccuMAX for possible damage in shipment. Check that all components are included. Save the shipping carton and packing materials for future storing or shipping of the AccuMAX.
- Check the performance as soon as possible. If damage is noted, immediately notify the carrier and supplier and do not use the instrument.

2.2 TECHNICAL DATA

AccuMAX™ XRP-3000 SPECIFICATIONS



| | |
|--------------------------------|--|
| Readout Unit (XR-1000) | |
| Resolution | 4-digit autoranging display with backlight |
| Screen | 128 x 64-dot pixel chip on glass STN transmissive monochrome LCD |
| | 2.8 in (7.1 cm) diagonal |
| Sampling Rate | 7.5 Hz (Single Sensor) |
| | 15 Hz (Dual Sensor) |
| Read Update | 2 Hz |
| Overall Accuracy | Better than ±5% with reference to NIST standards |
| Temperature Coefficient | ±0.025%/°C (0 to 50°C) |

| | | |
|--|--|----------------|
| Dual UV-A/Visible Sensor Detector (XDS-1000) | | |
| | Measurement Range | Spectral Range |
| • UV-A Sensor | 0-100 mW/cm² | 320-420 nm |
| • Visible Sensor | 0-5,300 lux (0-500 fc) | 460-675 nm |
| Power Requirements | | |
| Battery Operation | Two nonrechargeable 9V alkaline battery cells are included as standard | |
| Dimensions | | |
| Readout Unit | | |
| • Length | 7.75 in (19.7 cm) | |
| • Width | 4.25 in (10.8 cm) | |
| • Thickness | 1.25 in (3.2 cm) | |
| • Weight | 0.8 lb (360 g) | |
| Sensor | | |
| • Length | 4.75 in (12.0 cm) | |
| • Width | 2.0 in (5.1 cm) | |
| • Thickness | 7/8 in (2.2 cm) | |
| • Weight | 0.22 lb (100 g) | |
| Accessories | | |
| • USB cable with water-resistant adapter | XCB-100 | |
| • Rubber boot | XRB-100 | |
| • Carrying case | XCC-100 | |

2.3 ELECTRICAL SPECIFICATIONS

Two nonrechargeable 9-volt alkaline batteries are included. Fresh batteries will provide a typical, usable operation period of 12 hours.

2.4 OPTICAL ACCURACY AND CALIBRATION

The AccuMAX™ XRP-3000 radiometer/photometer kit uses a dual-wavelength UV-A/VIS sensor detector to simultaneously measure both ultraviolet and visible light. Featuring automatic zeroing, integration and signal hold, the unit provides accurate readouts for UV irradiance and visible illuminance. The LCD readout features ±0.2% linearity with the sensor sending the linearity correction data to the readout unit during initial power-up. To ensure consistent results, sensors are designed with superior bandpass filters, while optical stacks are assembled in Class 100 clean workstations.

For precise spectral coverage, these high-quality interference filters will effectively resist degradation.

2.5 ENVIRONMENTAL SPECIFICATIONS

The AccuMAX radiometer/photometer is designed to be safe under the following conditions:
Indoor use;

- Altitude up to 2,000 m (6,562 ft.);
- Temperature 5°C to 40°C (41°F to 104°F);
- Maximum relative humidity 80% for temperatures up to 31°C (88°F) decreasing linearly to 50% relative humidity at 40°C (104°F);
- Mains supply voltage fluctuations not to exceed ±10% of the nominal voltage;
- Installation Category II;
- Pollution Control 2.

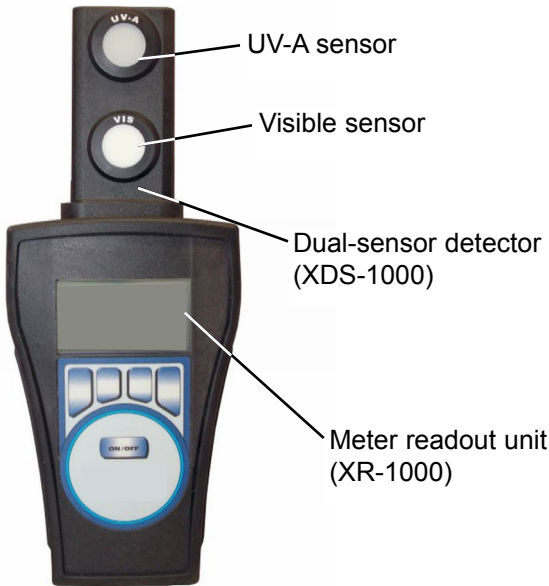
3. INSTALLATION

3.1 CONTROLS, CONNECTORS AND INDICATORS

The AccuMAX dual-sensor detector (XDS-1000) may be connected to the meter readout unit (XR-1000) by *direct connection* or by *remote connection* via USB connector (see below). Either of these options allows a complete transfer of information in digital form.

3.2 DIRECT CONNECTION

Attach detector by lining up USB connections and pushing together.



3.3 ATTACHING WATER-RESISTANT ADAPTER (REMOTE CONNECTION)

The AccuMAX XRP-3000 kit includes a custom 5 ft (1.5 m) USB cable (XCB-100) with a water-resistant sensor adapter. The male USB connector port attaches to the top of the AccuMAX readout unit and the female port inside the adapter attaches to the bottom of the sensor detector.

With sensors facing upward, align the arrows on the adapter to the detector. Gently expose the USB port inside the adapter by flipping the rubber edge outward, then connect it to the USB port on the sensor detector. **Note:** To ensure water resistance, make sure the two rows of ridges on the adapter are firmly in place within the grooves of the detector.



4. CONTROLS



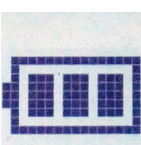

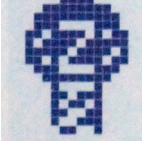

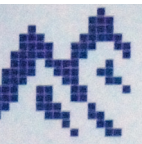
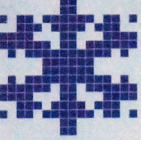
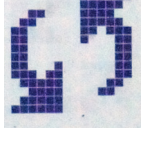
4.1 BUTTONS



- The sealed membrane keypad on the readout meter is equipped with five pressure-sensitive buttons that provide multiple functions and easy operation. The ON/OFF button turns the meter on and off. The four side-by-side buttons provide intuitive customer interactive functions.
- The instrument will automatically turn itself off to preserve the battery life if no buttons are pressed for 60 minutes.

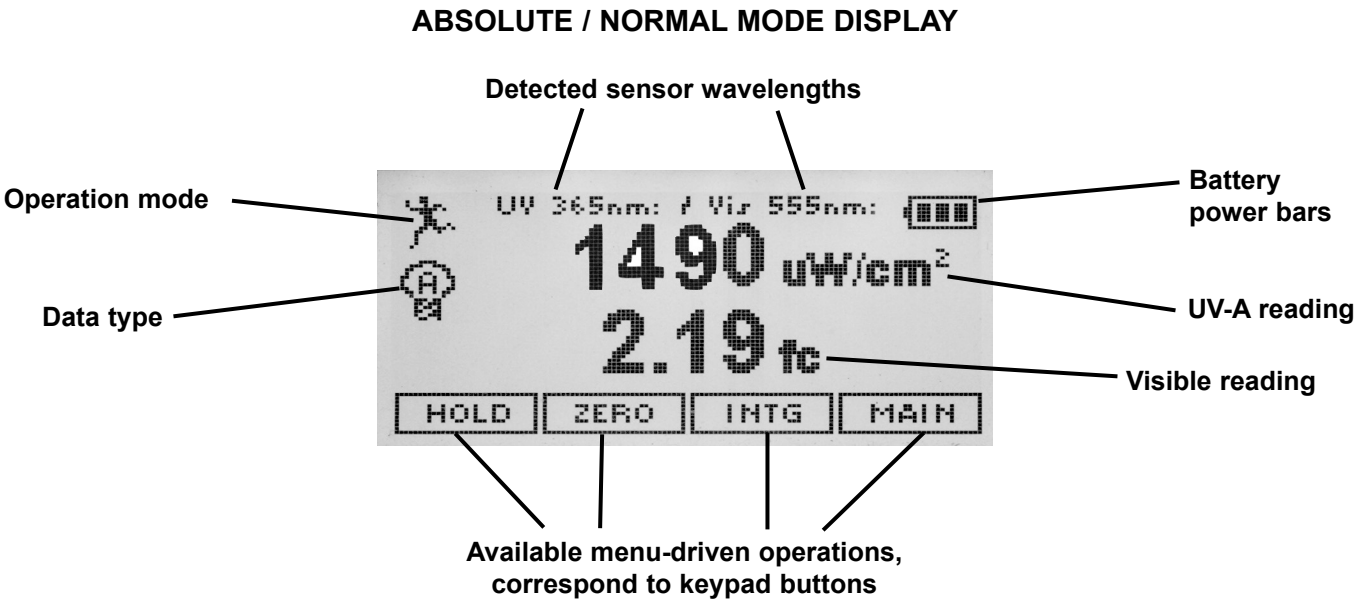
4.2 DISPLAY AND ICONS

The AccuMAX meter uses a liquid crystal display (LCD) with a combination of easy-to-read icons and alphanumeric characters to denote readings, units, operating mode and meter status in a four-line format. UV and VIS level readings are automatically adjusted for the magnitude of the measurement (autoranging) and then displayed with the appropriate 4-digit resolution units. For example: 12,000 $\mu\text{W}/\text{cm}^2$ would be displayed as 12.00 mW/cm^2 . This enables the readout unit to accept and respond to a wide range of light levels. Icons provide a quick glance at data type and the available functions at every operational screen.

| | | |
|---|---|--|
|  Running man icon— Meter in running operation |  Bulb A icon— Absolute readings displayed |  Battery power bars |
|  Open hand icon— Holds data-constant display |  Bulb Z icon— Zero readings with ambient light subtracted |  Hourglass icon— Integration of light levels— continuous count |
|  Mountain peak icon— Peak value displayed |  Snowflake icon— Freezes data during integration |  Circular arrows icon— Integration in progress |

5. OPERATION—QUICK GUIDE

- **TO TURN ON METER**, press and hold **ON/OFF** button for two seconds.
- Displays **Spectro-UV® AccuMAX™ Series** splash screen.
- Displays **Establishing Sensor Communications** when sensor detector is attached.
- Displays **Detector Not Found/Try Cycling Power** *ONLY* if sensor detector is *NOT* connected or detector was disconnected during operation. Reestablishing connection will shut off meter.
- **TO RESTART METER**, press and hold **ON/OFF** button.
- Meter automatically opens in **ABSOLUTE DATA/NORMAL MODE DISPLAY** (see screen below) ready for operation.



- To change meter display settings, press **MAIN** to select **OPERATION**, then press **DOWN** to select **SETTINGS** option (see SETTINGS section).
- For light level reading, press **UP** to select **OPERATION**, then press **ENTER**.
- Shine light directly over sensor of interest (UV or VIS) on dual detector. Meter instantly displays light level for each wavelength (intensity/unit area).
- Access higher level operations such as autozeroing and integration through menu-driven functions (see individual sections for details).
- To turn off meter, press and hold **ON/OFF** button. Displays **Shutting Down -NOW-** then goes to blank screen.
- Meter will automatically shut off after 60 minutes of inactivity except in integration (**INTG**) mode. Unless the meter is at low battery status, all user-selectable parameters will have been saved and used for future meter operations. Press and hold **ON/OFF** button to restart meter.

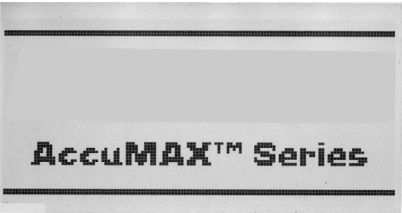
CHOOSING AN OPERATING LANGUAGE

- The AccuMAX is equipped to operate in four languages: English, French, German and Spanish. To access and choose each language, when the meter is turned on and opens in the screen pictured above, press **MAIN** to access the **OPERATION/SETTINGS** screen.
- Press **DOWN** to access **SETTINGS**, then **ENTER** to access the next screen, which defaults to **UNITS** and **LANGUAGE**.
- Press **UP** to access the word **LANGUAGE**, then press **ENTER**.
- Two words appear on the screen. Each time you press **UP** or **DOWN**, the name of the language will change. When it reaches the language you want to use, press **EXIT** to set and use the language. The language will remain in use until you set it to another language.

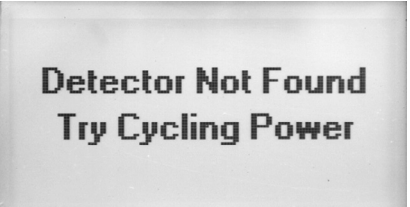
6. USING THE AccuMAX

6.1 ON/OFF

Press and hold the ON/OFF button to turn the meter on. Splash screen below will be displayed.



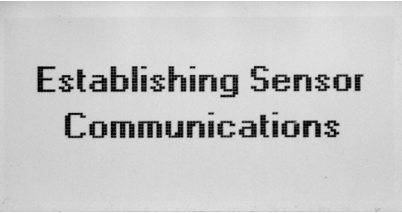
A detector must be plugged in when the AccuMAX is first turned on for the instrument to initialize properly and communicate with the detector for information on calibration factors, range limitations and units. If the instrument is turned on without a detector plugged in, the display will show



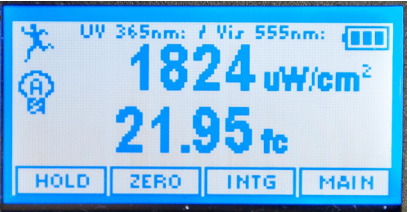
and will automatically shut off in 30 seconds. This same message is displayed if the detector is removed while the instrument is running. To remedy this situation, simply turn off the AccuMAX, plug in the detector, and turn the unit on. The instrument will then initialize itself automatically.

6.2 DETECTOR ATTACHED

After the sensor detector is attached and the AccuMAX is turned on, the screen will display

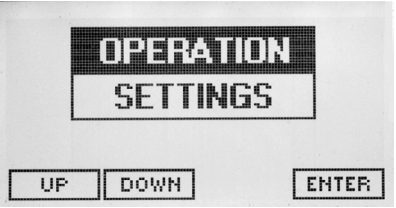


and automatically proceed to the next screen.



6.3 CHOOSING AN OPERATING LANGUAGE

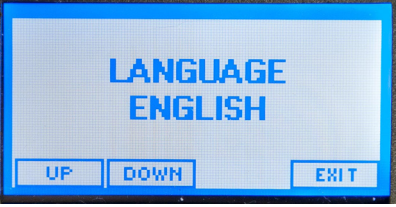
The AccuMAX is equipped to operate in four languages: English, French, German and Spanish. To access and use each language, when the meter is turned on and opens in the screen pictured above, press **MAIN** to access the **OPERATION/SETTINGS** screen,



Press **DOWN** to access **SETTINGS**, then **ENTER** to access the next screen, which defaults to **UNITS** and **LANGUAGE**.



Press **UP** to access **LANGUAGE**, then press **ENTER**. Two words will appear on the screen.

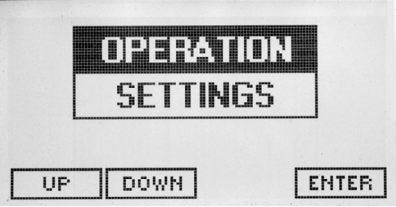


Each time you press **UP** or **DOWN** the name of the language will change.

| | | | |
|---------------------|---------------------|--------------------|--------------------|
| LANGUAGE ENGLISH | LANGUAGE SPANISH | LANGUAGE FRENCH | LANGUAGE GERMAN |
|---------------------|---------------------|--------------------|--------------------|

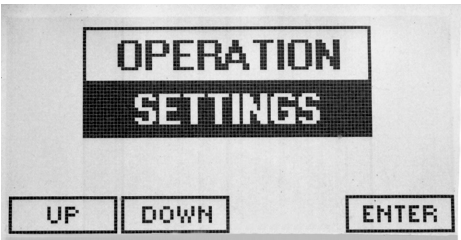
When it reaches the language you want to use, press **EXIT** to set and use the language. The unit will default to **UNITS** and **LANGUAGE** and will remain in that language until you set it to another language.

Press **UP** to return to the left column, press **DOWN** until you reach **EXIT**, press **ENTER** and return to **OPERATION** and **SETTINGS**.



The AccuMAX is immediately operational with software-driven, established default parameters. However, you may choose to customize some of its features. A quick run-through of the various options may be of value in your operating conditions.

7. CUSTOMIZING SETTINGS



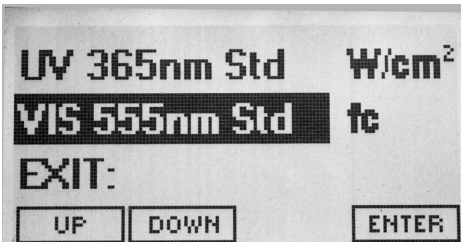
Press DOWN to highlight SETTINGS. Press ENTER to access the next screen, which defaults to UNITS and LANGUAGE.



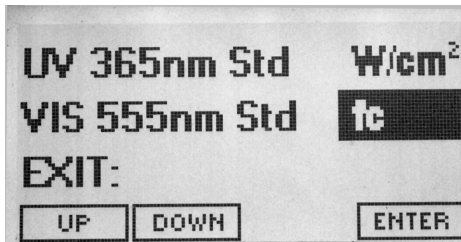
Press UP or DOWN to highlight the feature to be changed and ENTER to access the next screen, or highlight EXIT and press ENTER to return to OPERATION.

7.1 CHANGING UNITS OF VISIBLE LIGHT MEASUREMENT

AccuMAX provides users the capability of choosing the default visible light unit of measure to either foot-candles (fc), Lux, lm/ft² or lm/m². UV intensity units will autorange from µW/cm² to mW/cm² to W/cm².



Press ENTER to highlight the right column, then UP or DOWN to change from fc to Lux.



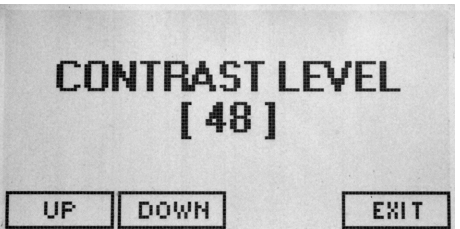
Press ENTER to return to left column, DOWN to highlight EXIT and ENTER again to access UNITS.

7.2 ADJUSTING CONTRAST

Press DOWN to highlight CONTRAST.



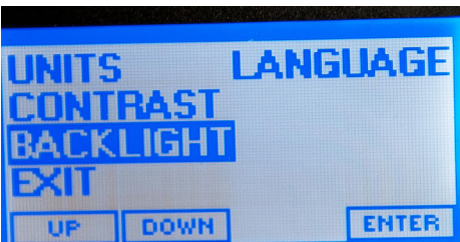
Press ENTER to access the next screen, where the default contrast level is 48, which gives the best display in most lighting environments. This level can be changed to range from 42 to 55 by pressing UP or DOWN. Press EXIT to save the setting and return to the previous screen. **NOTE:** Any changes to the contrast level will revert to default level when the AccuMAX is shut off.



7.3 ADJUSTING BACKLIGHT

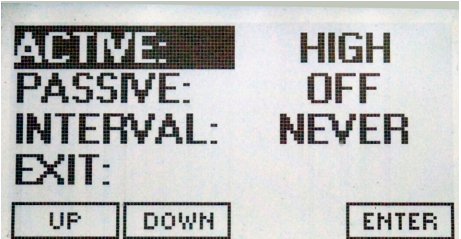
The screen BACKLIGHT intensity can be adjusted to suit ambient light conditions and user preferences.

The meter is ACTIVE immediately after being turned on or after pressing any button, and will go into PASSIVE operation after a set time INTERVAL expires. Press DOWN to highlight BACKLIGHT.

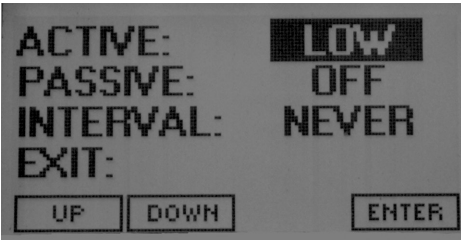
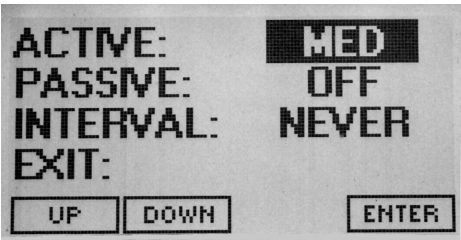
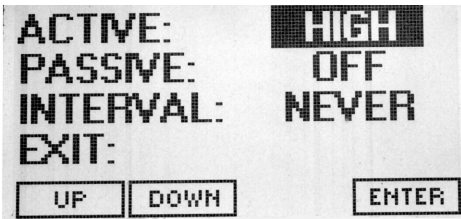


7.3.1 SELECTING BACKLIGHT FOR ACTIVE AND PASSIVE OPERATIONS

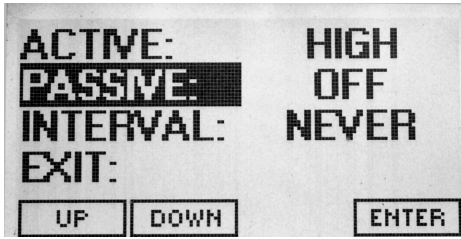
Press ENTER to access the next screen where ACTIVE is highlighted.



Press ENTER, then UP or DOWN to change options in the right column.



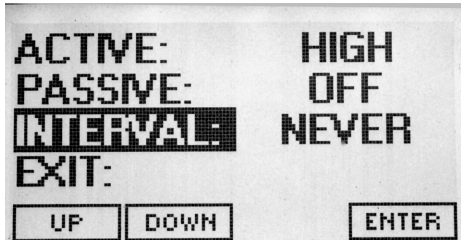
Press ENTER to save the setting and return to the left column. Press DOWN to highlight PASSIVE.



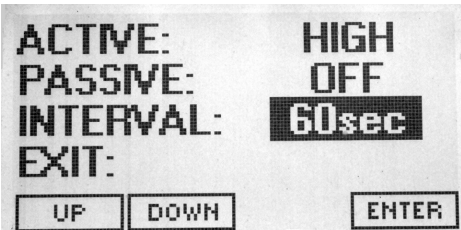
Press ENTER and then UP or DOWN to change the BACKLIGHT setting in the right column. Press ENTER to save the setting and return to the left column.

7.4 ADJUSTING INTERVAL BETWEEN ACTIVE AND PASSIVE OPERATIONS

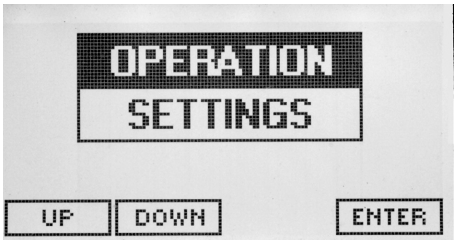
Press DOWN to highlight INTERVAL, the length of time the meter stays in ACTIVE operation before reverting to PASSIVE.



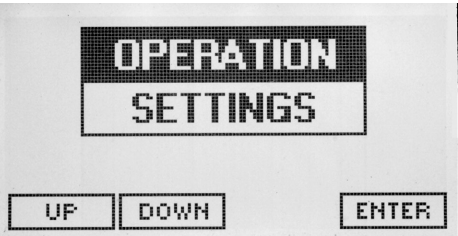
Press ENTER again to access the right column to set the length of time (60sec, 30sec, 10sec) between ACTIVE and PASSIVE operations. Setting NEVER keeps the BACKLIGHT level at the ACTIVE brightness level continuously.



Press ENTER to save the setting and return to the left column. Press DOWN to highlight EXIT, then ENTER again to return to OPERATION.



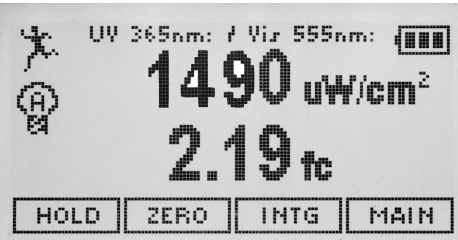
8. AccuMAX OPERATION MODES



With OPERATION highlighted, press ENTER to access operational screens.

8.1 ABSOLUTE DATA / NORMAL MODE

When a detector is attached, AccuMAX automatically begins operating in NORMAL mode after OPERATION is selected. This mode will measure the absolute total light intensity the sensor is exposed to, including any background or ambient light.

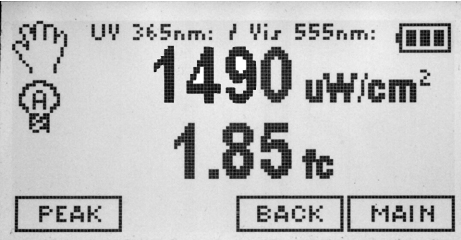


ABSOLUTE/NORMAL mode display. ZERO and INTEGRATION modes can be reached ONLY from this mode. Press MAIN to return to OPERATION/SETTINGS display

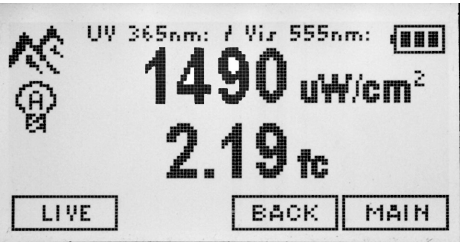
- The A light bulb icon indicates the readings are ABSOLUTE values.
- The running man icon indicates that the meter is operating in real time.
- The bars indicate battery power level.
- The UV reading will display in whole numbers from 0 to 9999.
- The visible reading will display in floating decimal format in a maximum of four digits.
- If the incoming light exceeds the maximum measurement range of the sensor, OVR RNG will be displayed. Any signal that goes below the detector's minimum sensitivity or "zero floor" will display 0.00 on the LCD.

8.2 HOLD AND PEAK FUNCTIONS

Press HOLD to freeze the reading. The open hand icon will appear.



Press PEAK to display the highest readings recorded during normal operation. The mountain peak icon will appear.



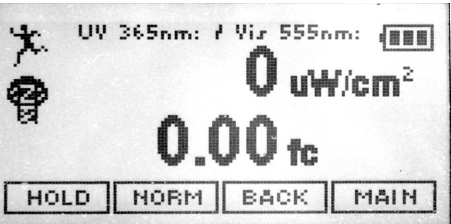
When in PEAK function, press LIVE to return to NORMAL mode, or press BACK to return to the previous HOLD screen, and press BACK again to return to NORMAL mode.

NOTE: Pressing BACK will always result in returning to the previous screen.

8.3 ZERO MODE

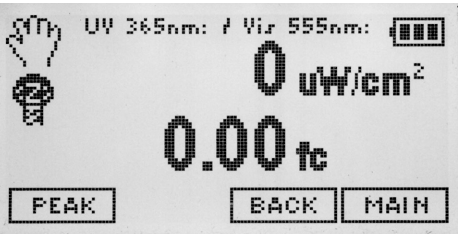
AccuMAX can automatically subtract "unwanted" ambient light values by selecting the ZERO mode.

While in the NORMAL mode, press ZERO. The Z light bulb icon will appear. Once the meter is allowed to stabilize, the readings will display zero values, and all subsequent readings will be relative and based on this subtracted zero light level.

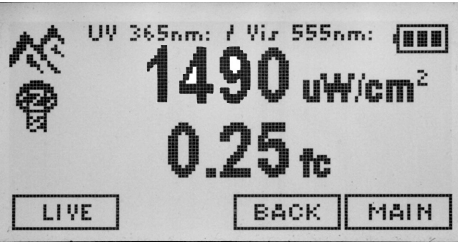


NOTE: The meter will immediately begin registering any subsequent changes in light level.

While in ZERO mode, press HOLD to freeze the reading. The open hand icon will appear.



While in HOLD press PEAK to display the highest readings recorded during the ZERO mode. The mountain peak icon will appear.

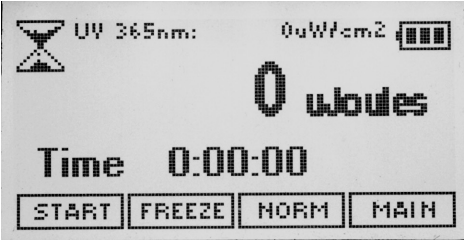


Press LIVE to return to ZERO mode, and then press NORM to return to NORMAL mode.

8.4 INTEGRATION (INTG) MODE

In INTEGRATION mode, the meter sums up the cumulative ultraviolet light that the sensor is exposed to over an interval of time, and displays the resultant total energy in joules.

While in NORMAL mode, press INTG. All values will be set to zero, the hourglass icon will appear. Top line display includes UV wavelength and real-time intensity reading (autoranging between $\mu\text{W}/\text{cm}^2$ and W/cm^2).

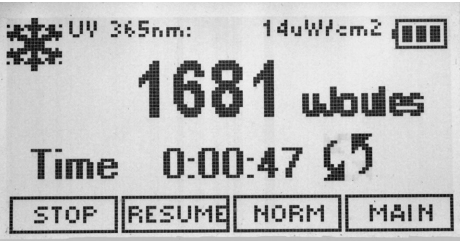


Press START to begin real-time INTEGRATION. Timer starts counting in seconds as indicated by running man icon.



While integrating, press FREEZE to freeze and hold the displayed data. The snowflake icon will indicate that the display is static.

The AccuMAX will continue the INTEGRATION process in the background, as indicated by the circular arrows icon.



Press RESUME to display the ongoing integration readings.

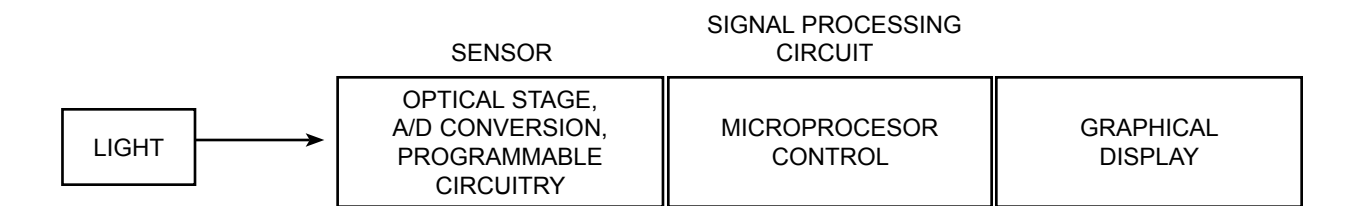
Press STOP to end INTEGRATION cycle.



Press NORM to return to NORMAL mode.

NOTE: While integrating, the AccuMAX will not shut off automatically after 60 minutes as it would in other modes and settings. This allows the user to continue integrating for extended periods of time.

9. SPECTRAL RESPONSE (Theory of Operation)



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 2π steradians. The sensor units of the AccuMAX meter minimize this problem by being outfitted with optimal transmission diffusing materials for various spectral regions. These diffusion materials are mounted close to the surface of the sensors so that the oblique rays are not obstructed. The spectral range is selected by adding an appropriate UV interference filter within the optical stack before the sensor cell assembly.

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 photocurrent, 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 quasilogarithmic 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.

10. WARRANTY, MAINTENANCE AND BATTERY REPLACEMENT

10.1 WARRANTY

The warranty policy for the AccuMAX XRP-3000 radiometer/photometer kit is provided on the Certificate of Limited Warranty enclosed separately with each unit.

NOTE: For assistance of any kind, including help with a meter under warranty, contact the Customer Service Department at Spectro-UV. In the United States and Canada, call toll-free 1-866-230-7305. Include the model number, serial number and date of purchase. If return of the unit 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. Out-of-warranty service work will not be performed without customer approval.

10.2 PREVENTIVE MAINTENANCE

- Immediately clean all spilled materials from the unit 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.
- Whenever possible, avoid exposure or use in areas that are subject to temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes, or strong electrical or electromagnetic interference.
- It is recommended that both the sensor detector and the readout unit be returned to the factory or a recognized Spectro-UV AccuMAX calibration service center for a complete overall check and recalibration **at least every 6 or 12 months**, depending on your facility's Standard Operating Procedures. Before returning the units to our factory, contact the Customer Service Department for shipping instructions.
- When the AccuMAX is not in use, store it in a location free from temperature extremes, dust or corrosive fumes, and vibration or mechanical shock.
- If storing for an extended period, place the AccuMAX in its carrying case after removing the batteries.

10.3 BATTERY REPLACEMENT

- Disconnect the sensor detector.
- Remove the readout unit from its rubber boot.
- Slide the battery cover to the right to expose the internal battery compartment.
- Carefully remove the used batteries and replace both 9V batteries.
- Follow the instructions for battery polarity marked on the battery compartment.
- Slide the battery cover back until fully in position.
- Return the readout unit to its rubber boot encasement.

10.4 HIGH VISIBLE LIGHT READINGS

Certain black light lamps, including the new UV-A LED lamps, have extremely high UV intensities, which can lead to higher visible light readings. This can sometimes be attributed to naturally fluorescing materials that may be present on, or part of, meter sensors. It may also be caused by high ambient light in the testing area. Make sure that meter sensors are clean, serviceable and calibrated properly. See Preventive Maintenance for more information.

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