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Introduction

Today, UV energy is increasingly used in industrial processes, particularly in curing and imaging operations. Widespread use of UV energy creates a need for ways to monitor, measure, and control it in industrial settings. This helps improve the efficiency of processes and the quality of the products, as well as providing the quantitative data necessary for applying SPC/SQC methods.

WHAT'S NEEDED IN A UV INSTRUMENT?

UV energy is difficult to measure because of its nature and because of the mechanical restrictions of the process equipment in which it's used. Therefore, an instrument that measures UV in industrial applications must meet various criteria. The instrument must withstand the extremes of heat and UV used in these processes, and it must mechanically fit into the systems.

Also, the instrument must be sensitive to only the UV energy. Typically, UV radiation sources produce a large amount of energy in the visible and infrared portions of the spectrum as well as the UV portion. The visible and infrared wavelengths are not used in the radiation curing process, but their presence complicates measuring and controlling the UV. The instrument must reject visible and infrared energy as well as accurately measure the UV energy.

Typical lab grade equipment used to measure UV is not generally appropriate for industrial processes because it does not meet these criteria. With this in mind, UVIMAP and other EIT UV instruments have been developed to serve the industrial UV process market.

WHAT TYPES OF UV MEASUREMENTS ARE VALUABLE?

The important data to be gathered in a UV process are the intensity of the UV output, temperature of the product, and a correlation between the two. To maintain product quality, it is necessary to know that the product has received an adequate amount of UV exposure without becoming too hot from infrared energy. To maintain an efficient process, it is helpful to know exactly when curing is complete so that the process isn't continued unnecessarily.

UVIMAP ®

UVIMAP, a member of EIT's family of instruments for measuring and controlling UV, measures UV and temperature in industrial processes. The instrument, shown in Figure 1, is a small, battery powered instrument that is placed directly in the curing environment where it measures UV and temperature in relation to time. The measurements are digitized and stored within the instrument. After the measurement is taken, the UVIMAP is connected to a standalone thermal printer that automatically plots the results. Figure 2 shows the types of information on a UVIMAP plot. The UVIMAP also transfers data to an IBM compatible personal computer where the data can be presented in tabular form, printed in hard copy form, and/or stored on floppy or hard disk.

The complete UVIMAP system provides a convenient means of measuring, storing and providing hard copy UV and temperature data. The system also provides a data base for future analysis of the UV process. Figure 3 shows a functional overview of the system.

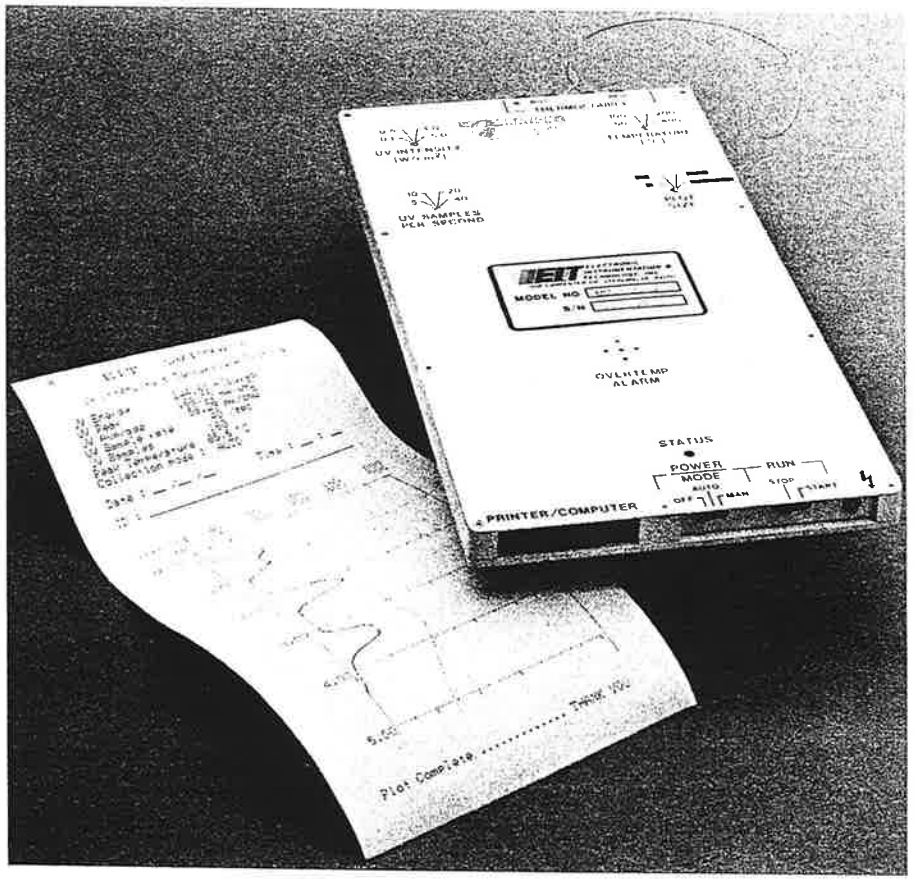

Figure 1 - UVIMAP And Printout

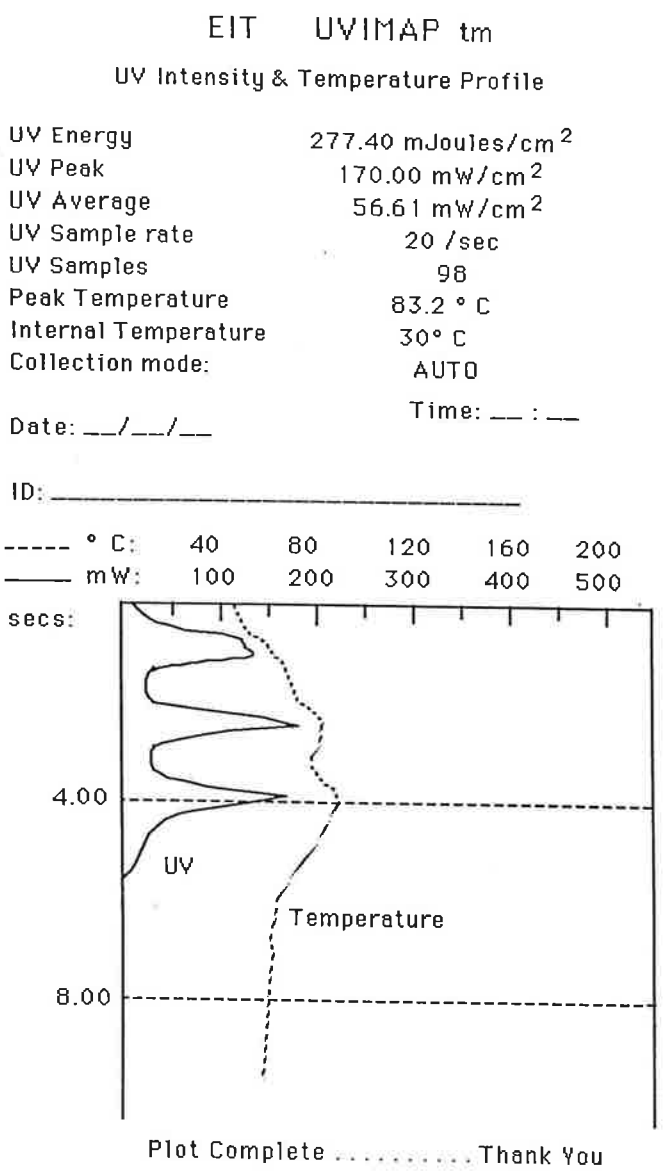

Figure 2 - UVIMAP Plot

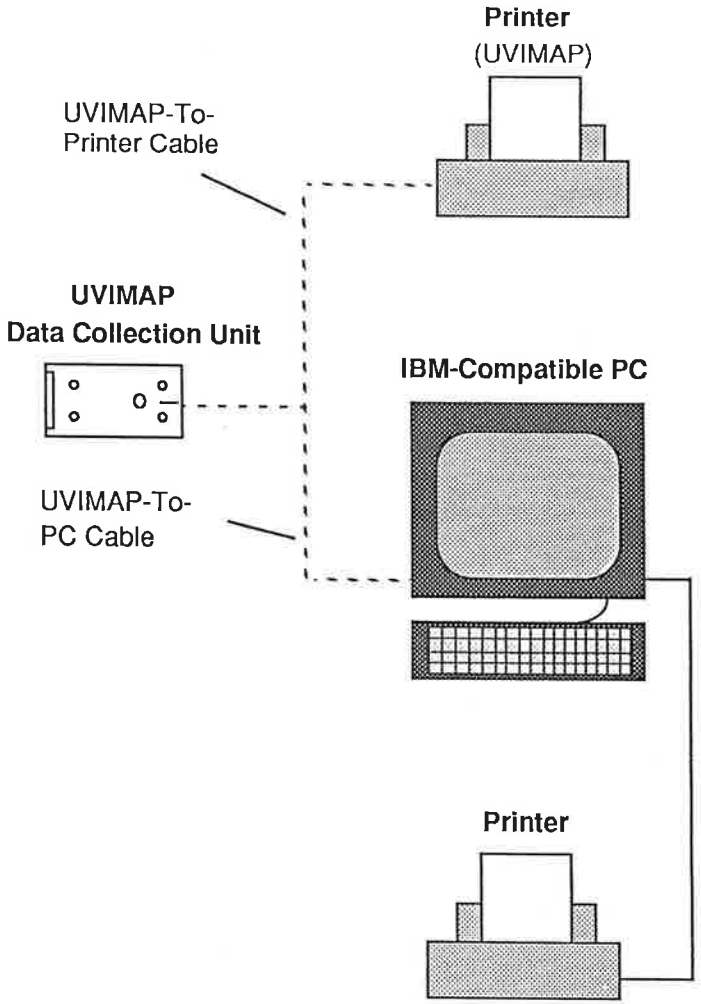

Figure 3 - UVIMAP System

WHAT DO UV MEASUREMENTS SHOW?

RADIOMETRY

UVIMAP precisely integrates instantaneous UV intensity with respect to time, indicating the total amount of UV energy impinged on a device. The energy is measured in milliJoules/cm^2. It calculates also the average intensity of UV in milliwatts per centimeter squared. Both values are printed at the beginning of the plot as shown in Figure 2.

EVALUATING MAXIMUM TEMPERATURE

UV curing typically involves compounds that deteriorate or undergo physical change when subjected to excessive temperatures. Since high infrared temperatures accompany UV, it is critical to achieve the necessary amount of UV without exceeding the temperature range of the product. For example, polyethylene sheet stock is formed into shopping bags and printed with ink that is UV curable. Since the sheet stock fuses and deteriorates at temperatures over 60° C, it is critical to achieve and maintain adequate UV without exceeding 60° C. The UVIMAP shows the exact levels of UV and temperature in relation to each other, making it possible to maintain the critical balance in this type of curing operation.

EVALUATING UV LAMP OUTPUT

Figure 4 shows how UVIMAP measures the output of each lamp in a 3-lamp conveyorized UV curing system. The trace shows the UV intensity of each lamp. Lamps 2 and 3 have similar peak intensities of 400 mW/cm^2, while lamp 1 has a peak intensity of only 225 mW/cm^2. This is 55% of the output of lamps 1 and 2. In this application, the low intensity of lamp 1 is showing that it is due to be changed.

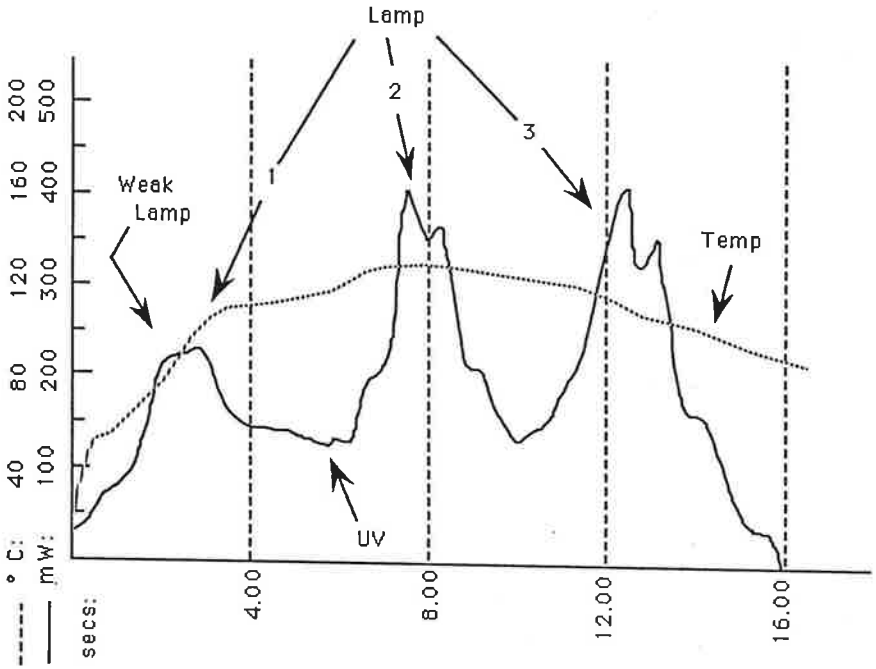

Figure 4 - Three-Lamp System With Ellipsoidal Reflectors

FOCUSING REFLECTORS

Figure 5 shows how UVIMAP indicates whether reflectors are positioned so that lamps are properly focused. A non-uniform curve indicates the lamp is not physically located at the focus of the reflector. For example, the uniform curves of lamps 2 and 3 in Figure 5 indicate the lamps are properly focused. The jagged curve of lamp 1 indicates that it is not well focused. It is useful to know this because the focused lamps typically cure more efficiently.

Also, Figures 4 and 5 show the difference in UV intensity between parabolic and ellipsoidal reflectors. The ellipsoidal reflectors in Figure 4 peak and produce a higher maximum intensity than the parabolic shown in Figure 5. Note how lamps 2 and 3 in Figure 4 are not properly focused.

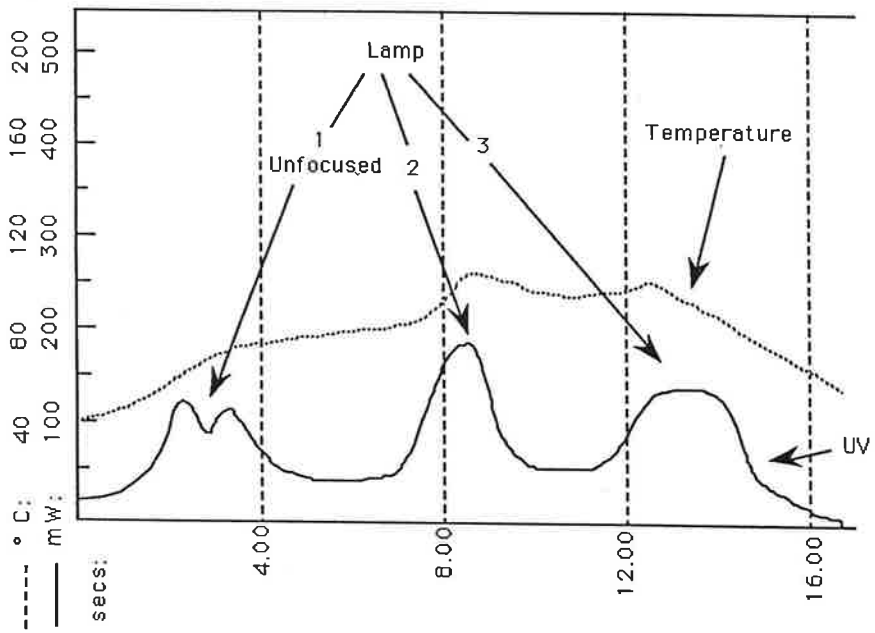

Figure 5 - Three-Lamp System With Parabolic Reflectors

UVIMAP APPLICATIONS

UV processes can be stationary or conveyorized. In either case, setting operating parameters is a trial-and-error process. The material is exposed to various intensities and amounts of UV radiation until developing or curing appears to have occurred properly. These levels are used until the quality of the product deteriorates, then new parameters are established again through trial and error. The following examples describe how UVIMAP has been applied to processes and used to accurately set parameters.

RESIN CURING

Figure 6 shows a curing process. The material being processed is a polyester film - UV curable resin - polyester film sandwich. UV radiation is impinged on the sandwich to cure the resin and bond the layers of polyester together. UVIMAP's small thermocouple is inserted in the resin between the two polyester layers. A nominal intensity of 3mW/ cm^2 from a longwave UV lamp is focused on the sandwich.

Figure 7 shows the plot of the UV and temperature conditions that occurred while curing the sandwich. The plot shows a small rise in UV intensity as the lamp rose in temperature. The resin produced little exotherm, an indication of chemical activity, until a certain amount of UV energy had fallen on it. After about 150 milliJoules had fallen, chemical activity accelerated sharply. The activity raised the resin temperature to a maximum of 132° C, which is near the critical level for polyester. The resin temperature then began to decrease, indicating less chemical activity, and a complete curing process. This plot shows that even though the curing process is complete, UV energy continues to be applied. Finally after 1.2 Joules have been applied, the UV is extinguished, even though polymerization has occurred earlier. With this kind of quantitative data it is possible to improve the efficiency of this process as well as the quality of the product by extinguishing the UV as soon as the curing is complete.

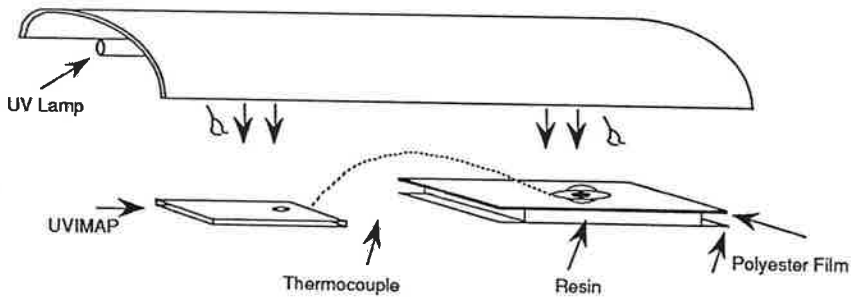

Figure 6 - Polyester Film-Resin Curing Process

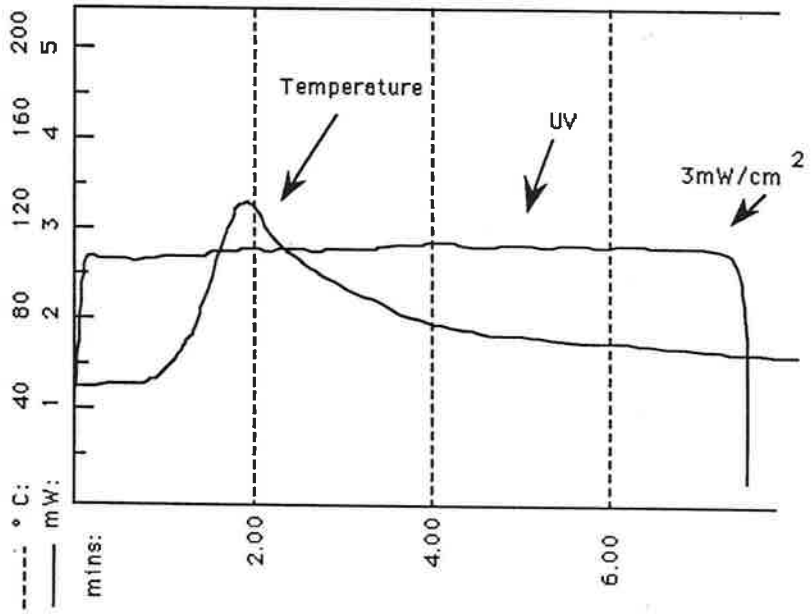

Figure 7 - UVIMAP Plot Of Exothermic Reaction

TEMPERATURE OF PC BOARD SOLDER MASK

Figure 8 shows the temperatures encountered by the dry film solder mask on a 0.0625" thick PC board as it moves through a conveyorized, 3-lamp UV curing system at various speeds. At 20 feet per minute (fpm) the maximum temperature reached by the solder mask was 80° C. At 10 fpm the maximum temperature was 110° C and at 5 fpm, 160° C.

Typically, a manufacturer specifies solder mask to withstand 260° C for 10 seconds. By extrapolating UVIMAP data it is possible to determine that 3 fpm is the slowest speed that can be used without overheating this dry film solder mask.

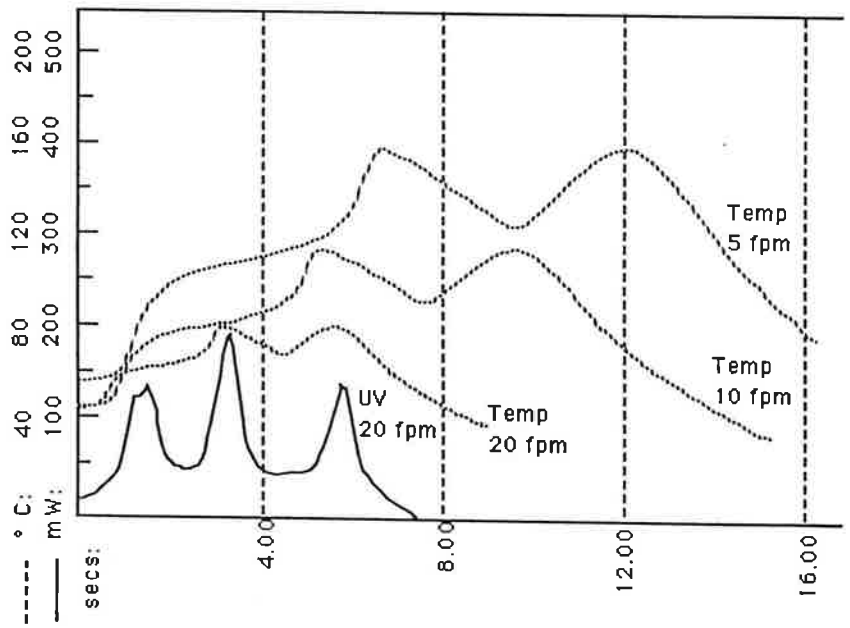

Figure 8 - Temperature Of Solder Mask

UVIMAP MODELS

There are two models of UVIMAP -- low power and high power. The low power model measures UV intensity between 5 and 100 mW/cm^2. Typically, this model is appropriate for imaging applications. The high power model measures UV intensity between 0.1 and 5 W/cm^2. This model is generally used in curing applications.

COMPONENTS SHIPPED

Figure 9 shows the components shipped with the UVIMAP system. You will receive the following components:

1. The Data Collection Unit (DCU) with a thermocouple attached.
2. The battery charger.
3. Two spare thermocouples.
4. A screwdriver for setting control switches.
5. The UVIMAP user manual.
6. A certificate of calibration showing radiometer readings of the tested energy levels.
7. A carrying case.
8. The printer with AC adapter.
9. Both 5.25" and 3.5" double-sided, double-density floppy diskettes with program for interfacing UVIMAP to the PC.
10. Two interface cables -- one for interfacing UVIMAP to the PC and one for interfacing UVIMAP to the printer.

All components except the two interface cables, the printer, and AC adapter are packed in the carrying case. The printer, AC adapter, and printer user manual are packaged separately by the manufacturer.

Figure 9 - Components Shipped With UVIMAP

MANUAL

This manual contains all the information you need to use and maintain the UVIMAP. There is an introduction to the instrument and its uses, a description of the hardware, the theory of how the instrument operates, instructions for using it in your application, and maintenance and troubleshooting tips. Any maintenance problems that are not covered in this manual should be addressed to the EIT Return Department.

OTHER EIT PRODUCTS

UVICURE ® High Energy UV Integrating Radiometer: Measures UV at 254nm or 365nm in the 2.5m W/cm ^{2} to 2.5 W/cm ^{2} range. Display is from 0 to 9.999 Joules/cm^2.

UVIRAD ® Low Energy UV Integrating Radiometer: Measures UV at 365nm in 100 µW/cm ^{2} to 100 mW/cm ^{2} range. Display in Millijoules/ cm^2. For use in platemaking, primary imaging, and soldermask imaging.

UVITROL ™ UV Constant Energy Controller: Provides consistent UV curing by controlling amount of UV energy. The user selects the energy level that provides suitable curing, and the conveyor speed is automatically adjusted to obtain the selected energy level.

UVINTEGRATOR ®: The user dials up the total amount of UV exposure required, and the instrument begins exposure. When requested total energy level is reached, a contact closure terminates UV exposure.

UVIBRITE ®: Measures the UV output of an individual UV lamp and displays it as a digital readout on a panel display.

MULTIBRITE ™: Measures up to four UV lamps simultaneously and sounds an alarm when any of the lamps fall below a user-selectable threshold.

THERMOMAP: Measures three temperature channels and prints a profile on a printer or an IBM compatible PC.

Hardware

SPECIFICATIONS

UVIMAP

UV Ranges:
High Power Model: 0 - .1; 0 - .5; 0 - 1 and 0 - 5 W/cm²; switch-selectable.
Low Power Model: 0 - 5; 0 - 10; 0 - 50 and 0 - 100 mW/cm²; switch-selectable.

UV Accuracy:
± 5% typical; ± 10% maximum (Measurement made on medium pressure linear mercury lamp).

Temperature Measurement Ranges:
0-50°, 0-100°, 0-200°, and 0-400° Centigrade.

Number of Sample Points:
4000 for UV, 2000 for temperature.

UV Sample Rate:
5, 10, 20, and 40 samples per second; switch-selectable.

Temperature Sample Rate:
1/2 the selected UV sample rate (1 temperature sample is taken for every two UV samples).

UV Spectral Response:
250-260nm (10% Points).
320-390nm (10% Points).

UV Angular Response:
Approximately cosine (e.g. response is 0.5 @ 60° angle of incidence).

Operating Temperature Range:
0° to 70° Centigrade internal. External temperatures as high as 500°C can be sustained for 10 seconds or less.

User Calibration Adjustments:
None.

Recharge Time:
14 hours maximum.

Operating Time:
4 - 6 hours between charges.

Unit Dimensions:
9 1/8" L x 5" W x 1/2" H.

Weight:
Approximately 19 oz (544 grams).

CHARGER

Output:
20 VDC limited to 25mA maximum; short circuit proof; indicator LED.

Recharge Rate:
10mA; 14 hours for completely discharged batteries.

Charger Cord:
60" long; jack mates with connector on the UVIMAP.

Power Requirements:
US -- 115VAC, 60Hz, ± 10%
European -- 230VAC, 50 Hz, ± 10%
Japanese – 100VAC, 50 Hz, ± 10%

Power Plug Configuration:
US -- conventional three prong; unit supported in wall outlet.
European -- 4' long, 3 conductor cord supplied without plug.
Japanese -- two prong; supported in wall outlet.

PHYSICAL DESCRIPTION

UVIMAP

The UVIMAP Data Collection Unit (DCU) is shown in Figures 10 and 11. It is contained in a fiberglass and aluminum housing that measures 9 1/8" x 5" x 1/2" (LxWxH). Looking at the unit as it is oriented in Figure 10, you see the EIT logo and UV filter-sensor. The filter-sensor consists of an Inconel quartz window covering a diffuser, a filter and a silicon photodetector.

Looking at the unit as it is oriented in Figure 11, the DCU has the following physical features:

On the forward right edge of the housing the Type J thermocouple is attached to a pair of terminals, labeled WHT (+) and RED (-). The (+) lead on the thermocouple is attached to the inside terminal of the pair connected to the white wire coming from inside the housing. The (-) lead is attached to the inside terminal of the pair connected to the red wire from inside the housing. Figure 12 shows the correct position of the thermocouple wire. Refer to Table 3 in the Appendix for appropriate thermocouple color codes.

On the forward half of the unit are four rotary switches for selecting the UV intensity range, the temperature range, the number of UV samples read per second, and the plot size. The screwdriver supplied with the unit is used to position the receded line at the selected value printed on the housing.

The UV intensity range sets the DCU for the range of UV intensity to be measured. The ranges are 0-.1, 0-.5, 0-1.0, or 0-5.0 W/cm^2 for the high power model and 0 - 5; 0 - 10; 0 - 50 and 0 - 100 mW/cm^2 for the low power model.

The temperature range sets the DCU for the range of temperature to be measured. The ranges are 0-50, 0-100, 0-200, 0-400° C.

The sample rate options are 5, 10, 20 and 40 per second. This is the number of UV samples taken per second while data is being collected. One temperature sample is taken for every two UV samples.

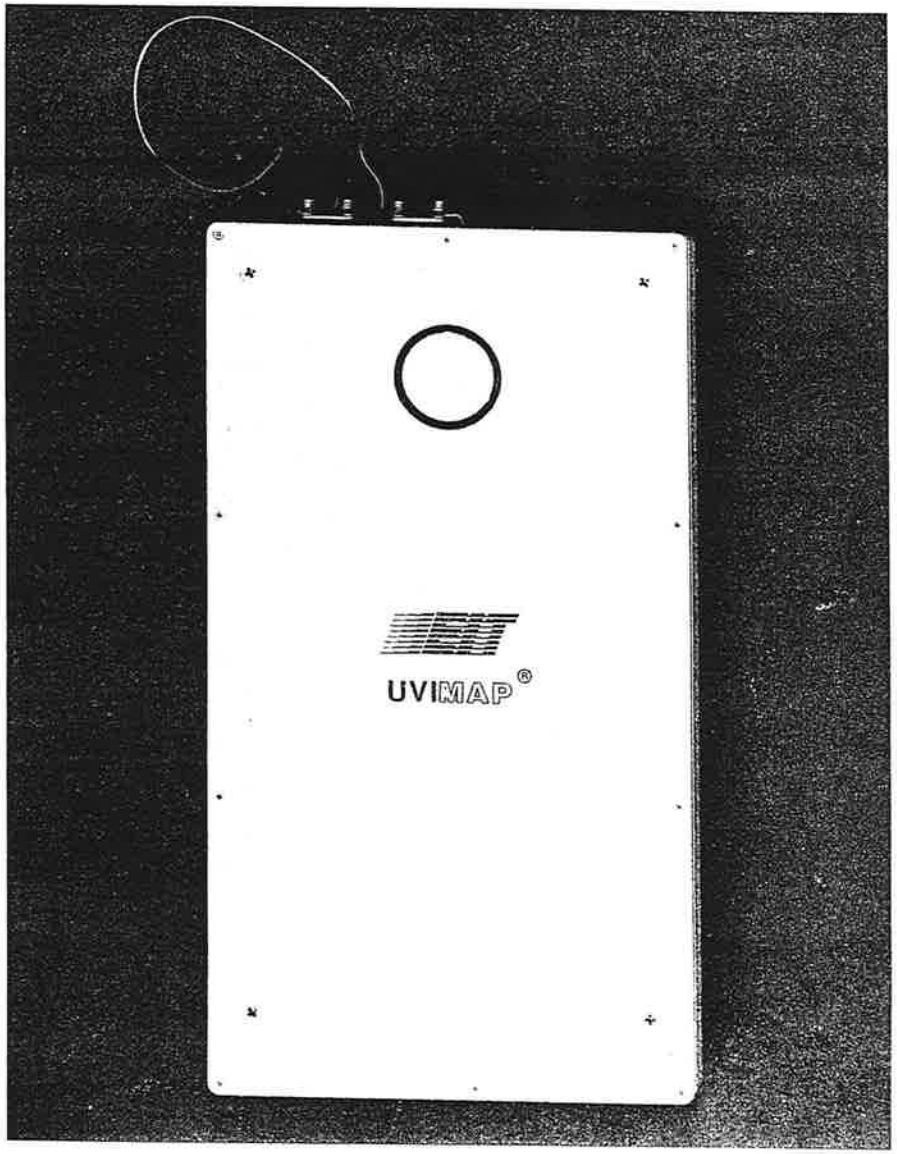

Figure 10 - Top of UVIMAP Data Collection Unit

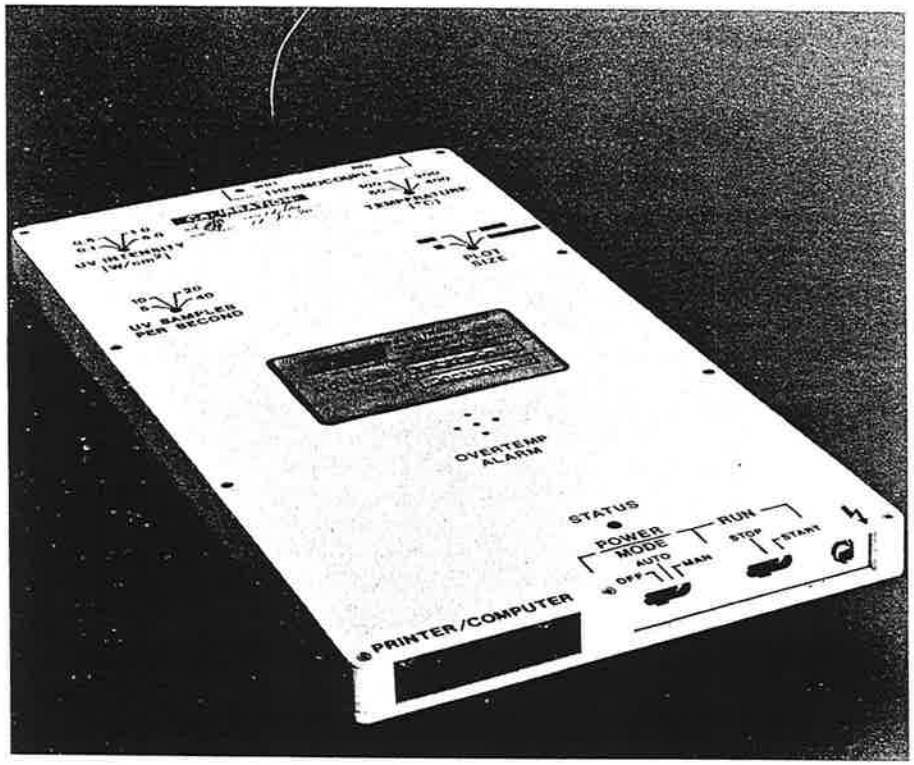

Figure 11 - Bottom of UVIMAP Data Collection Unit

The plot size options are .35, .7, 1.4, and 2.8. This is the distance in millimeters between the points plotted on the printout. These options are indicated by bars that increase in size, the smallest bar corresponding to the shortest distance, etc.

The status LED indicates the mode of operation and the charge status of the battery.

In the center of the unit is the over-temperature alarm. This emits a high frequency tone when the temperature of the internal components exceeds 75° C.

On the forward lower edge is a jack for connecting the DCU to the battery charger. This is marked by a lightning bolt symbol.

On the bottom right edge are two slide switches, one labeled POWER/MODE and the other RUN. The POWER/MODE switch supplies power from the battery power supply to the microprocessor and is necessary for the RUN function to be in effect. It also sets the mode for collecting data. There are three settings -- "Off", "Auto", and "Man". Moving from the "Off" position to "Auto" or "Man" turns on power to the unit. In the "Auto" mode, the DCU begins to collect data when the UV intensity on the unit reaches a specified level, providing the RUN switch is in the "Start" position. This level is 2% of the top of the range selected. In the "Man" mode, the DCU begins collecting data when the RUN switch is moved to the "Start" position.

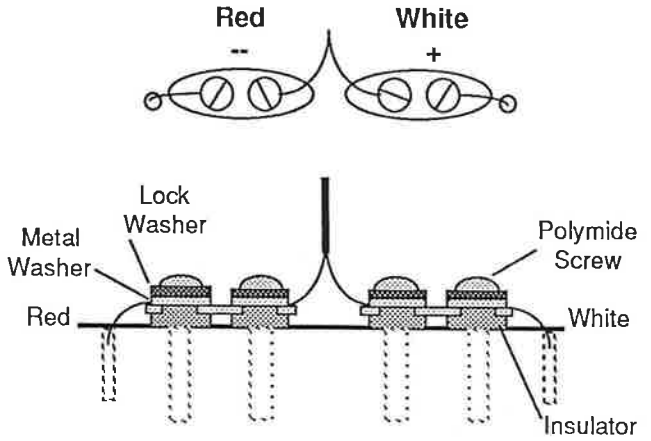

Figure 12 - Thermocouple Wire

CAUTION

All data is cleared from DCU memory when the POWER MODE switch is turned off. Be sure all data has been transferred to the printer or PC before turning off this switch.

The RUN switch starts and stops data collection. The Power switch must be in either the automatic or manual mode for the RUN switch to be functional. When the RUN switch is placed in the "Stop" position after collecting data, the data is stored in DCU memory and can be repeatedly transferred to the printer or PC until the POWER MODE switch is turned "Off".

The 17-pin connector, labeled PRINTER/COMPUTER, interfaces the DCU to the printer or PC using the cables supplied with the unit.

PRINTER

The Seiko standalone thermal printer, DPU-411, Type 11 or Type 21, is shipped with the original user documentation. Specifications and operating instructions are included in that manual. Although the printer DIP switches are set correctly when the unit is shipped, correct settings are shown also in the Appendix of this manual.

BATTERY CHARGER

There are three battery charger options - one for U.S. power sources, one for European, and one Japanese. The UVIMAP is shipped with the battery charger compatible with the power standard designated when the unit is ordered.

Theory Of Operation

The UVIMAP comprises two assemblies, the Data Collection Unit (DCU) and the printer. Figure 3 shows the complete system and how it interconnects. The function of the DCU is to measure, digitize and store UV and/or temperature data. The function of the printer is to display the data. The data also may be stored and displayed on an IBM-compatible PC.

Figure 13 is a block diagram of UVIMAP function. Radiation of all wavelengths is impinged on the attenuator/filter on the top of the unit. The function of the attenuator is to reduce the energy to levels that the filter can accommodate. A Teflon diffuser in the attenuator reduces energy levels and provides nearly cosine response for the unit. The attenuated and diffused energy falls on a color interference filter that accepts the UV wavelengths and rejects all others. Rejecting other wavelengths of energy is important, because high levels of infrared radiation are usually present and interfere with an accurate UV measurement.

The UV radiation falls on a silicon photodetector and is converted to current that is proportional to the intensity of the UV. Then, the current is converted to a voltage, proportional to UV intensity, by a current-to-voltage converter (I/E). The gain of the I/E is switch-selectable to accommodate different intensity ranges.

A type J thermocouple signal is scaled and cold junction compensated by a thermocouple conditioning circuit.

The UV and temperature signals are connected to a multiplexer that periodically connects the signals to the input of an analog to digital converter. The UV signals are sampled at a rate of 5, 10, 20, or 40 samples per second. This rate is user-selectable.

When the DCU is operated in the Auto mode, and it senses UV energy equal to 2% of the top of the range, the instrument begins to sample and store data. This continues at the rate specified until the RUN switch is turned to STOP. The instrument samples at a 2:1 ratio - two UV

samples to one temperature sample. Then, the digital signals are stored in RAM to be displayed on the printer or the IBM-compatible PC. The RAM holds up to 4000 UV samples and 2000 temperature samples.

The DCU circuitry is battery-powered. The unit can be operated for four to six hours on a single charge. More energy is drawn from the DCU when the unit is interfaced with the printer or PC. The unit does not operate if the battery charge is below a preset level. If the charge is too low for proper operation, the Status LED illuminates continuously. Normally it flashes, indicating adequate charge.

After the UVIMAP has completed the measurement, the cable is connected to the externally powered printer or an IBM PC. The UV and temperature data in the RAM is formatted by the microprocessor and transmitted to either source.

Various other quantitative data are calculated and plotted along with the raw temperature and UV data. They include total UV energy, peak UV intensity, average UV intensity, sample rate, the number of samples above the threshold, peak temperature, internal temperature, and data collection mode.

The printer displays the data as it is shown in Figure 2. The PC displays data in tabular form, stores it on disk or diskette, or prints a hardcopy.

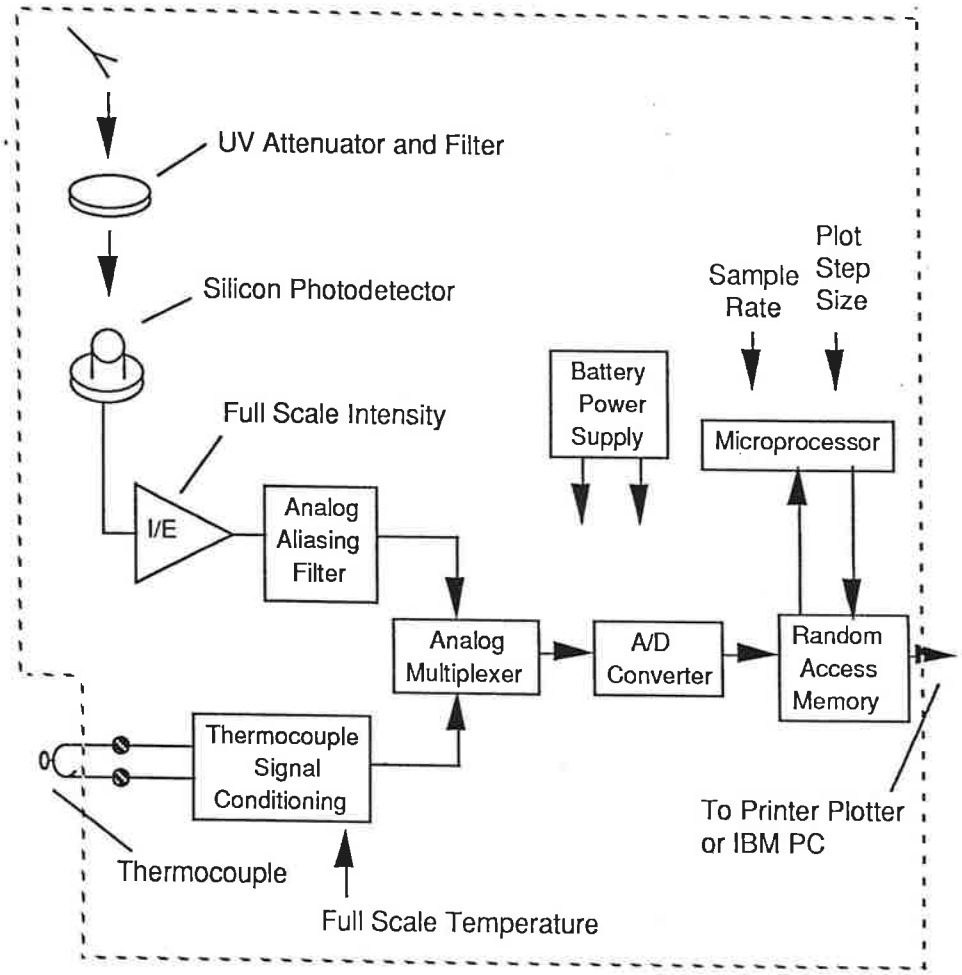

Figure 13 - Block Diagram Showing The Function Of The DCU

Operation

SELECTING SAMPLE RATE

The UV unit collects samples at the rate of 5, 10, 20, or 40 per second. Determining the number of samples to be collected per second depends on the length of time the unit is exposed and collecting data. Because the DCU memory holds a maximum of 4000 samples, the unit should not reach this total before the exposure is over. For best resolution, determine the maximum time of exposure and select a sample rate as high as possible, without exceeding 4000 samples. Table 1 provides a guideline for sample rates and exposure times.

An optimum sample rate may be selected to obtain a plot with the highest resolution possible, without reaching the DCU memory limit of 4000 samples by using Table 1. For example, in a conveyorized application, you estimate the expected exposure time by dividing the distance, in inches, the UVIMAP will travel on the conveyor while under the UV source by the conveyor speed in feet per minute. Multiply the result by 5 to obtain the minimum time in seconds required for collecting data. From Table 1, select a sample rate corresponding to the next highest exposure time. Lower sample rates may be used, but the plot resolution will be significantly lower than it should be to accurately analyze the data.

The following equation for determining the expected exposure time may be used to determine the optimum sample rate from Table 1:

Expected Exposure Time = 5 x Distance (inches)/Speed (feet/min)

Where:

Distance (inches) = The distance in inches the UVIMAP will travel under the UV source.

Speed (feet/min) = Conveyor speed in feet per minute.

Expected Exposure Time (secs) = Time in seconds the UVIMAP will be exposed to the UV light source.

Table 1 - Sample Rates and Exposure Times

Length Of Time Of Exposure	Sample Rate
Up to 100 Secs	40
101 to 200 Secs	20
201 to 400 Secs	10
401 to 800 Secs Max	5

SELECTING UV INTENSITY RANGE

The low power model offers a full scale range from 5 to 100 mW/cm². The high power model offers a full scale range from 0.1 to 5W/cm². Unless you know the approximate peak of the intensity range of your UV system, it is recommended that a test run be performed at the top range. Repeat the test, lowering the range each time, until the UV peak is at the middle or just above the middle of the Y axis on the printout scale. For the best printout resolution, use the highest range possible. See the printout samples in Figures 14 through 16.

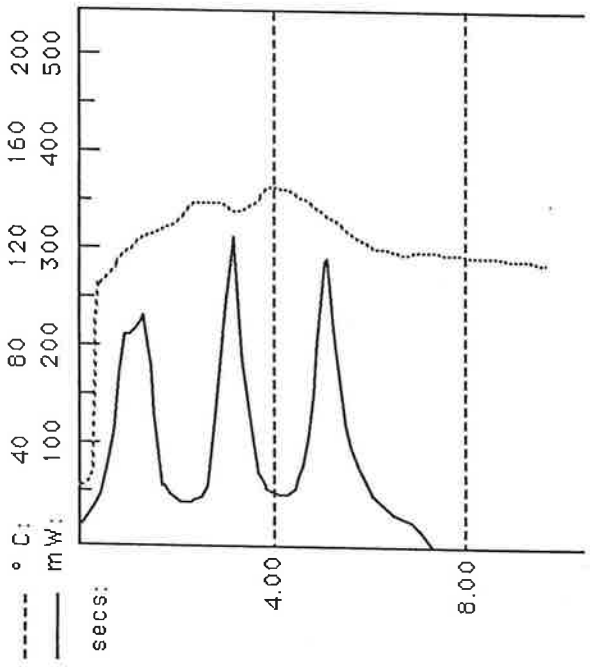

Figure 14 - Plot with UV Range Set Correctly

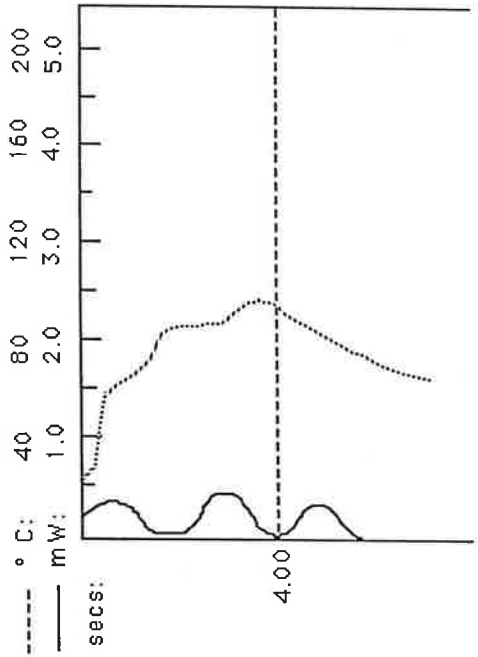

Figure 15 - Plot with UV Range Set Too High

SELECTING TEMPERATURE RANGE

Unless you know the temperature range of your UV system, perform a test beginning with the highest temperature range. Repeat the test, lowering the top of the range, until the temperature plot is at the middle or just above the middle of the printout scale.

PLOT STEP SIZE

Plot step size is the distance between plotted data points on the printout. There is a choice of spacings of .35, .7, 1.4 and 2.8mm between plotted data points. See Table 4 in the Appendix. Start with the smallest plot step size and increase this to increase the resolution of the scale. The plotter prints a Y axis every one inch. At each Y axis, the time in seconds that has elapsed since the beginning of data collection is printed. See the different plot step size examples in Figures 17 and 18.

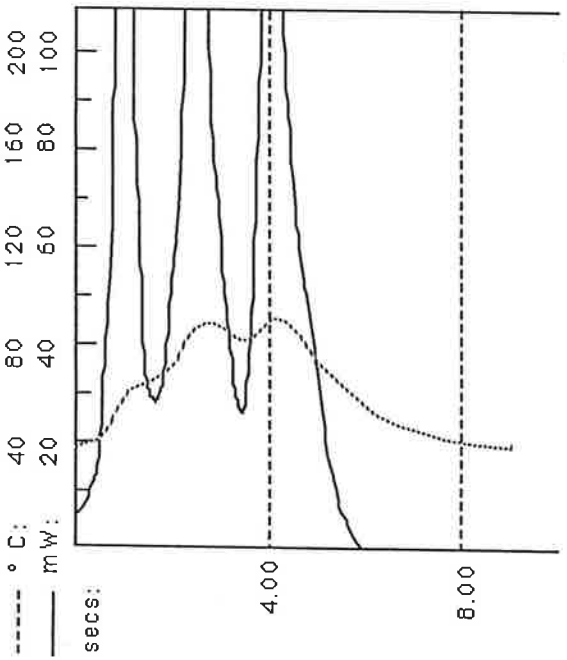

Figure 16 - Plot With UV Range Set Too Low

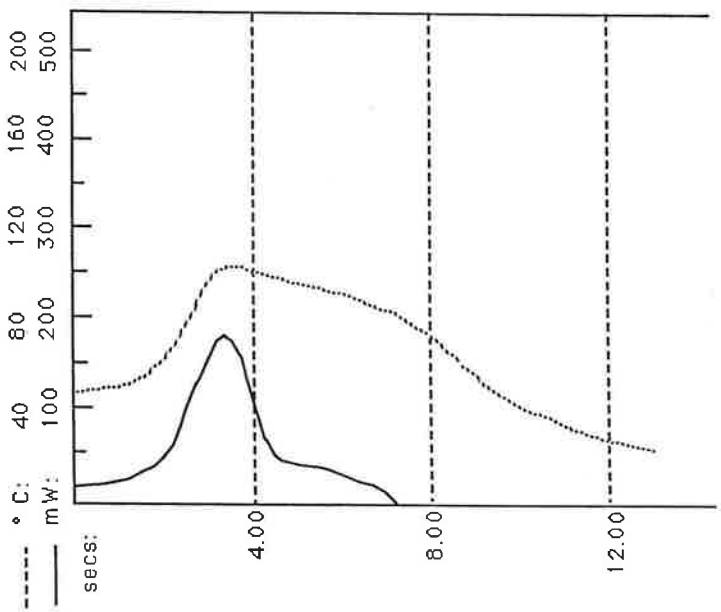

Figure 17 - Plot Step Size Condensed

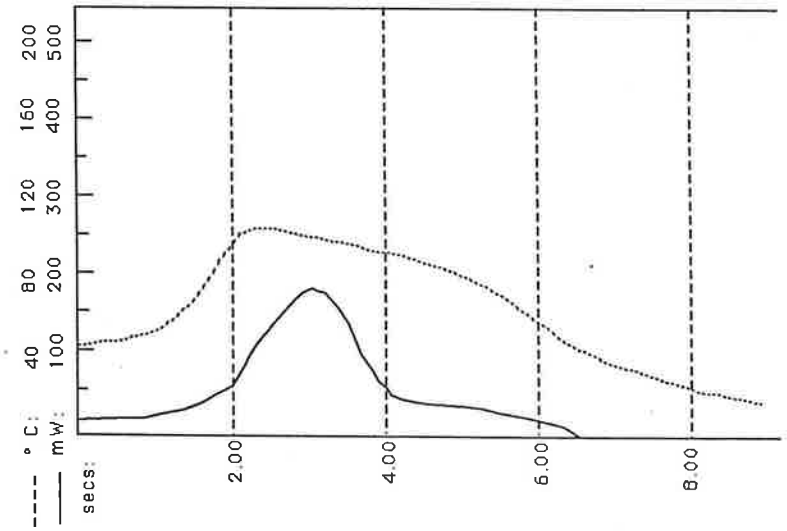

Figure 18 - Plot Step Size Enlarged (Two Times From Figure 17)

PROCEDURES FOR OPERATING UVIMAP

OVERVIEW OF OPERATING PROCEDURES

These are the main operations in operating UVIMAP:

1. Charge UVIMAP Batteries.
2. Connect the Thermocouple.
3. Set Control Switches.
4. Collect Data.
5. & 6. Transfer Data To the Printer Or a PC.

CAUTION

The UVIMAP has an over-temperature audio alarm that emits a high frequency tone when the temperature of the internal components exceeds 75° C. Permanent damage may occur if the UVIMAP is operated at temperatures substantially higher than the alarm temperature. The unit should be cooled before it is used again after the alarm has sounded.

1. CHARGING UVIMAP

1. Turn "Off" the UVIMAP POWER/MODE switch.

2. Plug the charger output into the charger jack on the bottom edge of the unit and insert the charger into an AC power source.

3. Charge the unit for 10 - 12 hours. To conserve the charge, keep the POWER/MODE switch "Off" until ready to collect data.

2. CONNECTING THE THERMOCOUPLE

1. If not already attached, connect the type J thermocouple to the terminals -- iron to the white (+) terminal and constantan to the red (-) terminal. Make this connection between the metal plate and metal washer. Refer to Figure 12 in the Physical Description section of this manual to be sure the leads are positioned correctly.

3. SETTING CONTROL SWITCHES

1. Set POWER/MODE switch to "Off" and the RUN switch to "Stop".

2. Set the following rotary switches by positioning the slot in the rotary switch at the desired range:
   a. UV Intensity
   b. Temperature
   c. UV Samples Per Second

   These range switches cannot be adjusted with the POWER/MODE switch "On." Details on setting these parameters are discussed earlier in the Operation section. Be certain that the data levels to be recorded fall within the selected ranges. If the UV and temperature ranges are too narrow, the data will be lost; however, the unit will not be damaged.

NOTE

If data has already been collected, set the POWER switch to "Off" for at least two seconds to erase all data.

4. COLLECTING DATA

The AUTO mode starts collecting data as soon as the UV threshold (2% of the top of the range of UV intensity selected) is exceeded. The MAN mode starts collecting data immediately when the RUN switch is moved to START.

1. Slide the POWER/MODE switch to "Auto" or "Man" to turn "On" the UVIMAP. Be sure the STATUS LED is flashing, indicating enough power for proper data collection.

2. Slide the RUN switch to "Start". If the "Man" mode has been selected, the STATUS LED will begin to flash twice as fast to indicate that data collection has started. If the Status LED stops flashing and remains lit, the battery needs to be charged before data is collected.

3. Place the UVIMAP on the belt in a conveyorized system or expose it to UV energy in a stationary system. If it is in the "Auto" mode, the unit begins to collect data as soon as the UV threshold is exceeded. The threshold is approximately 2% of full scale.

4. When data collection is completed, move the RUN switch to "Stop" to stop data collection and avoid spurious data. The DCU stops collecting data when 4000 UV samples and 2000 temperature samples have been collected. It does not overwrite data already collected.

CAUTION

Do not turn the power off until the data has been transferred. If power is interrupted, all data is erased from memory.

5. TRANSFERRING DATA TO THE PRINTER

1. Prepare the printer according to the instructions in the printer manual.

2. Printer DIP switches are set for operation when you receive the unit. If these have been changed for any reason, set them according to the tables in the Appendix of this manual.

3. Turn "On" the printer power switch. In the Model DPU-411, Type 11 the POWER and OFF LINE LEDs turn "On". In the Model DPU-411, Type 21 the unit comes on line when power is turned "On".

4. Connect UVIMAP to the printer using the printer interface cable. The 25-pin D-connector plugs into the serial interface connector of the printer; the 17-pin D-connector plugs into the PRINTER/COMPUTER connector on the UVIMAP.

5. Set the Plot Size rotary switch to the desired plotting scale factor. The scales are shown in Table 3 in the Appendix.

6. If using printer Model DPU-411, Type 11 press the ON LINE switch on the printer. The off-line LED turns "Off" and on-line LED turns "On". This step is not required for Model DPU-411, Type 21.

7. Slide the RUN switch on the UVIMAP to "Start". The plotter starts printing the summary data of the results before plotting the UV and temperature profiles.

8. When the plot is completed or if the plotting has to be stopped during the plot, move the UVIMAP RUN switch to "Stop."

CAUTION

Do not turn off the POWER/MODE switch until you are finished transferring data, because it clears all data from UVIMAP memory.

If the thermocouple was either open or not connected and doesn't collect temperature data, the printer prints THERMOCOUPLE OPEN along with the UV data summary. If the battery voltage becomes low after collecting the data, the data is plotted with this warning message: BATTERY NEEDS CHARGING.

9. To make another plot with the same data return to step 6. If desired, you may choose a different plot size. Table 3 in the Appendix shows how many data samples the printer is capable of plotting at each plot size, on one battery charge.

10. To collect a new set of data, remove the interface cable from the UVIMAP; select the data collection mode; then move the RUN switch to "Start." When you are finished collecting and plotting data, turn the UVIMAP POWER/MODE switch to "Off" to conserve the charge of the battery. Normal battery charge provides four hours of operation.

6. TRANSFERRING DATA TO THE PC

1. Turn on the PC.

2. Insert in drive A the floppy diskette containing the UVIMAP-PC interface program.

3. Type A: UVIMAP ; press ENTER.

4. Follow the instructions displayed on the computer screen. The function keys appear at the bottom of the screen display and are defined in Table 2.

CAUTION

If you want to transfer the data in the UVIMAP more than once - to the printer or to the PC again, do not move the UVIMAP POWER/MODE switch to OFF, because it clears data from UVIMAP memory.

Once the data has been transferred to the PC, the UVIMAP may be disconnected from the computer. The transfer program on the computer will continue to run on the data it has.

5. When finished with the transfer program, press F10 to exit to the operating system.

Table 2 - Function Keys

Key	Function
F1 (Cancel)	Stops the present operation. Further options after F1 (Cancel) are the following: **F1 (Start)** This is an interrupt that erases all data, preparing the program for a new set of data from the UVIMAP. **F2 (Resume)** This returns the program to the beginning screen, keeping the existing data.
F2 (UV)	Displays the UV data in tabular format, one page at a time.
F3 (Temp)	Displays the temperature data in tabular format, one page at a time.
F4 (Result)	Displays the UVIMAP panel switch settings and the UV data summary.
F5 (Print)	Prints the UV data, temperature data, and the UV data summary on a printer attached to the PC.
F6 (Disk)	Transfers the UV and temperature data to the file named by the operator. The format of this data transfer satisfies the data format requirements of Lotus 1-2-3 ®.
F9 (Help)	Displays descriptions of the function keys and error messages, and displays instructions for transferring data from the UVIMAP to the PC.
F10 (Exit)	Returns to the operating system. To return to the UVIMAP transfer program, type A: UVIMAP, then press ENTER.

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Maintenance And Troubleshooting

It is recommended that you return UVIMAP every six months for a calibration check and routine maintenance. Contact EIT, Incorporated, Return Department to obtain a Return Material Authorization (RMA) number before sending the UVIMAP.

The troubleshooting guide below will help solve minor problems encountered during normal operation.

Problem: The status LED does not light when UVIMAP power is on.
Solution: The UVIMAP battery may be low; recharge the unit.

Problem: The UVIMAP doesn't collect any data during data collection.
Solution: The UV range may be too high and data is not above the threshold, which is 2% of the top of the range selected.

Problem: The printer does not respond after the UVIMAP interface cable is connected.
Solution: Check the settings of the DIP switches on the bottom of the printer. Correct settings are in the Appendix.

Problem: The UV reading does not match the readings from other UV reading instruments.
Solution: One of the instruments may be out of calibration. Return one or both to the manufacturer for routine calibration and maintenance every six months. The UVIMAP is calibrated to NIST traceable standards. This may not be true for the other instruments.

Problem: The UVIMAP summary data indicates an open thermocouple.
Solution: Check for a proper thermocouple joint on the welded end. Check the connection at the WHT and RED terminals; refer to Figure 12.

Problem: The temperature reading seems low.
Solution: Check that the thermocouple is attached properly at the WHT and RED terminals. Refer to Figure 12.

Problem: The computer does not respond to the command "A:UVIMAP" or gives a readout error.
Solution: The floppy disk with the UVIMAP program may be damaged. Contact EIT for a replacement.

Problem: The computer will not transfer data from the UVIMAP.
Solution: Check that the UVIMAP-PC interface cable is properly connected from the PRINTER/COMPUTER to the 9-pin serial connector of the computer. If the computer has multiple serial ports, the UVIMAP must be connected to the COM 1 port. Refer to the computer manual for further information on the serial ports. If the computer has a 25-pin serial port, a 9-pin to 25-pin adaptor must be used.

WARRANTY

The warranty period for UVIMAP is 6 months from the date of purchase, abuse and neglect excepted. There are no user serviceable parts inside UVIMAP. If your unit does not operate properly, call EIT at (703) 478-0700. We will arrange for its return to the factory for repair and recalibration.

Appendix

Table 3 - Thermocouple Color Code Chart For Type J Thermocouple Wire

Thermocouple Color Code Chart (Type J)				
United States	United Kingdom	West Germany	Japan	France
ANSI 96.1	BS 1843	DIN 43714	JIS C1610/81	NF C42-323
+ White -- Red	+ Yellow -- Blue	+ Red -- Blue	+ Red -- White	+ Yellow -- Black

Table 4 - Plot Size Scales And Data Samples

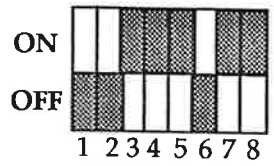
Plot Size Switch Position	Distance Between UV Data (mm)	Distance Between Temp Data (mm)	Number of Data Samples Printer Battery Charge Provides	Max. Avail. Plot Time At 40 Samples Per Second	Max. Avail. Plot time at 20 Samples Per Second	Max. Avail. Plot time At 10 Samples Per Second	Max. Avail. Plot time At 5 Samples Per Second
	0.35	0.7	12000	5 minutes	10 minutes	20 minutes	40 minutes
	0.7	1.4	6000	2.5 minutes	5 minutes	10 minutes	20 minutes
	1.4	2.8	3000	1.25 minutes	2.5 minutes	5 minutes	10 minutes
	2.8	5.6	1500	0.625 minutes	1.25 minutes	2.5 minutes	5 minutes

A maximum of 4.2 meters of paper will be plotted with a fully charged battery.

Table 5 - Printer DIP Switch Settings

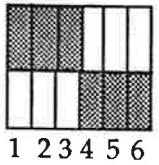
Printer Model DPU - 411, Type 11

KSS08



SW1 - OFF
SW2 - OFF
SW3 - ON
SW4 - ON
SW5 - ON
SW6 - OFF
SW7 - ON
SW8 - ON

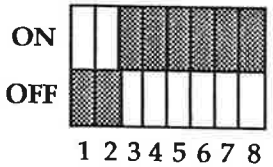
KSS06



SW1 - ON
SW2 - ON
SW3 - ON
SW4 - OFF
SW5 - OFF
SW6 - OFF

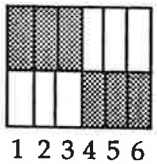
Printer Model DPU - 411, Type 21

KSS08



SW1 - OFF
SW2 - OFF
SW3 - ON
SW4 - ON
SW5 - ON
SW6 - ON
SW7 - ON
SW8 - ON

KSS06



SW1 - ON
SW2 - ON
SW3 - ON
SW4 - OFF
SW5 - OFF
SW6 - OFF