PHOTODYNE INC.

MODEL 44XL
OPTICAL POWER METER

MODEL 88XL
RADIOMETER/PHOTOMETER

INSTRUCTION MANUAL

INSTRUCTION MANUAL

FOR

MODEL 44XL
OPTICAL POWER METER

AND

MODEL 88XL
RADIOMETER / PHOTOMETER

- REVISED EDITION -

SECOND PRINTING, JUNE 1980, WESTLAKE VILLAGE, CA

UNITED STATES OF AMERICA

CONTENTS

IMPORTANT NOTICE ON INSIDE BACK COVER!!

ILLUSTRATIONS

SPECIFICATIONS

POWER RANGES: 1.999,19.99,199.9,1999 µW,fc,lx,cd
1.999,19.99,199.9,1999 nW,mfc,mlx,mcd (88XL only)

DC RESPONSE: 1/3 second

AC FREQUENCY: 10 Hz and up (average power)

ACCURACY: ± .5 % and ± 2 digits (microwatt range)
± 1% and ± 4 digits (nanowatt range)

DIGITAL OUTPUTS: Mulitplexed 7 Segment, digital ground.

ANALOG OUTPUTS: SIG.OUT, REF.OUT, ground, V+, V-

AMBIENT OFFSET DRIFT: 1% per 3 minutes

BATTERY: 7.2 volt, Eveready CH22, Ni-Cd rechargeable

BATTERY LIFE: 9 hours nominal -
4 hours with background light on

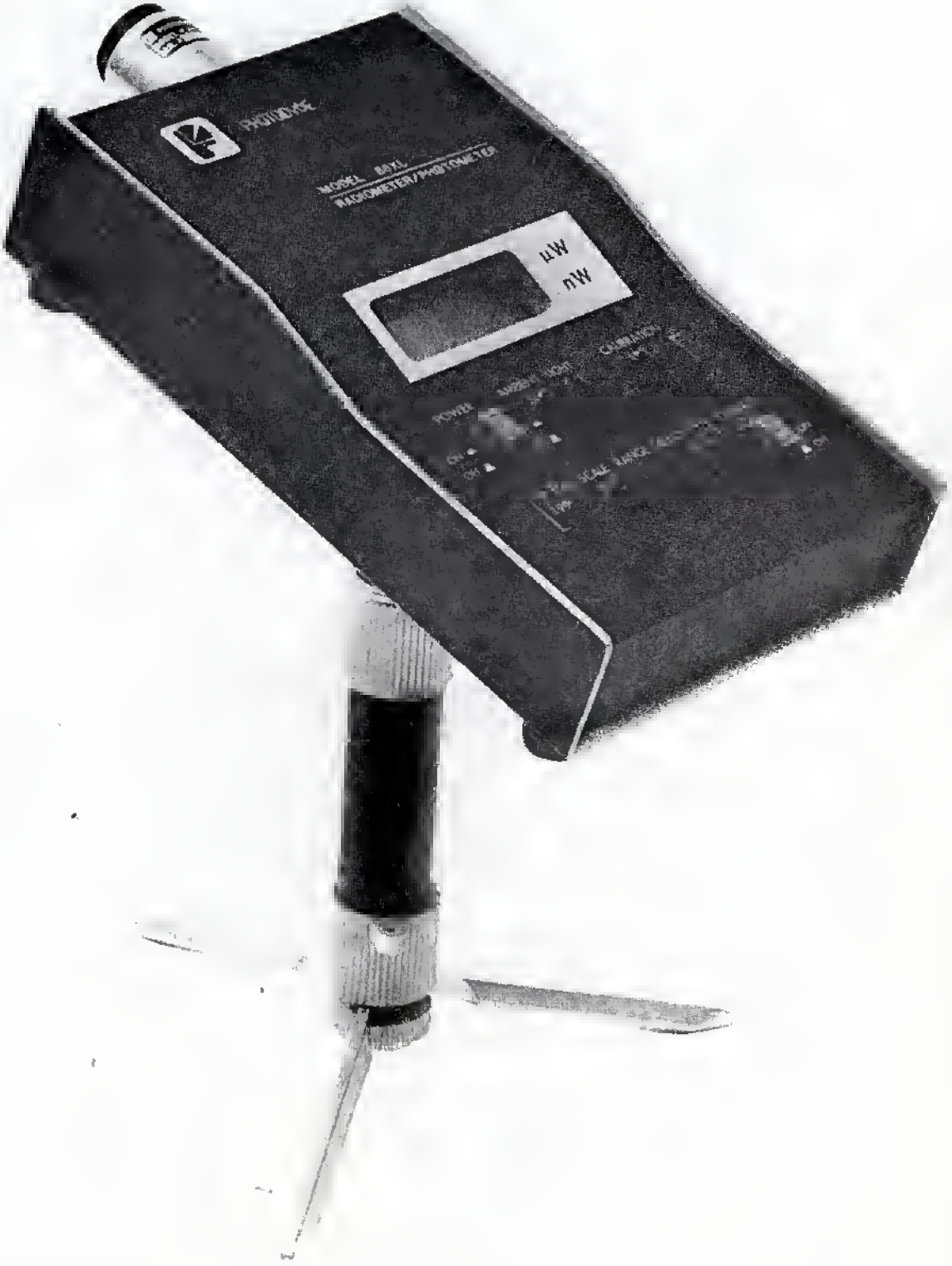
DIMENSIONS: Length 7.35 in. (18.7mm)
Width 4.45 in. (11.3mm)
Height 1.70 in. (4.3mm)

WEIGTH: 0.6 Kg (1 lb. 4 oz.)

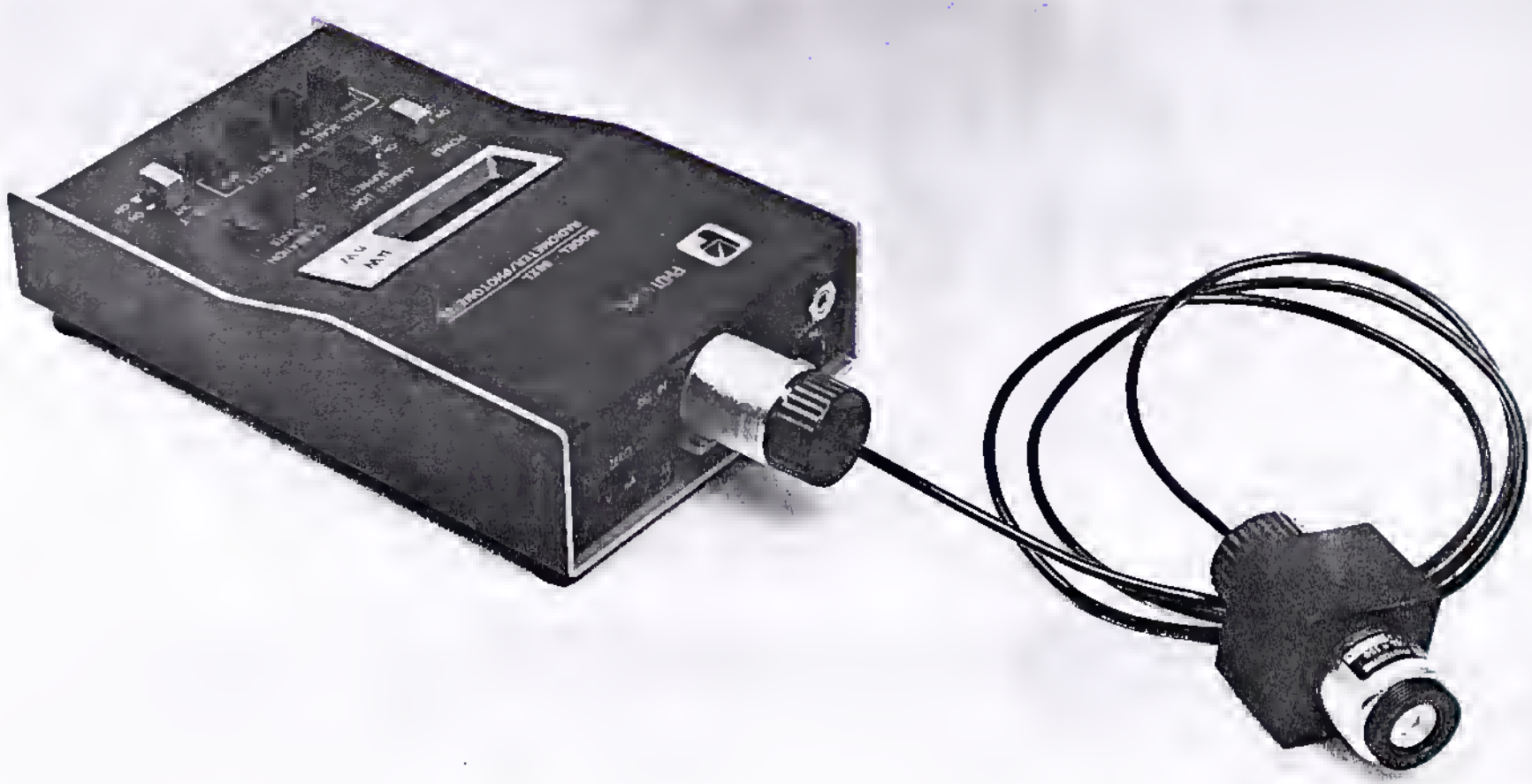
SHIPPING WEIGHT: 1.8 Kg (4 lbs.)

OPERATING TEMPERATURE: 0 to 55°C

NOTE: The Model 88XL does not separate AC and DC signals. The average power of all incoming light signals is correctly displayed, except for AC signals with a frequency between 1 and 10 Hz.



MAXIMUM PERFORMANCE IN LIGHT MEASUREMENTS... MODEL 88XL



MODEL 88XL RADIOMETER/PHOTOMETER SHOWN WITH MODEL 3001 EXTENSION CABLE

SECTION 1. GENERAL INFORMATION

1-1. INTRODUCTION

The PHOTODYNE Model 88XL Photometer/Radiometer is a 3½ digit, electro optics measurement lab with portability and range that is ideally suited for either field or lab operation. The Model 88XL features direct linear readout for radiant power in units of nanowatts, microwatts, and milliwatts, from 1 picowatt minimum resolution to 2 watts maximum reading. Direct linear photopic measurements are available in footcandles, lux, and candelas.

The PHOTODYNE Model 44XL Optical Power Meter provides a low-cost solution to optical power measurements. The Model 44XL provides essentially the same features as the 88XL, except offers limited sensitivity to 1 nanowatt resolution.

1-2. FEATURES

The Model 44/88XL establishes a new standard of performance and convenience for radiometric and photmetric measurements:

* Two absolute internal references are switch selectable - nanowatt and microwatt - and color coded for an unambiguous, direct readout in the units selected (Model 88XL only - Model 44XL reads microamps only).
* Range switching is pushbutton selectable, setting the full scale value and decimal points for clear reading.
* Ambient ight suppress function operates on all ranges.
* Display light switch for backlighting the LCD in darkroom usage.

* Optional plug-in sensor heads available for specific ranges of spectral and power applications, including matched pairs. Each sensor carries its own calibration to the electronics upon insertion. This calibration is NBS traceable, documented, and included with each head.

The Model 44/88XL takes advantage of the latest IC, display and packaging technology to achieve the lowest possible comonent count. This, in turn, ensures reliability, accuracy, stability, and rugged, easy-to-handle instrument.

* Liquid-crystal display (LCD) and CMOS circuitry for low power consumption and extended field operation.
* A built-in nickel-cadmium battery provides 9 hours continuous operation - 4 hours with backlight on. Plug-in charger maintains operation while recharging battery.
* LOW BATTERY indicator incorporated in display.
* Small size, lightweight, rugged, dual-annodized enclosure allows laboratory precision mesurements while adverse field conditions.
* Briefcase-style carrying case allows storage and safe transportation of the instrument and all accessories (charger, heads, manuals).
* 34 pin edge connector brings out all digital and analog signals for user interface requirements.

1-3. WARRANTY INFORMATION

The warranty is stated on the inside front cover of the manual. If there is a need for service, contact your local PHOTODYNE representative or Photodyne headquarters in Westalke Village, California. A warranty registration card is included with each new instrument. This card should be filled out and returned immediately after receipt and inspection.

FEATURES

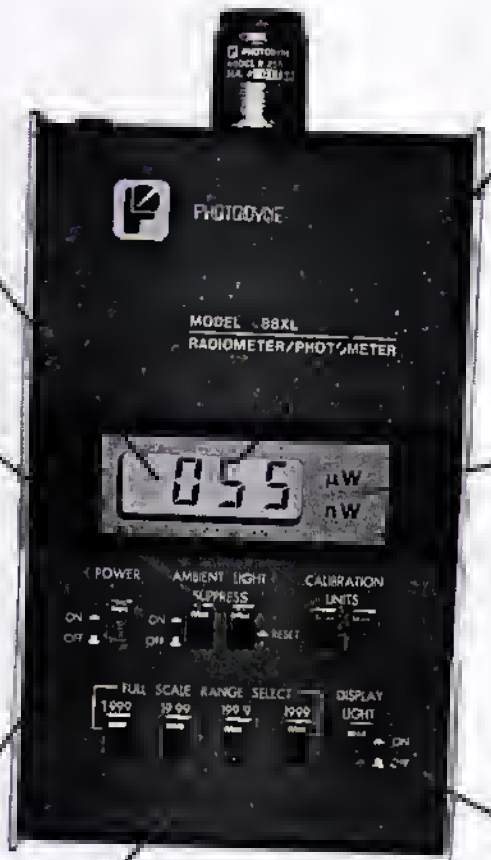
Sensor head plugs in and carries its' calibration to the electronics. An extension cable is available for operating the head remotely from the instrument.

NI-Cd rechargeable battery with life of 9 hours - with LCD background display light on, 4 hours.

One board circuit construction with all major components socketed for easy repair.

34 pin circuit card connector brings out all digital and analog signals.

DC and AC average power response from 10Hz up.



½ inch high, LCD display, backlit for darkroom use.

Battery low indicator is on display, while internal circuitry continuously monitors battery.

Ambiant light suppress is pushbutton actuated and operates on all ranges.

Two absolute internal references are switch selectable and color coded for an unambiguous, direct readout in the units selected.

On/Off power switch is color coded red.

Display light switch for backlighting the LCD in darkroom useage.

Range switching is pushbutton selectable, setting the full scale value and decimal points while the display remains direct reading without any scale factor interpretation required.

1-4. CHANGE NOTICE

Improvements or changes to the instrument not incorporated into the manual will be explained on a yellow change notice sheet attached to the inside back cover of the manual.

1-5. HOW TO USE THIS MANUAL

This manual serves to provide the operating instructions for both the Model 44XL Optical Power Meter and the Model 88XL Photometer/Radiometer. The two instruments are both physically and electrically similar in most respects, and where differences appear, are distinctly noted in this manual.

SECTION 2. INITIAL PREPARATION

2-1. GENERAL

This section provides information needed for incoming inspection and preparation for use.

2-2. INSPECTION

The Model 88XL was carefully inspected both mechanically and electrically before shipment. When received, the 88XL shipping carton should contain the following items listed below. Account for, and inspect each item before the carton is discarded. In the event of a damaged instrument, write or call your local Photodyne representative, or contact Photodyne headquarters in Westlake Village, California. Please retain and use the shipping carton if reshipment is required.

FIGURE 2-1. PHOTOGRAPH OF MODEL 88XL INSTRUMENT CASE

CONTENTS:

1 - Model 88XL Radiometer/Photometer

1 - Model 88XL Instruction Manual

1 - Battery Charger (specific model as ordered)

Model 115 - 115V, 60 Hz
Model 220 - 220V, 50/60Hz

1 - Model 4001 Briefcase-style Carrying Case

1 - Warranty Registration Card (return immediately after check-out)

ACCESSORIES AS ORDERED:

Each Plug-in Sensor Head should include the sensor head assembly, blank adapter, and calibration documentation (computer printout).

Each Threaded Adaptor for the Sensor Heads should have the appropriate fiber optic cable connector as ordered.

Model 2001 - Adaptor with AMP connector

Model 2002 - Adaptor with Siecor connector

Model 2003 - Adaptor with Amphenol connector

Model 2004 - Adaptor with Augat connector

Model 2005 - Blank Adaptor

Having verified the correct contents of your shipment, it is necessary to verify the electrical specifications of the 88XL instrument. Carefully read the instructions given in the following section on Preparation for Use, then proceed to section 7.

2-3. PREPARATION FOR USE

The Model 88XL is shipped ready-to-use. The instrument is powered from a built-in, rechargeable nickel-cadmium battery. The battery is recharged using the appropriate Photodyne battery charger corresponding to the available source of AC electrical power.

BATTERY INSTALLMENT/REPLACEMENT. The battery furnished with the Model 88XL Radiometer/Photometer comes already installed inside the unit. It is a single transistor-type unit with two polarized connector posts on top. The battery is equivalent of EVERYREADY #CH22, and may be reordered as Photodyne Model CH22. To install or replace the Model CH22 battery, hold the instrument in hand so that the bottom cover faces up. Loosen the screws holding the 4 rubber feet in place, as shown in Figure 7-1. Turn the instrument over with the top cover facing up, taking care to hold the top and bottom covers together. Carefully lift the top cover and lay backwards to expose the printed circuit board, as shown in Figure 2-2. Gripping the bottom chassis and holding it firmly in place, disconnect the battery holder retaining clips. Install the new battery in the opposite manner by pushing it through the battery holder retaining clips with the battery posts aligned correctly with the battery holder terminals. After the battery is installed, replace the top cover. Turn the instrument over with the bottom cover facing up

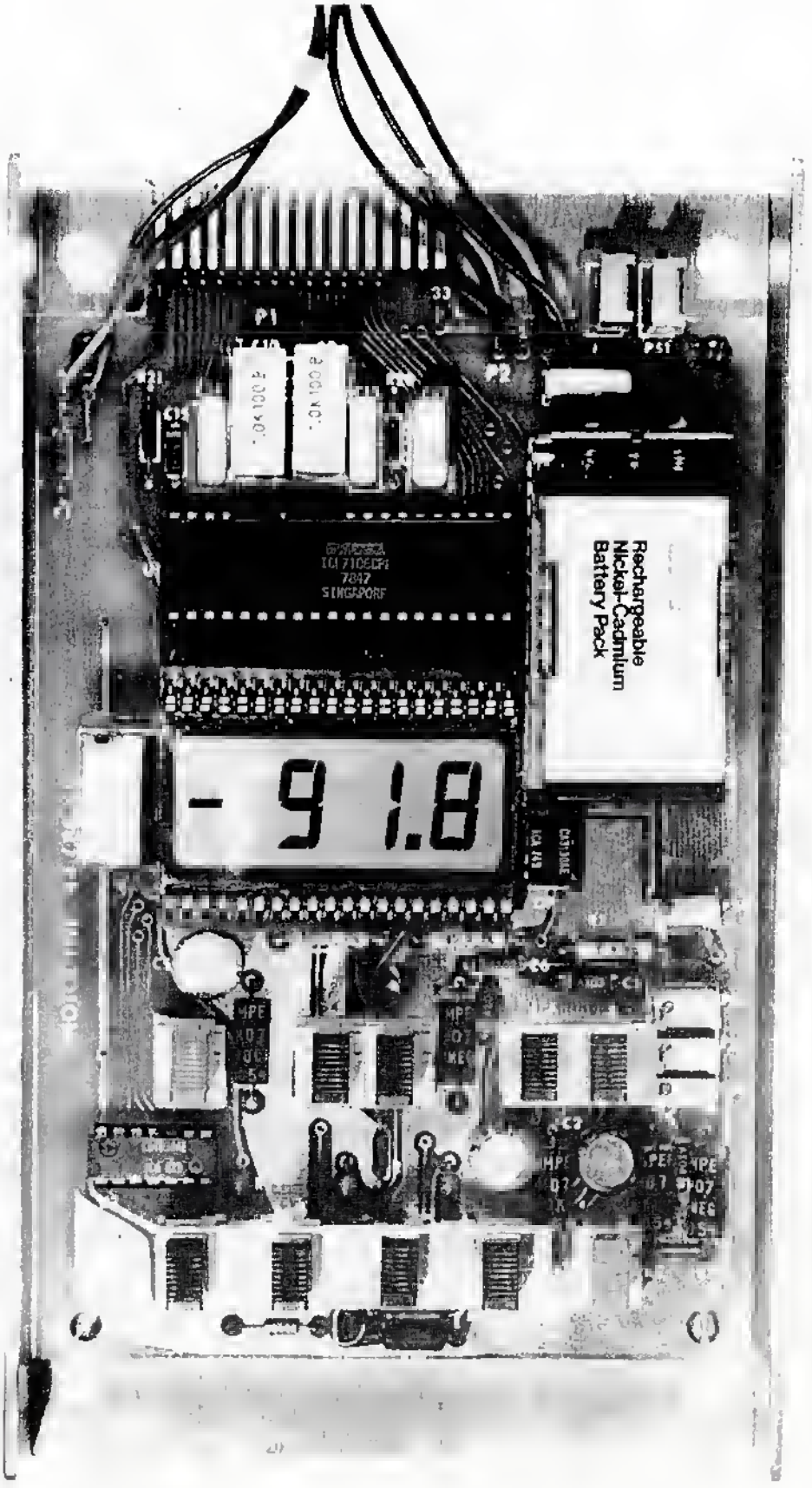


FIGURE 2-2. INSIDE VIEW OF MODEL 88XL SHOWING BATTERY PLACEMENT AND REMOVAL.

and re-install the 4 rubber feet with the screws.

HOW TO CHECK THE BATTERY. Whenever the Model 88XL is on, the battery condition is continuously monitored. A low battery condition exists when the battery voltage falls below 6.8 volts. This is indicated by a LO BATT appearing in the upper lefthand corner of the LCD display. If the LO BATT appears or the instrument does not operate at all, first suspect a discharged battery and charge according the procedures given in the following section.

HOW TO CHARGE THE BATTERY. The Model 88XL provides built-in recharging circuitry for recharging the Model CH22 battery pack. To recharge the internal battery, connect the appropriate Photodyne battery charger to the CHARGER-IN connector on the rear panel of the 88XL. (See Figure 2-3.) Consult Table 2-1 for correct battery charger selection, according to available AC electrical power. Typically, the recharge time is 1½ hours per hour of discharge (or 6 hours of charging time for every 4 hours of operating time). A full charge will typically require approximately 14-18 hours.

TABLE 2-1

BATTERY CHARGER SELECTION CHART

Model	Available AC Power	Country
115	115 VAC, 60 Hz	US, Canada
220	220 VAC, 50/60 Hz	Europe

FIGURE 2-3. DIAGRAM OF BATTERY CHARGER CONNECTION TO MODEL 88XL

CAUTION

Overcharging may shorten the life of the battery.

NOTE

The Model 88XL may be operated while the battery charger is plugged into the unit. However, the battery charger should never be used unless a battery is installed within the instrument. No other unit but a Photodyne Battery Charger may be connected to the CHARGER INPUT, and no other battery than the Photodyne Model CH22 should be used. Improper use voids the Photodyne warranty.

SECTION 3. OPERATING INSTRUCTIONS

3-1. GENERAL

This section provides information needed to operate the Model 88XL. First, basic principles of electro-optic measuremen are presented as applied to the capabilities of the Model 88XL Photometer/Radiometer. Following sections detail the operation of all controls and connections.

3-2. PRINCIPLES OF MEASUREMENT

Optical radiation measurements are divided according to two subdisciplines - radiometry and photometry. Radiometric quantities are physical quantities, being expressed in terms of energy and geometrical units. Photometric quantities are not strictly physical, but provide an evaluation of the human observe response to radiant energy that reaches the retina of the eye as a stimulus. Since psychological stimuli and responses are involved, the quantities can better be called psychophysical.

The terms of radiometry are similar to the terms of photometry except that the term radiant is substituted for luminous. See Table 3-1. Radiometry is concerned with the radiant power expressed in watts at the wavelengths in question, whereas photometry relates to that fraction of the radiant power (in lumens) determined by the product of the spectral radiant power and the spectral luminous efficacy of radiant energy. The efficiency is a dimensionless term, defined by the C.I.E. "standard observer" spectral response curve, that expresses the ratio of the efficacy of a particular wavelength to that at the wavelength of maximum efficiency (eye response). The efficacy of radiant flux is expressed in lumens per watt.

	Parameter and Symbol		Definition	Units	Abbrev.
RADIOMETRIC	Radiant Energy	Q_e		erg joule calorie kilowatt-hour	 J cal kWh
	Radiant Flux	P	$P = \frac{dQ_e}{dt}$	erg per second watt	erg s^{-1} W
	Radiant Emittance (see Note 2) Irradiance	W H	$W = \frac{dP}{dA}$ $H = \frac{dP}{dA}$	watt per sq. cm, watt per sq. m, etc. watt per sq. cm, watt per sq. m, etc.	W cm^{-2} W m^{-2} W cm^{-2} W m^{-2}
	Radiant Intensity (see Note 1)	J	$J = \frac{dP}{d\omega}$	watt per steradian	W sr^{-1}
	Radiance (see Note 1)	N	$N = \frac{d^2P}{d\omega(dA \cos\Theta)}$ $N = \frac{dJ}{(dA \cos\Theta)}$	watt per steradian and sq. cm watt per steradian and sq. m	W sr^{-1} cm^{-2} W sr^{-1} m^{-2}
PHOTOMETRIC	Luminous Efficacy	K	$K = \frac{F}{W}$	lumen per watt	lm W^{-1}
	Luminous Efficiency	V	$V = \frac{K}{K_{maximum}}$		
	Luminous Energy (quantity of light)	Q_v	$Q_v = \int_{380}^{760} K(\lambda) Q_e \lambda d\lambda$	lumen-hour lumen-second (talbot)	lm h lm s
	Luminous Flux	F	$F = \frac{dQ_v}{dt}$	lumen	lm
	Luminous Emittance (see Note 2) Illumination (illuminance)	L E	$L = \frac{dF}{dA}$ $E = \frac{dF}{dA}$	lumen per sq. ft footcandle (lumen per sq. ft.) lux (lumen per sq. m) phot (lumen per sq. cm)	lm ft^{-2} fc lx ph
	Luminous Intensity (candlepower)	I	$I = \frac{dF}{d\omega}$	candela (lumen per steradian)	cd
	Luminance (brightness)	B	$B = \frac{d^2F}{d\omega(dA \cos\Theta)}$ $B = \frac{dI}{(dA \cos\Theta)}$	candela per unit area stilb (candela per sq. cm) nit (candela per sq. m) foot-Lambert (cd per πft^2) apostilb (cd per πm^2) Lambert (cd per πcm^2)	cd in^{-2}, etc. sb nt ft-L asb L

NOTES: 1. ω is a solid angle through which flux from point source is radiated

Θ is angle between line of sight and normal to surface considered

λ is wavelength

2. W and L refer to "emitted from" and H and E refer to "incident on"

FIGURE 3-1. FRONT PANEL CONTROLS OF MODEL 44XL OPTICAL POWER METER.

CONTROL	FUNCTIONAL DESCRIPTION	SECTION
POWER ON/OFF (S5)	Instrument Power ON or OFF	3-3
FULL SCALE RANGE SELECT 1.999 (S2A) 19.99 (S2B) 199.9 (S2C) 1999. (S2D)	Full scale range of display.	3-6
AMBIENT LIGHT SUPRESS ON/OFF (S4)	Ambient light offset control	3-7
AMBIENT LIGHT SUPPRESS ON/OFF (S3)	Set reference offset for Ambient Light Suppression.	3-7
DISPLAY LIGHT (S6)	Background light for LCD.	3-8

TABLE 3-2. SUMMARY OF FRONT PANEL CONTROLS ON MODEL 44XL OPTICAL POWER METER.

FIGURE 3-2. FRONT PANEL CONTROLS OF MODEL 88XL RADIOMETER/PHOTOMETER.

CONTROL	FUNCTIONAL DESCRIPTION	SECTION
POWER ON/OFF (S5)	Instrument Power ON or OFF	3-3
CALIBRATION UNITS - µW (S1A) nW (S1B)	Interlocked switch Used on Model 88XL only. Model 44XL displays µW.	3-5
FULL SCALE RANGE SELECT 1.999 (S2A) 19.99 (S2B) 199.9 (S2C) 1999. (S2D)	Full scale range of display.	3-6
AMBIENT LIGHT SUPRESS ON/OFF (S4)	Ambient light offset control	3-7
AMBIENT LIGHT SUPPRESS ON/OFF (S3)	Set reference offset for Ambient Light Suppression.	3-7
DISPLAY LIGHT (S6)	Background light for LCD.	3-8

TABLE 3-3. SUMMARY OF FRONT PANEL CONTROLS ON MODEL 88XL RADIOMETER/PHOTOMETER.

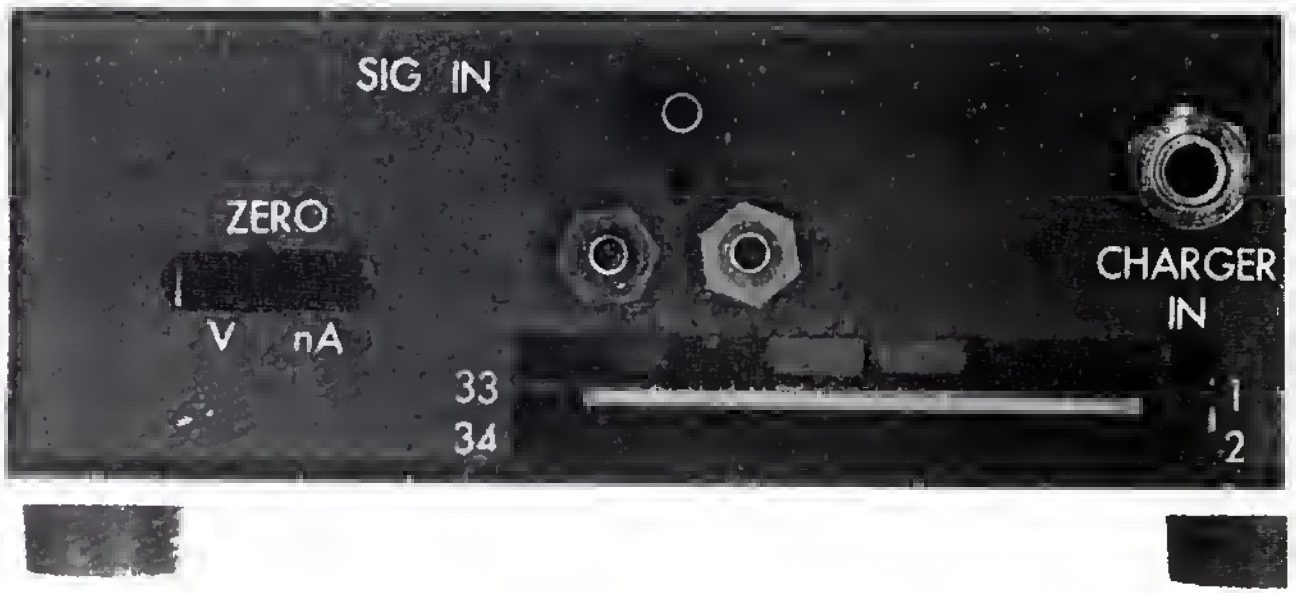


FIGURE 3-4. REAR PANEL CONTROLS OF MODELS 44XL AND 88XL.

CONTROL	FUNCTIONAL DESCRIPTION	SECTION
SIG.IN (J2,J3,J4)	Plug-in sensor head input.	3-10
CHARGER IN (J1)	Plug-in battery charger jack.	3-3
ZERO V (R51)	Voltage zero adjustment.	3-9
ZERO nA (R55)	Current zero adjustment. Model 88XL only.	3-9
PCB Contacts	34-contact PC board extension brings out all relevant digital and analog signals for external interfacing.	

TABLE 3-4. SUMMARY OF REAR PANEL CONTROLS ON MODEL 44/88XL.

3-3. HOW TO TURN ON POWER

Power to the unit is controlled by the position of the POWER switch (S5) located on the front panel. Power OFF is designated by the UP position; power ON corresponds to the DOWN position. The instrument may be turned on, with the charger either connected or disconnected. However, the battery charger should be connected only with the power OFF, and then switched ON.

3-4. HOW TO READ DISPLAY

The Model 44/88XL incorporates a .5-inch 3½-digit LCD display for purposes of readability and low power consumption. Besides numeric readout, the display also features a LO BAT indicator that appears upon a low battery condition. Battery voltage is continuously monitored. Figure 3-4a depicts the characteristics of the Model 44/88XL display.

In the course of performing measurements, a particular range may become overloaded, causing an overrange display. This display is illustrated in Figure 3-4b. To obtain a valid read-out, it may be necessary to decrease sensitivity by changing the FULL SCALE setting, or CALIBRATION UNITS setting (88XL only).

3-5. HOW TO SELECT CALIBRATION UNITS (MODEL 88XL ONLY)

There are two calibration units available - nanowatts (nW) and microwatts (µW). When the green button is in, nanowatts are selected. When the black button is in, microwatts are select-ed. Note that the color of the button also corresponds to the color of the units printed on the display bezel.

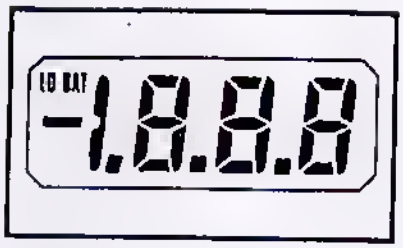


FIGURE 3-4a. FULL DISPLAY OF MODEL 44/88XL.

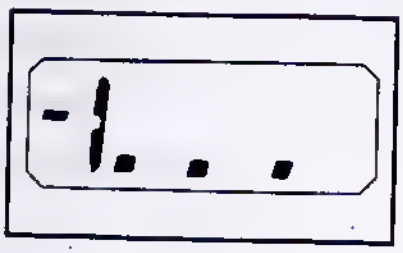


FIGURE 3-4b. OVERRANGE DISPLAY OF MODEL 44/88XL.

3-6. HOW TO SELECT FULL SCALE RANGE

For the instrument to operate properly, one (and only one) of the four buttons associated with the FULL SCALE RANGE SELECT must be pushed in. These buttons define the full scale reading associated with each range, and set the appropriate decimal point position for the display. When measuring an unknown light source, begin with a high range (1999) and work down progressively to a low range (1999 to 199.9 to 19.99 to 1.999). The display reads out directly.

3-7. HOW TO USE AMBIENT LIGHT SUPPRESS

The AMBIENT LIGHT SUPPRESS feature is used to null out a background light signal. The AMBIENT LIGHT SUPPRESS ON/OFF button must first be off (up) and a reading of the background light obtained by selecting the proper calibration units and full scale range, with only the light to be suppressed falling on the sensor head. The AMBIENT LIGHT SUPPRESS button is then pushed in (ON). Following this, the RESET button is pushed in, held down, and slowly released. The light source to be measured in the presence of the background is then allowed to fall on the sensor head. Note that the CALIBRATION UNITS and FULL SCALE RANGE SELECT settings must remain unchanged during the use of this function.

Fluctuations over time in a light source are also handily measured with this feature. In this case, the light source signal is nulled per the instructions above. Deviations from zero on the display then represent light source fluctuations over time. The AMBIENT LIGHT SUPPRESS function has a drift loss of 1% per 5 minutes.

3-8. HOW TO SELECT DISPLAY LIGHT

The red DISPLAY LIGHT button turns on a background light for the display when in. This display light is only observable in darkroom conditions. It should not be on when the display is readable in ambient light, as the battery life is reduced to four hours with this light on.

3-9. HOW TO ZERO INSTRUMENT

The Model 44/88XL instruments incorporate two zero adjustment controls for nulling input offset voltage and offset bias current prevalent in the instrument/sensor head combination. These two trimpots are accessible from the rear panel via a cutout marked ZERO and are correspondingly marked V (voltage offset) and nA (current offset). The Model 44XL uses only the voltage offset adjustment.

The Model 44XL is adjusted as follows:

1. With the sensor head plugged into the instrument and a blank adaptor screwed onto the head, set the unit to the 1.999 µW scale.
2. Adjust the ZERO V trimpot until the display just shifts between .000 and -.000 .

The Model 88XL is adjusted as follows:

1. With the sensor head plugged into the instrument and a blank adaptor screwed onto the head, set the unit to the 1.999 µW scale.
2. Adjust the ZERO V trimpot until the display just shifts between .000 and -.000 .
3. Set the unit to the 1.999 nW scale.
4. Adjust the ZERO nA trimpot until the display just shifts between .000 and -.000 .

3-10. HOW TO MAKE SENSOR HEAD CONNECTIONS

Both the Model 44XL OPTICAL POWER METER and the Model 88XL RADIOMETER/PHOTOMETER are single head optical power sensors, operating as wide range current measureing devices. The conversion from light power to electrical current takes place in the plug in sensor head. The instruments receive the photogenerated current from the sensor head as well as a calibration factor. The display then reads out directly in the light power units for which the head was calibrated.

Large area silicon and germanium photodiodes, and photodiode/filter combinations, in socket-mounted head assemblies, are the basic sensors. Each sensor head has variable resistor which can be set, from a calibration chart, to give a direct reading at any chosen wavelength, within the calibration range of the sensor head. A detailed explanation of sensor head operation and calibration procedures is available in Section 5-3.

PHOTODYNE offers a wide range of sensor heads to match the spectral and optical power characteristics of the application. Consult Figure 3-5 for information regarding selection of PHOTODYNE sensor heads for radiometric applications. Figure 3-6 details selection of PHOTODYNE photometric sensor heads.

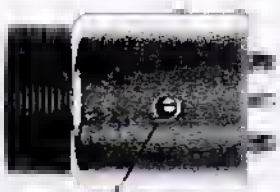
Fiber optic cable and connectors attack with threaded adaptors to the sensors. PHOTODYNE provides a wide product line of adaptors for the popular industry standards of connectors. In the case of unique customer requirements, PHOTODYNE offers a blank adaptor for the user to devise his own configuration. See Figure 3-7 for the appropriate selection of PHOTODYNE threaded adaptors.

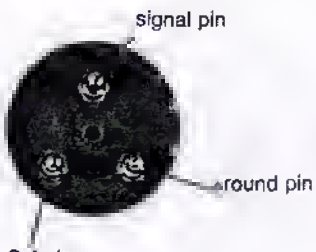
RADIOMETRIC APPLICATIONS

General: The 88XL is a wide range current measuring instrument. The conversion from light power to electrical current takes place in the plug in sensor head. The 88XL receives the photogenerated current from the sensor head as well as a calibration factor. The display on the 88XL then reads out directly in the light power units for which the head was calibrated. The great variety of available sensor heads give unusual versatility to the 88XL system.

RADIOMETRIC SENSOR HEAD SPECIFICATIONS:

Models: 150, 250, 450, 550





Model 350

Model Number	150	250	350	450	550
Sensor Type	Silicon Photodiode	Silicon Photodiode	Silicon Photodiode	Silicon Photodiode	Germanium Photodiode
Application	General Purpose Low Light	Flat From 500-950 nm (± 10%)	Power Sphere	UV Sensitive	IR response
Active Area (cm^2)	.40 cm^2 .58 x .68 cm	.40 cm^2 .53 x .76 cm	.31 cm^2 .63 cm dia.	.40 cm^2 .58 x .68 cm	.20 cm^2 .50 cm dia.
Power Range	1 picowatt 2 milliwatt	1 picowatt 1 milliwatt	1 nanowatt 2 watts	10 picowatts 1 milliwatt	10 nanowatts 1 milliwatt
Spectral Cal. (nm)	400-1150 nm 50 nm interval	400-1150 nm 50 nm interval	400-1150 nm 50 nm interval	220-400 nm 20 nm interval	800-1800 nm 100 nm interval
Cal. Set (nm)	900 nm	900 nm	900 nm	360 nm	1200 nm
Cal. Accuracy %	± 6% 400-900 nm ± 10% 950-1150 nm	± 6% 400-900 nm ± 10% 950-1150 nm	± 9% 400-900 nm ± 12% 950-1150 nm	± 10% 220-300 nm ± 8% 300-400 nm	± 12%
Linearity %	± 1	± 1	± 1	± 1	± 2
Reproducibility % (% of full scale)	± .5	± .5	± .5	± .5	± 1
Power Density (Max. for Linear Reading)	1 milliwatt per mm^2	.1 milliwatt per mm^2	.2 watt per mm^2	.5 milliwatt per mm^2	5 milliwatt per mm^2

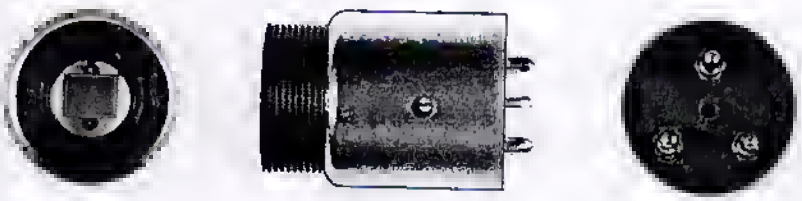
FIGURE 3-5. SELECTION OF PHOTODYNE RADIOMETRIC HEADS.

PHOTOMETRIC APPLICATIONS

General: The sensitivity of the eye to radiant energy depends upon wavelength. Photometry refers to the measurement of light according to the C.I.E. "standard observer" spectral response curve. Photometric sensor heads from Photodyne are glass subtractiv .filter/silicon photodiode combinations. They are computer matched to the C.I.E. Photopic curve of luminous efficiency.

PHOTOMETRIC SENSOR HEADS SPECIFICATIONS:

Model 650:



Model 750:

Model Number	650	750
Application	T.V. displays, indoor & outdoor lighting.	Visible LED's, LED displays
Sensor Type	Silicon Photodiode and Filter Combination	Silicon Photodiode & Filter Combinatior
Measurement Units*	mFt. candle or mLux / Ft. candle or Lux	mCandela / Candela
Range	10^{-6} . 10^{3} Ft.candle or Lux	10^{-6} . 10^{3} Candela
Cal Set	600nm	600nm
Cal Accuracy	± 6%	± 6%
Linearity	± 1%	± 1%
Reproducibility	± .5%	± .5%

*When photometric heads are plugged into the 88XL, a new bezel is screwed onto the display, for a direct readout in the proper units.

FIGURE 3-6. SELECTION OF PHOTODYNE PHOTOMETRIC HEADS.

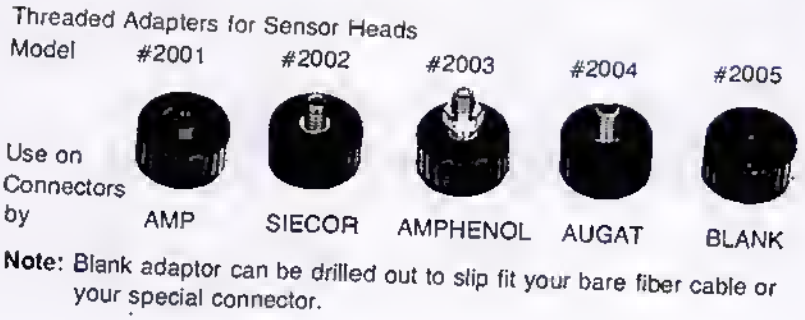
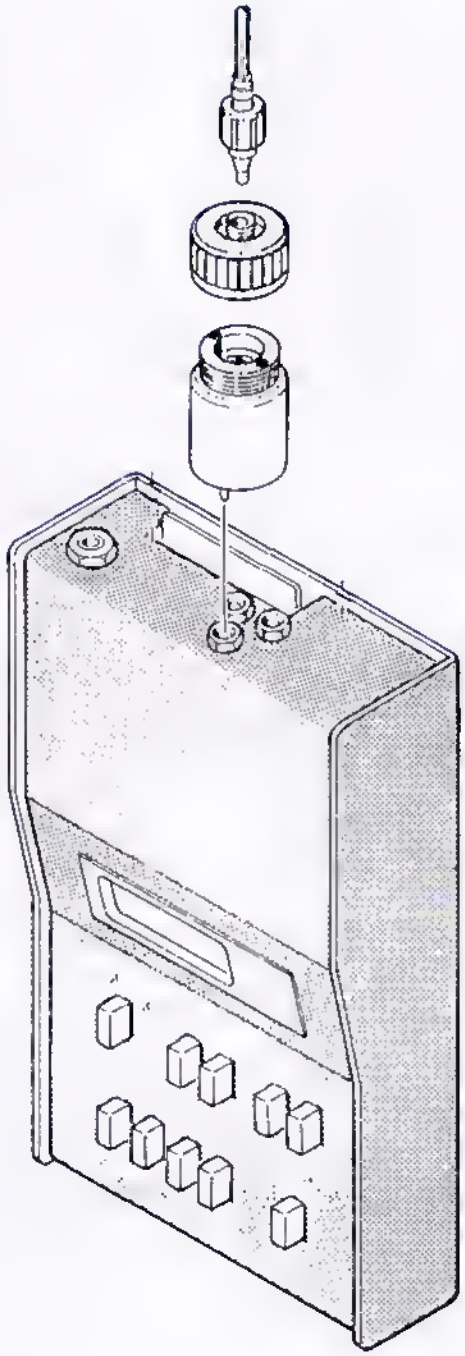


FIGURE 3-7. THREADED ADAPTORS FOR SENSOR HEADS

Figure 3-8 illustrates the mechanical configuration of connections to the Model 44/88XL. The pins on the bottom of each sensor are arranged to prevent incorrect insertion of the head into the isntrument. The connection is formed by a triangle of 3 color-coded miniature banana sockets - black, red, and green. Consult Section 5-3 for more detailed information.



MECHANICAL CONFIGURATION

Fiber Cable or connectors mount into threaded adaptors.
Adaptors thread into sensor heads.
Sensor heads plug into Model 44/88XL.
Accessory Cable available to operate sensor heads remotely from instrument.

FIGURE 3-8. SENSOR HEAD CONNECTIONS TO MODEL 44/88XL.

3-11. HOW TO MOUNT THE MODEL 44/88XL

Both the Model 44XL and 88XL require no special hardware for stand alone use. For special applications, the instrument mounts easily on an optical bench with aid of a ¼-20 nut, which is an integral part of the bottom case. Also, a standard camera tripod may be used in the same way. The small size and light weight of the unit make it ideal for this type of fixed set-up. Figure 3-9 illustrates a typical laboratory set-up of the Model 88XL on an optical bench.

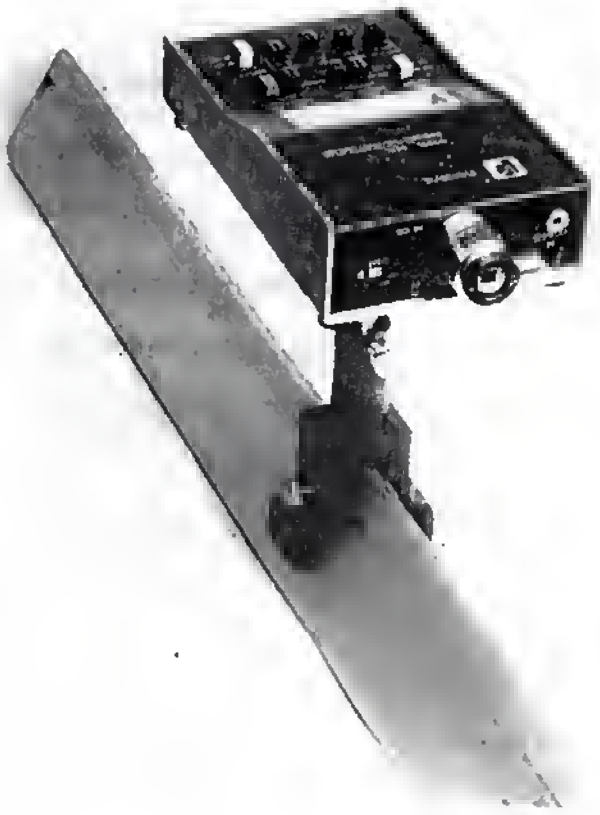


FIGURE 3-9. MODEL 88XL MOUNTED ON AN OPTICAL BENCH.

SECTION 4. APPLICATIONS

4-1. GENERAL

This section provides information needed to operate the Model 44/88XL for radiometric measurements of light sources and photoreceivers, and photometric measurements including light emitting diodes.

4-2. HOW TO MEASURE LIGHT SOURCES

The light source radiation is brought to the sensor head through the threaded adaptor cap, either through fiber cable, or in a laboratory darkroom through free air. The remote head extension cable accessory (PHOTODYNE Model 3001) can be utilized to bring the sensor head to the light source, remote from the instrument. Absolute measurements in uW and nW (88XL only) can be made with a sensor head plugged into the SIG.IN position and controls set to the particular reference level.

4-3. HOW TO MEASURE PHOTORECEIVERS

An important parameter in electro optic measurements is the responsivity of the photoreceiver. Responsivity is the ratio of photocurrent to incident radiation. The user's source can be calibrated by directing the signal on the SIG.IN sensor head as described in the previous section. The source can then be directed onto the detector to be calibrated. The signal output from the unknown photodiode to be calibrated can be put into either the Model 44XL or 88XL for measurement of detector response.

Photocurrent is measured by proper connection of the photodiode to the SIG.IN sensor connections. The detector outputs are directly connected through the black (SIGNAL) and green (GROUND) jacks of the sensor head input. The red (CAL) jack is left open. In this mode, the instrument will read out in ua (microamps) and na (nanoamps - 88XL only), so that an absolute photocurrent can be measured from an unknown photodiode with the known absolute input radiation power from the user's source. These results may then be combined to allow computation of responsivity in amps/watt.

NOTE

The photocurrent into the sensor SIGNAL terminal (black) must be positive with respect to GROUND (green) or else a random reading will result.

CAUTION

No bias voltage can be used on the photodiode under test (photovoltaic current mode), or else the input amplifier of the instrument may be damaged.

4-4. HOW TO MAKE PHOTOMETRIC MEASUREMENTS

Photometry is concerned with the measurement of radiant energy evaluated according to its ability to produce a visual sensation in the human eye. The sensitivity of the eye to radiant energy depends upon wavelength. Photometry refers to the measurement of light according to the C.I.E. "standard observer" spectral response curve. Photometric sensor heads from PHOTODYNE are glass subtractive filter/silicon photodiode combinations. They are computer matched to the C.I.E. Photopic

curve of luminous efficiency.

PHOTODYNE calibrates its photometric sensor heads at all visible wavelengths, referencing against an NBS silicon photodiode, which was radiometrically calibrated to an absolute accuracy of ± 3%. The transfer between radiometric and photometric units, using the luminous efficiency of radiatioj at each wavelength, is computed, listed, and plotted by SAM - PHOTODYNE's in-house Spectral Analysis Microcomputer. From the computer listed values for actual luminous efficiency of the sensor head at each wavelength, a resistance value can be calculated and turned into the Cal set variable resister, which then gives the sensor head an exact match to the C.I.E. curve at that wavelength and nearby wavelengths.

The present state of the Photometric art does not permit a precise (± 5% or better) match of sensor heads to the C.I.E. Photopic "eye" curve at all visible wavelengths. Often times, when a sensor head spectral response is precisely matched to the C.I.E. curve at a few wavelengths, other wavelengths can vary by several hundred percent. Most often, actual spectral response data on production sensor heads are not provided by the manufacturer. For this reason, Photometric measurements of spectrally selected light sources, such as visible LED's, can vary significantly from one sensor head to another, even though these sensor heads give the same reading for a broadband tungsten lightsource. PHOTODYNE has alleviated these problems with a two-part solution: (1) We provide individual spectral plots of the response of all Photometric sensor heads, and also provide a comparison of the actual data to the C.I.E. photopic curve, and

(2) PHOTODYNE sensor heads have a trim resistor adjustment which can be set to give a precise match to the C.I.E. curve at any wavelength desired.

Important Photometric Terms :

LUMINOUS FLUX : Luminous flux is the rate of flow of light energy, that characteristic of radiant energy which produces visual sensation. The unit of luminous flux is the lumen, which is the flux emitted by a uniform point source of one candela. Such a source produces a total luminous flux of 4π lumens.

ILLUMINANCE : Illuminance (or illumination) is the density of luminous flux incident on a surface. A common unit of illumination is the footcandle, the illumination produced by one lumen uniformly distributed over an area of one square foot. It follows that a source of one candela produces an illumination of one footcandle at a distance of one foot. The metric equivalent of a footcandle is the lux, defined as the illumination produced by one lumen uniformly distributed over an area of one square meter.

For performing general purpose photometric measurements, PHOTODYNE offers the Model 650 Sensor Head. The Model 650 head, when plugged into a PHOTODYNE instrument, reads out in illuminance values (footcandle or lux, as calibrated). The sensor head must be fully illuminated with radiation for the measurement to be valid. If the sensor head is underfilled with a radiation beam, lumens in the beam can be measured. Consult the instruction sheet for the Model 650 Sensor Head for detailed information on its use and operation.

4-5. HOW TO MEASURE LIGHT-EMITTING DIODES

Important Photometric Terms :

LUMINOUS INTENSITY : Luminous intensity (or candlepower) describes luminous flux per unit solid angle in a particular direction from a light source. The measure of luminous intensity is the fundamental standard from which all other photometric units are derived. The standard of luminous intensity is the candela. One candela is a luminous intensity of one lumen per steradian of solid angle.

The measurement of luminous intensity is performed using the PHOTODYNE Model 750 Sensor Head. The Model 750 head measures luminous intensity directly in candelas. A cross section of the head is given in Figure 4-1. The "tube" section of the sensor head defines a fixed solid angle, whose value is taken into account in the calibration of the head directly in candelas. The source to be measured is simply placed at the entrance of the hole of the MOdel 750 Sensor Head. The cal data sheet supplied with the head can be used to derive resistance values, for the trim resistance of the head, for a precise match to the C.I.E. photopic curve at any L.E.D peak wavelength. The measuring angle of the Model 750 Sensor Head is 2 degrees. Consult the instruction sheet for the Model 750 Sensor Head for detailed information on its operation and calibration.

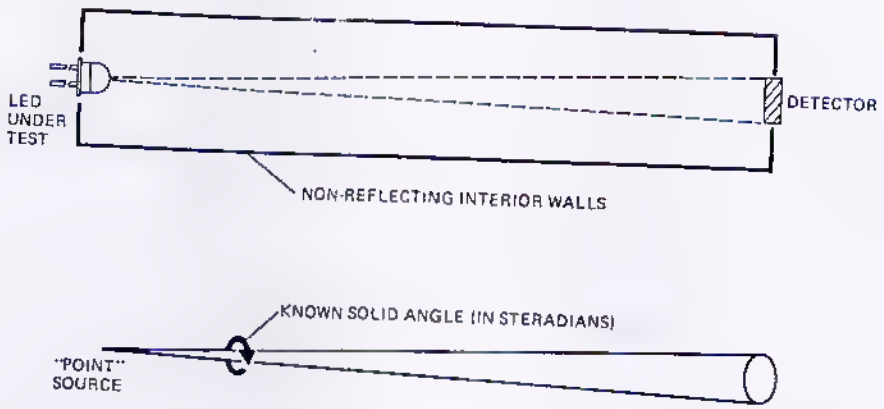


FIGURE 4-1. CONIGURATION OF MODEL 750 SENSOR HEAD.

SECTION 5. THEORY OF OPERATION

5-1. GENERAL

This section contains information to describe the operation of the Model 44XL/88XL instruments and plug in Sensor Heads. This operation is broken down into two parts: the operation of the 44XL/88XL electronics, and the operation of the plug in sensor heads. The sensor heads convert light into electrical current. The electronics amplifies and converts the sensor head signal current into a digital display.

5-2. MODEL 44XL/88XL

The electronics are all arranged on a single board, including battery, switches, and display. This board is operational even when removed from the case. However, low signal level performance is lost without the shielding provided by the metal case. Circuitry breaks down into three parts: (1) Current to voltage, conversion of sensor signal currents, (2) Voltage reference generation from sensor head trim resistor, and (3) analog to digital conversion and display. The 44XL does not have the nanowatt ranges of the 88XL. Otherwise, the electronics are identical. Figure 5-1 shows an overall block diagram for the 44XL/88XL electronics. The signal input current from the SIG-IN sensor head comes onto the circuit board at location P2-3. C1 and R10 form the high frequency AC to DC passive current

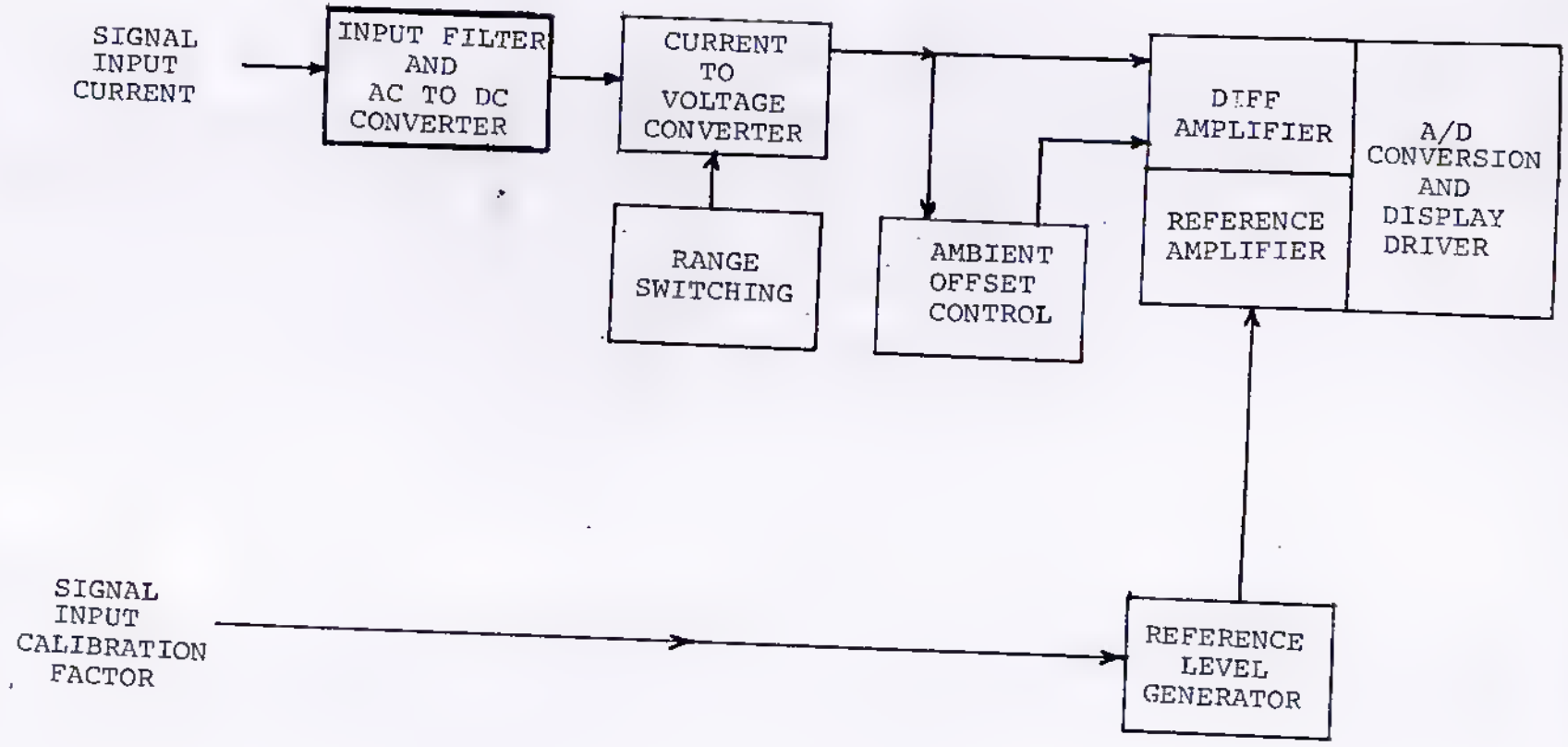


FIGURE 5-1. BLOCK DIAGRAM OF 44XL/88XL ELECTRONICS

converter network for the SIG IN current from the sensor head. OP-1 and its associated passive components forms the current to voltage converter. Range switching is accomplished with S1A/S1B and S2A/B/C/D, plus R1-R8 and C1-C7. In the 44XL, S1A/S1B plus R8,R6,R3,R1 are deleted, and the circuit board is hand wired into the uw position. R9,R22, and R55 form the zero current adjust network for the 88XL. These components are deleted on the Model 44XL.

Ambient Offset light circuitry is comprised of S3,S4,C9,and C10. When ambient light suppress is on, 3 goes to 2 in S4. When S3 is depressed, C10 comes to the same potential as C9. When S3 is released, C10 holds the voltage previously set. The potential on C9 varies as a new light level falls on the sensor head. The Diff amp then amplifies the difference between the signals on C9 and C10.

R54,R16, and PDR, in the sensor head, form the resistance controlled voltage generator. The PDR leads come onto the circuit board at P2-1 and P2-2. The diff amplifier, ref amplifier, A/D converter and display driver are all contained within the LSI circuit of U1. Q1 and U2 set the decimal point correctly for the range switch position of S2. LCD is a transflective display, allowing an effective backlighting function.

5-3. SENSOR HEADS

Photodyne Sensor Heads are comprised of silicon or germanium photodiodes and trim resistor. The signal current from the photodiode is linearly related to the input light power. The conversion factor is called responsivity (amps/watt). All calibration data is traceable to the National Bureau of Standards (Washington, D.C.). The data is obtained from a double-grating monochromator measurement system which is totally computer controlled, from data sampling to data analysis and presentation. SAM - Photodyne's Spectral Analysis Microcomputer - is a state-of-the-art development in spectral calibration systems, providing both radiometric and photometric analysis. Every Photodyne Sensor Head is accompanied by three pages of data analysis and graphic plot automatically provided by SAM at the end of each measurement cycle. A carbon copy of all data is kept on file at Photodyne Headquarters for purposes of questions and loss of printout.

An example of Photodyne calibration data is shown in Figure 5-2 for a Model 150 Silicon Photodiode Sensor Head. The first page (Page 01) of the computer generated printout shows manufacturing information about the sensor head. The model number and serial number of each sensor head are given for cross reference purposes, as well as the date, time, and operator during the spectral data generation.

The second page (Page 02) is the spectral data presentation organized into seven columns. The first and second columns (from the left) list the photocurrents (in microamperes) which were sampled during the data collection process at each wavelength. The third column lists the responsivity results in amps/watt at each wavelength. The fourth column lists the quantum efficiency,

calculated from the responsivity. The fifth column shows the relative responsivity response of the sensor head, computed from column three, with the spectral peak normalized to one. Columns 6 and 7 list correction factors, to be applied to instrum readings at wavelengths other than the Cal Set Wavelength. The sixth column lists linear multiplier factors for each calibration wavelength; column 7 provides the DB add-on factors for each wavelength (used only with the Model 22XL Optical Multimeter).

PHOTODYNE Sensor Heads can be adjusted to produce direct readings in Photodyne instruments at wavelengths other than the factory Cal Set Wavelength (see Figure 3-6). Using the example of Figure 5-2, the Cal Set Wavelength is given as 900 nm (bottom of Page 02) which corresponds to a trimpot setting of 89.2K ohms. Therefore, this sensor head will provide direct power readings for 900 nm light sources when plugged into <u>any</u> Photodyne instrume For other wavelengths, the user must use the correction factors of columns 6 or 7, or else adjust the trimpot for direct reading at another wavelength. The following formula is used to determine the resistance value associated with a new wavelength:

$$K\Omega \text{ (kilohms)} = \frac{R}{1 - R} \times 100$$

where R is the responsivity of the Sensor Head at the specified wavelength. For example, assume a direct reading is desired at 600 nm, and spectral analysis data shows a responsivity value of 0.324 amps/watt. Using the above equation, the trimpot setting would 47.9K ohms. This is then accomplished by connecting an ohm- meter between the Cal Trimpot and Common pins of the sensor head, and dialing in the new trimpot setting.

The third page (Page 03) contains a graphic plot of the responsivity data. The plot is a three-decade log arithmic plot falling off from the relative peak response versus wavelength. The data column to the left of the plot is the absolute spectral response (responsivity) as given on Page 02, but is duplicated here for convenience. For example, if the responsivity peaked at .48 amps/watt at 900 nm, then on the log scale, .1 corresponds to .048 A/W, .01 corresponds to .0048 A/W, and .001 corresponds to .00048 A/W.

CALIBRATIONS

Traceability to the NATIONAL BUREAU OF STANDARDS:
All calibrations are made by direct ratio comparison to working standard photodiodes, which were calibrated against an NBS Standard Detector. NBS detector data and working standard data are all stored in PROM in the Photodyne calibration computer (SAM), which totally controls the measurement process and data analysis, eliminating operator variable and error.

Cal Data with Every Head.

Every Sensor Head comes with a three page data presentation and graphic plot, direct from SAM, our spectral analysis microcomputer.

Recalibration Cycle: It is recommended that sensor heads be re-calibrated once a year under normal usage. With continuous usage, adverse conditions, or military program requirements, a six month re-calibration cycle is recommended

PHOTODYNE, INC. - WESTLAKE VILLAGE, CA. - 07/16/79 - 14:00:00 PAGE 01

SPECTRAL ANALYSIS : SENSOR HEAD

MANUFACTURER : PHOTODYNE, INC.

MODEL NO. : MODEL 150 - GENERAL PURPOSE HEAD

SERIAL NO. : 1

DATE : 07/16/79

TIME : 14:00:00

OPERATOR : BWW

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LIST : SPECTRAL ANALYSIS DATA

WAVELENGTH (NM)	PHOTOCURRENT (DA)	RESPONSIVITY (AMPS/WATT)	QUANTUM EFFICIENCY	RELATIVE RESPONSIVITY	LINEAR MULTIPLIER	DB ADD-ON FACTOR
400	1.00 E+00	1.56 E-01	4.83 E-01	3.25 E-01	3.03 E+00	4.81 E+00
450	1.00 E+00	2.14 E-01	5.89 E-01	4.45 E-01	2.21 E+00	3.44 E+00
500	1.00 E+00	2.60 E-01	6.44 E-01	5.41 E-01	1.82 E+00	2.59 E+00
550	1.00 E+00	2.95 E-01	6.66 E-01	6.15 E-01	1.60 E+00	2.03 E+00
600	1.00 E+00	3.24 E-01	6.69 E-01	6.74 E-01	1.46 E+00	1.64 E+00
650	1.00 E+00	3.48 E-01	6.64 E-01	7.25 E-01	1.35 E+00	1.32 E+00
700	1.00 E+00	3.73 E-01	6.60 E-01	7.76 E-01	1.26 E+00	1.02 E+00
750	1.40 E+00	4.04 E-01	6.67 E-01	8.40 E-01	1.17 E+00	6.74 E-01
800	1.00 E+00	4.30 E-01	6.67 E-01	8.95 E-01	1.10 E+00	4.00 E-01
850	1.00 E+00	4.48 E-01	6.53 E-01	9.33 E-01	1.05 E+00	2.24 E-01
900	1.00 E+00	4.72 E-01	6.58 E-01	9.82 E-01	1.00 E+00	0.00 E+00
950	1.00 E+00	4.78 E-01	6.24 E-01	9.95 E-01	9.87 E-01	-5.85 E-02
1000	1.00 E+00	4.63 E-01	5.75 E-01	9.63 E-01	1.02 E+00	7.56 E-02
1050	1.00 E+00	3.75 E-01	4.03 E-01	7.83 E-01	1.24 E+00	9.94 E-01
1100	1.00 E+00	1.99 E-01	2.24 E-01	4.13 E-01	2.38 E+00	3.74 E+00
1150	1.00 E+00	6.01 E-02	6.48 E-02	1.25 E-01	7.85 E+00	8.95 E+00

CALIBRATION SETTING (NM) : 900

FEEDBACK SETTING (OHMS) : 8.92 E+04

PHOTODYNE, INC. - WESTLAKE VILLAGE, CA. - 07/16/79 - 14:00:00 PAGE 03

PLOT : WAVELENGTH VS. RESPONSIVITY

WAVELENGTH	DATA
400	1.56 E-01
450	2.14 E-01
500	2.60 E-01
550	2.95 E-01
600	3.24 E-01
650	3.48 E-01
700	3.73 E-01
750	4.04 E-01
800	4.30 E-01
850	4.48 E-01
900	4.72 E-01
950	4.78 E-01
1000	4.63 E-01
1050	3.75 E-01
1100	1.99 E-01
1150	6.01 E-02

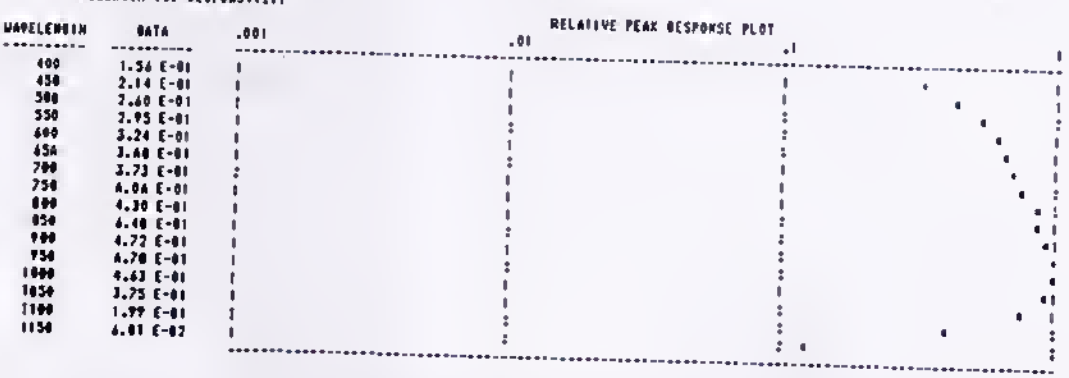


FIGURE 5-2. EXAMPLE OF CALIBRATION DATA SUPPLIED WITH PHOTODYNE SENSOR HEADS (MODEL 150 ABOVE).

SECTION 6. ACCESSORIES

6-1. GENERAL

The following Photodyne accessories can be used with the Model 44XL or 88XL to provide additional convenience and versatility.

6-2. LIST OF ACCESSORIES

PLUG-IN SENSOR HEADS

150	General Purpose Silicon Photodiode Sensor Head with Cal: 400-1150 nm, 50 nm interval.
250	Spectrally Flat Silicon Photodiode Sensor Head with Cal: 400-1150 nm, 50 nm interval.
300	Large Area Power Sensor Head for Lasers with Cal: 400-1150 nm, 50 nm interval.
350	Light Integrating Sphere-High Power Sensor Head with Cal: 400-1150 nm, 50 nm interval.
400	Broadband Silicon Photodiode Sensor Head for UV/VIS/IR with Cal: 220-1150 nm, 20 nm interval.
450	Ultraviolet Sensitive Silicon Photodiode Sensor Head with Cal: 220-400 nm, 20 nm interval.
500	Radiant Intensity Silicon Photodiode Sensor Head with Cal: 400-1150 nm, 50 nm interval. Units in Watts/Steradian.
550	Germanium Photodiode Sensor Head with Cal: 800-1800 nm, 100 nm interval.
650	Photometric Corrected Photodiode Sensor Head with Cal: 400-720 nm, 20 nm interval. C.I.E. Comparison : Ft. Candle and Lux.
750	Photometric Corrected Photodiode Sensor Head with Cal: 400-720 nm, 20 nm interval. C.I.E. Comparison: Candela.
850	Photometric Corrected Photodiode Sensor Head with Cal: 400-720 nm, 20 nm interval. C.I.E. Comparison: Ft. Lambert and Nit.
MATCH	Selection and Matching of two sensor heads with the same model number for 22XL or 99XL dual ratio use.
CAL#1	Special calibration intervals available for above sensor heads. All heads except Model 550 are 10 nm intervals. Model 550 calibrated in 50 nm intervals.

FIBER OPTIC ADAPTORS FOR SENSOR HEADS

2001	Sensor Head Adaptor for AMP connector (male).
2002	Sensor Head Adaptor for SIECOR connector (male).
2003	Sensor Head Adaptor for AMPHENOL connector (male).
2004	Sensor Head Adaptor for AUGAT connector (male).
2005	Sensor Head Blank Adaptor.
2006	Sensor Head Adaptor for Deutsch connector (male).
2007	Fiber Pigtail Adaptor, 400 µm and under.
2008	Fiber Pigtail Adaptor, 160 µm and under.
2009	Sensor Head Adaptor for Hewlett/Packard connector (male).
2010	Sensor Head Adaptor for ITT Cannon FON connector (male).

MISCELLANEOUS SENSOR HEAD ACCESSORIES

3001	Extension Cable for operating all plug in sensor heads remote from the XL instruments (36" length).
3002	Neutral Density (ND1.0) Filter Kit. Includes ND1.0 Filter (spectrally flat from 400-900 nm, ± 15%) and Hi Profile Sensor Threaded Cap with 0.25" diameter aperture. For use with models 150,250,400,450,550 Sensor Heads.

BATTERY CHARGERS

CH22	Rechargeable battery for use with Models 115A and 220A chargers. Equivalent to Everready CH22 (7.2V, 80 mA-hr).
CS9T	Rechargeable battery for use with Models 115 and 220 chargers. Equivalent to Gould CS9T (8.4V, 80 mA-hr).
115	115VAC, 60 Hz, 10 mA charger. For all XL instruments.
115A	115VAC, 60 Hz, 100 mA power supply/charger. For all XL instruments.
220	220VAC, 50/60 Hz, 10 mA charger. For all XL instruments.
220A	220VAC, 50/60 Hz, 100 mA power supply/charger. For all XL isntruments.

CALIBRATION/REPAIR SERVICES

RECAL	Standard calibration of any Photodyne Sensor Head.
RECAL#1	Calibration of any Photodyne Sensor Head per Special CAL#1
RECAL#2	Calibration of any Photodyne Sensor Head per Special CAL#2
XLCAL	Standard calibration of any Photodyne XL instrument

***Contact Photodyne for latest price list and additional accessories.

SECTION 7. MAINTENANCE

7-1. GENERAL

This section contains information necessary to maintain both the Model 44XL and 88XL. Included are procedures for electrical Performance Checks, Calibration, Troubleshooting, and Battery Replacement and Charging.

7-2. REQUIRED TEST EQUIPMENT

Recommended test equipment for checking and maintaining the instrument is given in Table 7-1. Test equipment other than that recommended may be substituted if specifications equal or exceed the stated characteristics.

TABLE 7-1.

RECOMMENDED TEST EQUIPMENT FOR PERFORMANCE VERIFICATION.

ITEM	DESCRIPTION	MINIMUM SPECIFICATION	MFGR.	MODEL
A	Voltmeter, Digital	1.000V @ 0.01%	KEITHLEY	191
B	Picoampere Source	1,10,100ua @ .25% 1,10,100na @ .6%	KEITHLEY	261

7-3. PERFORMANCE VERIFICATION

Use the following procedures to verify basic operation of the instrument. All measurements should be made at ambient temperature of approximately 25°C and relative humidity below 50%. If the instrument is out of specification at any point, perform a complete calibration as given in section 7-4. For each function that is checked, an additional uncertainty due to temperature coefficient should be considered if the ambient temperature is different from 25°C. Procedures designated with an asterisk "*" are deleted for the Model 44XL.

NOTE

This procedure is intended to verify only the basic accuracy of the instruments. Test equipment accuracy is specified X10 better than measurement accuracy.

a. BATTERY CHECK

1. Performance verification of the unit should be done only when the instrument is fully charged, and with the battery charger disconnected. This procedure is described in Section 2-3.

2. Push POWER switch to ON position. Although an arbitrary readout will result, the LO BAT indicator should not be on. If LO BAT does appear, either the battery or battery charger is defective.

b. MICROWATT REFERENCE CHECK

1. With POWER on, set controls to MICROWATT CALIBRATION UNITS and 1999 FULL SCALE RANGE SELECT. It should be

noted that the Model 44XL reads in microwatt units only, so no reference control setting applies here, only the FULL SCALE RANGE SELECT.

2. Connect the current source (with power off) to the SIG.IN sensor head position at the rear of the instrument. Miniature banana plugs are recommended for this operation (H.H. Smith P.N. 197). The SIGNAL (black) socket should be positive with respect to the GROUND (green) socket, for proper readings to be obtained.

3. With the current source turned on, the instrument should display the following values corresponding to the current input and the FULL SCALE RANGE SELECT setting.

TABLE 7-2.

ACCURACY CHECK FOR MICROWATT CALIBRATION UNITS.

FULL SCALE RANGE SELECT Setting	Current Source Input	Display Reading	Tolerance on Reading
1999	-100µa	- 100	± 3 digits
1999	100µa	100	± 3 digits
199.9	100µa	100.0	± 8 digits
199.9	10µa	10.0	± 3 digits
19.99	10µa	10.00	± 8 digits
19.99	1µa	1.00	± 3 digits
1.999	1µa	1.000	± 8 digits

*c. NANOWATT REFERENCE CHECK (MODEL 88XL ONLY!)

1. With POWER on, set controls to NANOWATT CALIBRATION UNITS AND 1999 FULL SCALE RANGE SELECT.

2. Connect the current source (with power off) to the SIG.IN sensor head position at the rear of the instrument. The SIGNAL (black) socket should be positive with respect to the GROUND (green) socket.

3. With the current source turned on, the instrument should display the values corresponding to the current input and the FULL SCALE RANGE SELECT setting.

TABLE 7-3.

ACCURACY CHECK FOR NANOWATT CALIBRATION UNITS.

FULL SCALE RANGE SELECT Setting	Current Source Input	Display Reading	Tolerance on Readinc
1999.	-100na	- 100	± 5 digits
1999	100na	100	± 5 digits
199.9	100 na	100.0	±15 digits
199.9	10na	10.0	± 5 digits
19.99	10na	10.00	±15 digits
19.99	1na	1.00	± 5 digits
1.999	1na	1.000	±15 digits

d. AMBIENT LIGHT SUPPRESS MODE

1. With POWER on, set controls to AMBIENT LIGHT SUPPRESS mode ON and MICROAMP CALIBRATION UNITS. As before, the Model 44XL reads automatically in microwatts.

2. Connect current source to the SIG.IN sensor head position so that the SIGNAL (black) socket is positive with respect to the GROUND (green) socket.

3. With the current source turned on, the instrument should display the values corresponding to the current input, FULL SCALE RANGE SELECT, and RESET settings given in TABLE 7-4.

TABLE 7-4.
ACCURACY CHECK FOR AMBIENT LIGHT SUPPRESSION MODE.

RESET Setting	FULL SCALE RANGE SELECT Setting	Current Source Input	Display Reading	Tolerance On Reading
(Depress)	19.99	1µa	0.00	± 3 digits
Up	19.99	-1µa	-2.00	± 3 digits
Up	19.99	2µa	1.00	± 3 digits
Up	19.99	5µa	4.00	± 4 digits
Up	19.99	10µa	9.00	± 7 digits

7-4. ADJUSTMENT/CALIBRATION PROCEDURE

The following adjustments should be performed when any specification has been determined to be out of tolerance. For checking the Model 44XL and 88XL to their published specifications, the Performance Verification procedures given in Section 7-3 should be used. Under normal conditions the instrument should be calibrated once a year to maintain the specifications given in the beginning of this manual. Each step in the calibration procedures also gives the probable component to be investigated if a certain adjustment cannot be performed.

IMPORTANT

Adjustments should be performed under laboratory conditions of approximately 25°C and less than 50% relative humidity.

a. HOW TO OPEN INSTRUMENT

1. Hold the instrument in hand with the bottom cover facing up. Loosen the screws holding the four rubber feet and set these aside.

2. Turn the instrument topside up. Carefully lift off the top cover and swing back and behind the base. Figure 7-1 illustrates the basic assembly of the Model 44XL and 88XL.

b. BATTERY CHECK

1. With the battery fully charged and charger disconnected, measure the voltage across the battery terminals. The voltmeter should read between 7.0 and 7.2 volts.

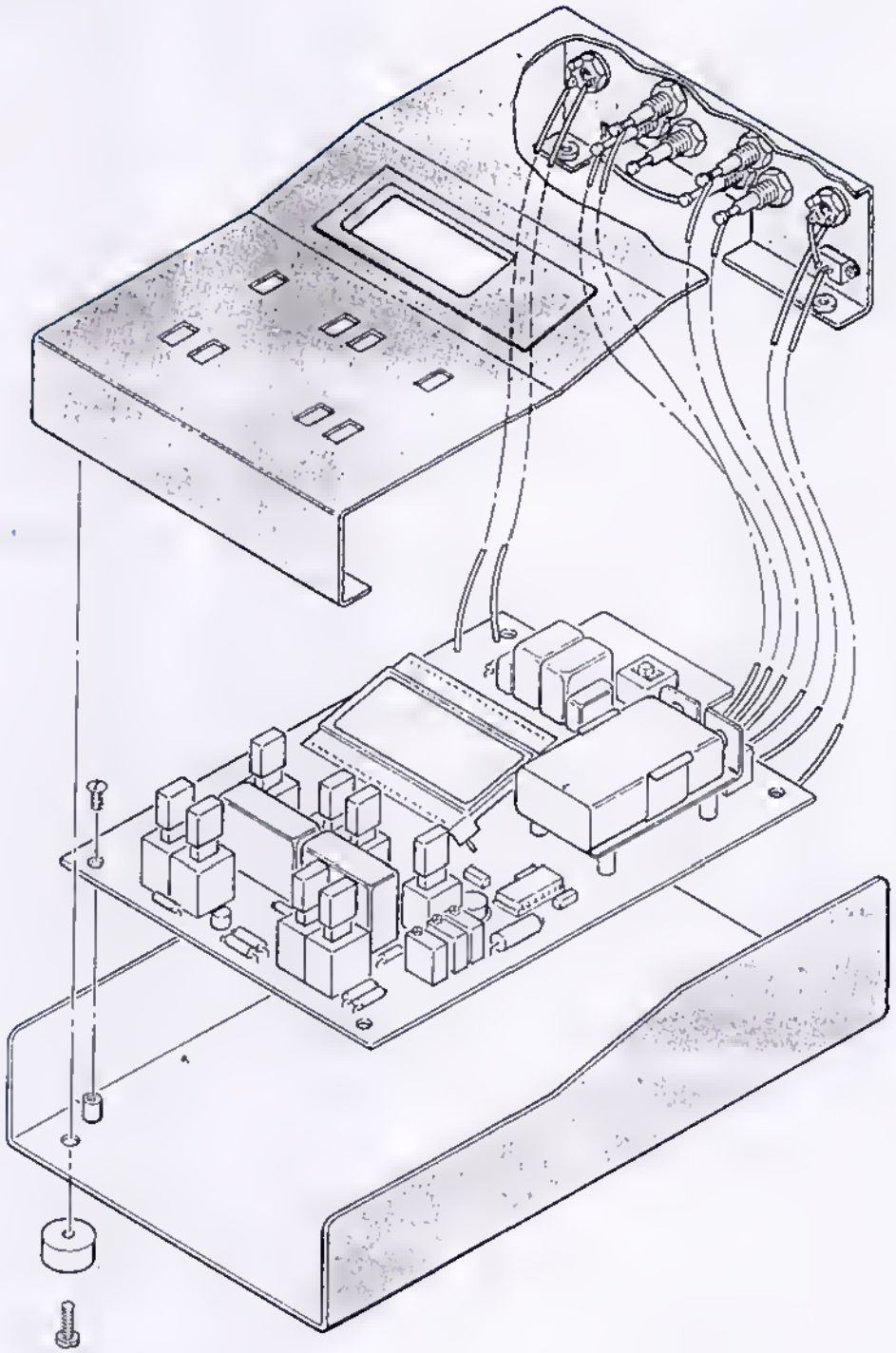


FIGURE 7-1. ASSEMBLY/DISASSEMBLY OF MODEL 44/88XL.

c. DISPLAY CHECKOUT

1. With POWER on, attach a test lead to the V+ terminal on the battery. Momentarily touch the other end to pin 37 of U1 (ICL7106). All segments should come on, exclusive of LO BAT and the decimal points. If segments fade away, then recheck battery condition. Otherwise, suspect U1. Disconnect clip from V+.

2. Step through the four settings of the FULL SCALE RANGE SELECT. Decimal point should appear at position corresponding to the range selection. If problems, suspect LCD, U2, and S2.

3. Attach one end of test lead to the righthand side of R17. Momentarily touch other end to pin 37 of U1. LO BAT display should appear on LCD. If not, suspect Q2. Disconnect clip from R17.

d. MICROWATTS REFERENCE ADJUSTMENT

1. With POWER off, remove all external connections to the instrument.

2. Connect voltmeter to instrument with positive (red) lead attached to P2-1 and negative (black) lead to ground at P2-2 or P2-4.

3. Turn POWER on and set controls to MICROWATTS CALIBRATION UNITS and 1.999 FULL SCALE RANGE SELECT.

4. Adjust trimpot R54 for voltmeter reading of 1.000VDC. Then disconnect voltmeter leads from instrument.

5. Adjust trimpot R51 until LCD displays .000 .

6. Connect current source to SIG.IN sensor head connections. Make connections such that the SIGNAL (black) socket is positive with respect to the GROUND (green) socket.

7. Set current source to 1 microamp and adjust trimpot R54 so that LCD displays 1.000 . Disconnect test leads.

*e. NANOWATTS REFERENCE ADJUSTMENT (MODEL 88XL ONLY!)

1. Connect current source to SIG.IN sensor head connection so that the SIGNAL (black) socket is positive with respect to the GROUND (green) socket.

2. Set controls to NANOWATTS CALIBRATION UNITS and 1.999 FULL SCALE RANGE SELECT.

3. Set current source to 1 nanoamp. Adjust R53 until LCD displays 1.000 .

4. Set controls to 19.99 FULL SCALE RANGE SELECT. Set current source to 10 nanoamps. Adjust R52 until LCD displays 10.00 .

5. Set controls to 199.9 FULL SCALE RANGE SELECT. Set current source to 100 nanoamps. Adjust R56 until LCD displays 100.0 .

6. Disconnect all test leads from instrument.

*f. OP AMP CURRENT OFFSET ADJUSTMENT (MODEL 88XL ONLY!)

1. Set controls for NANOWATTS CALIBRATION UNITS and 1.999 FULL SCALE RANGE SELECT.

2. Adjust R55 until LCD displays .000 . Repeat Procedure E - NANOAMPS REFERENCE ADJUSTMENT.

3. If any adjustment in step 2 required major correction, then go to step 2. Otherwise, calibration is completed and proceed to Procedure G.

*g. PERFORMANCE VERIFICATION

1. If all adjustments have been made properly, repeat the procedures given in Section 7-3. If problems persist, contact your local PHOTODYNE field representative or PHOTODYNE headquarters directly as directed in the inside front cover of this manual.

SECTION 8. REPLACEABLE PARTS

8-1. GENERAL

This section contains information for ordering replacement parts. The parts list is arranged in alphanumeric order of circuit designations.

8-2. ORDERING INFORMATION

To place an order or to obtain information concerning replacement parts, contact your local Photodyne representative or the factory. See the inside front cover of the manual for addresses. When ordering, include the following information:

a. Instrument Model Number

b. Instrument Serial Number

c. Parts Description

d. Photodyne Stock Part Number

8-3. SCHEMATICS

As noted on the inside back cover, there are two distinct versions of the printed circuit boards for the Model 44XL and 88XL. Figures 8-1 and 8-2 refer to versions B-C. Figures D-E correspond to Figures 8-3 and 8-4.

NOTE

An asterisk appears next to any component that deleted on the Model 44XL Optical Power Meter. Other changes are noted on the schematic diagram.

BATTERY AND HOLDER

Circuit Designation	Description	Quantity	Photodyne Part No.
---	9V Rechargeable Ni-Cd	(1)	6010-CH22
---	Battery Holder Assembly	(1)	6090-1291-1

CAPACITORS

Circuit Designation	Description	Quantity	Photodyne Part No.
C1*	.1 uf Ceramic DIP, 50V, 5%	(1)	0000-DIP-104-50V
C2	100 uf, Electrolytic	(1)	0030-RAD-107-10V
C3*	.01 uf Ceramic DIP, 50V, 5%	(1)	0000-DIP-103-50V
C4	10 uf, Electrolytic	(1)	0030-RAD-106-25V
C5	1 uf, Electrolytic	(1)	0030-RAD-105-50V
C6*	.001 uf Ceramic DIP, 50V, 5%	(1)	0000-DIP-102-50V
C7	.1 uf Ceramic DIP, 50V, 5%	(1)	0000-DIP-104-50V
C8 (Ver. E)	1 uf Polyester, 100V, 10%	(1)	0020-MMKO-105-100V
C9	1 uf Polyester, 100V, 10%	(1)	0020-MMKO-105-100V
C10	1 uf Polyester, 100V, 10%	(1)	0020-MMKO-105-100V
C11	.1 uf Polyester, 100V, 10%	(1)	0020-MMKO-104-100V
C12	.22 uf Polyester, 100V, 10%	(1)	0020-MMKO-224-100V
C13	.1 uf Polyester, 100V, 10%	(1)	0020-MMKO-104-100V
C14	.1 uf Polyester, 100V, 10%	(1)	0020-MMKO-104-100V
C15	100 pf Ceramic DIP, 50V, 5%	(1)	0000-DIP-101-50V
C16	.001 Ceramic DIP, 50V, 5%	(1)	0000-DIP-102-50V
C17 (Ver. E)	1 uf Polyester, 100V, 10%	(1)	0020-MMKO-105-100V
C18	1000pf Ceramic DIP, 50V, 5%	(1)	0000-DIP-102-50V
C19 (Ver. E)	10 uf Electrolytic	(1)	0030-RAD-106-25V

CONNECTORS

Circuit Designation	Description	Quantity	Photodyne Part No.
J1	Minature Phone Socket	(1)	4130-482
J2	Minature Banana Socket-Black	(1)	4110-1459-BL
J3	Minature Banana Socket-Green	(1)	4110-1459-GR
J4	Minature Banana Socket-Red	(1)	4110-1459-RD
---	8-Pin DIP Solder Socket	(1)	4220-US2-8
---	14-Pin DIP Solder Socket	(1)	4220-US2-14
---	40-Pin DIP Solder Socket	(1)	4220-US2-40
---	20-Pin SIP WW Socket-1W	(1)	4310-ME2-20-1W
---	20-Pin SIP WW Socket-3W	(1)	4310-ME2-20-W

DISPLAY

Circuit Designation	Description	Quantity	Photodyne Part No.
LCD	3½ Digit Transflective LCD	(1)	2090-FEO203 E-1
LAMP	12V @ 40 MA Bulb	(1)	2000-2174-D

OPERATIONAL AMPLIFIERS

Circuit Designation	Description	Quantity	Photodyne Part No.
OP1	Single BIMOS Op Amp	(1)	1000-CA3130
or OP1 (Ver. E)	Single CAZ Op Amp	(1)	1000-ICL7600

PACKAGING HARDWARE

Circuit Designation	Description	Quantity	Photodyne Part No.
---	2-56 RH Screw - 1/4" L	(4)	5000-256-A4
---	4-40 RH Screw - 3/16" L	(5)	5000-440-A3
---	Solder Lug Washer	(1)	4800-1468
---	Flat Insulating Washer	(1)	5290-3134
---	Extruded Insulating Washer	(1)	5290-4711
---	Rubber Feet w/screws	(4)	5440-2473
---	Model 88XL PC Board	(1)	5800-P-1088
---	88XL Enclosure - Top	(1)	5900-L-1088
---	88XL Enclosure - Bottom	(1)	5900-L-2022
---	88XL Display Bezel	(1)	5900-L-3044

TRANSISTORS

Circuit Designation	Description	Quantity	Photodyne Part No.
Q1	General Purpose - NPN	(1)	0400-2N3904

RESISTORS

Circuit Designation	Description	Quantity	Photodyne Part No.
R1*	1MEG, 1/4W, .05%, Wirewound	(1)	0110-MO7-1004
R2	1K, 1/4W, .05%, Wirewound	(1)	0110-MO7-1001
R3*	9MEG, 1/2W, 5%, Metal Oxide	(1)	0130-MOX401-905

RESISTORS (Continued)

Circuit Designation	Description	Quantity	Photodyne Part No.
R4	10K, 1/2W, 5%, Wirewound	(1)	0110-MO7-1002
R5	100K, 1/4W, .05%, Wirewound	(1)	0110-MO7-1003
R6*	90MEG, 1/2W, 5%, Metal Oxide	(1)	0130-MOX401-906
R7	1MEG, 1/4W, .05%, Wirewound	(1)	0110-MO7-1004
R8*	900MEG, 1/2W, 5%, Metal Oxide	(1)	0130-MOX401-907
R9*	900MEG, 1/2W, 5%, Metal Oxide	(1)	0130-MOX401-907
R10	49.9, 1/8W, 1%, Metal Film	(1)	0120-RN55-49R9
R13	100K, 1/8W, 1%, Metal Film	(1)	0120-RN55-1003
R16	100K, 1/4W, .05%, Wirewound	(1)	0110-MO7-1003
R17	68.1K, 1/8W, 1%, Metal Film	(1)	0120-RN55-6812
R18	1MEG, 1/8W, 1%, Metal Film	(1)	0120-RN60-1004
R19	1MEG, 1/8W, 1%, Metal Film	(1)	0120-RN60-1004
R20	255K, 1/8W, 1%, Metal Film	(1)	0120-RN55-2553
R21	100K, 1/8W, 1%, Metal Film	(1)	0120-RN55-1003
R22*	499K, 1/8W, 1%, Metal Film	(1)	0120-RN60-4993
R23	1MEG, 1/8W, 1% Metal Film	(1)	0120-RN60-1004
R24	1MEG, 1/8W, 1%, Metal Film	(1)	0120-RN60-1004
R25	1MEG, 1/8W, 1%, Metal Film	(1)	0120-RN60-1004
R26 (F1)	10.0, 1/8W, 1%, Metal Film	(1)	0120-RN55-10R0
R51 (VER.C)	10K, Cermet Trimpot, Side-turn	(1)	0210-850X-103
R52*	100K, Cermet Trimpot, Top-turn	(1)	0210-850W-104
R53*	100K, Cermet Trimpot, Top-turn	(1)	0210-850W-104
R54	2K, Cermet Trimpot, Top-turn	(1)	0210-850W-202
R55*	10K, Cermet Trimpot, Side-turn	(1)	0210-850X-103
R56*	100K, Cermet Trimpot, Top-turn	(1)	0210-850W-104

SWITCHES AND KNOBS

Circuit Designation	Description	Quantity	Photodyne Part No.
S1*	MPS Interlocked DPDT-2 station	(1)	3000-K4045-2
S2	MPS Interlocked DPDT-4 station	(1)	3000-K4045-4
S3	MPS SPST Momentary	(1)	3000-K4011-1
S4	MPS SPDT Push-Push	(1)	3000-K4032-1
S5	MPS SPDT Push-Push	(1)	3000-K4032-1
S6	MPS SPDT Push-Push	(1)	3000-K4032-1

SWITCHES AND KNOBS (Continued)

Circuit Designation	Description	Quantity	Photodyne Part No.
---	MPS Black Pushbutton	(7)	3090-B300-BL
---	MPS Green Pushbutton	(1)	3090-B300-GR
---	MPS Red Pushbutton	(2)	3090-B300-RD

INTEGRATED CIRCUITS

Circuit Designation	Description	Quantity	Photodyne Part No.
U1	A/D Converter and Display Driver	(1)	1100-ICL7106
U2	Cmos-Quad EX-OR Gates	(1)	1510-CD4030

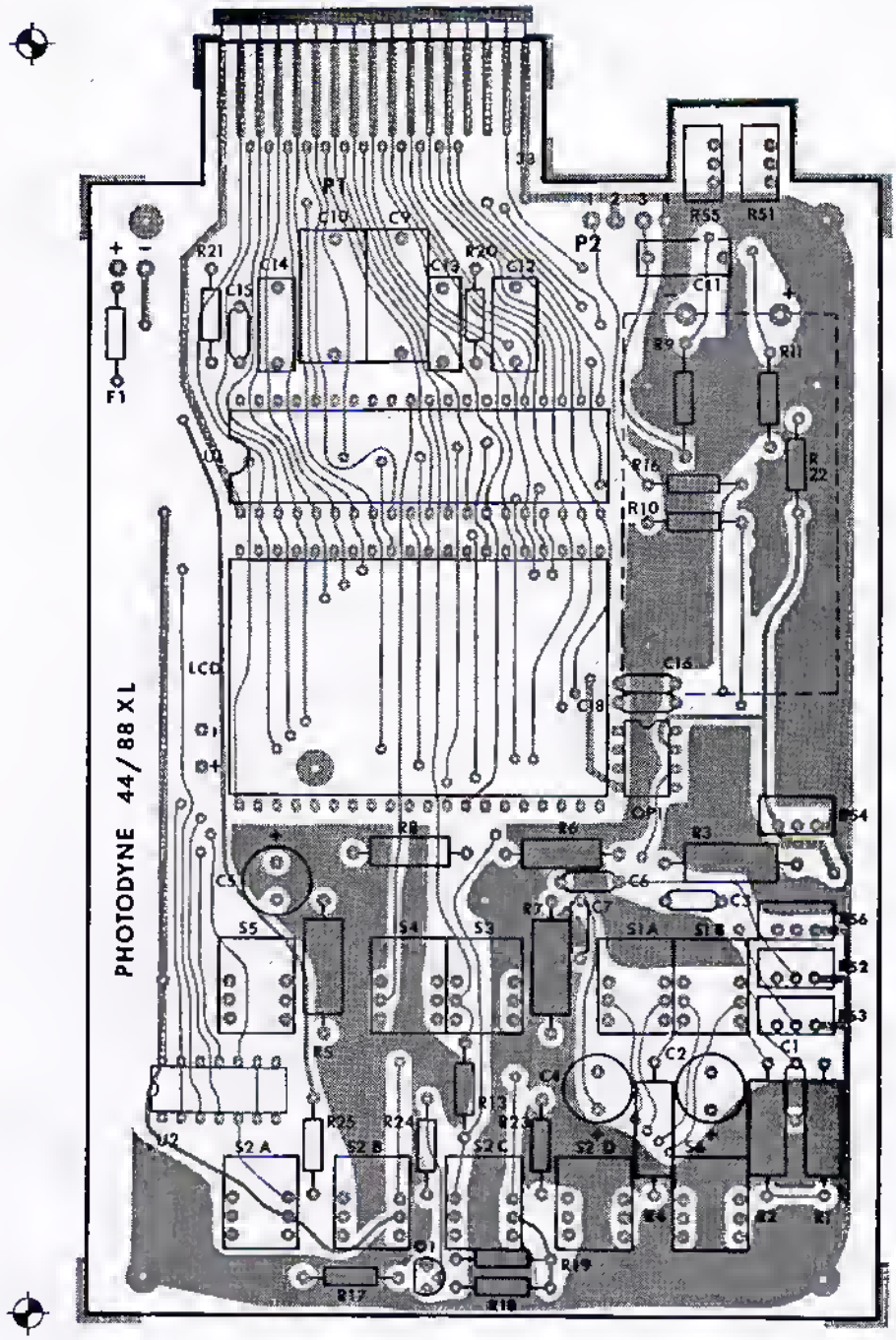
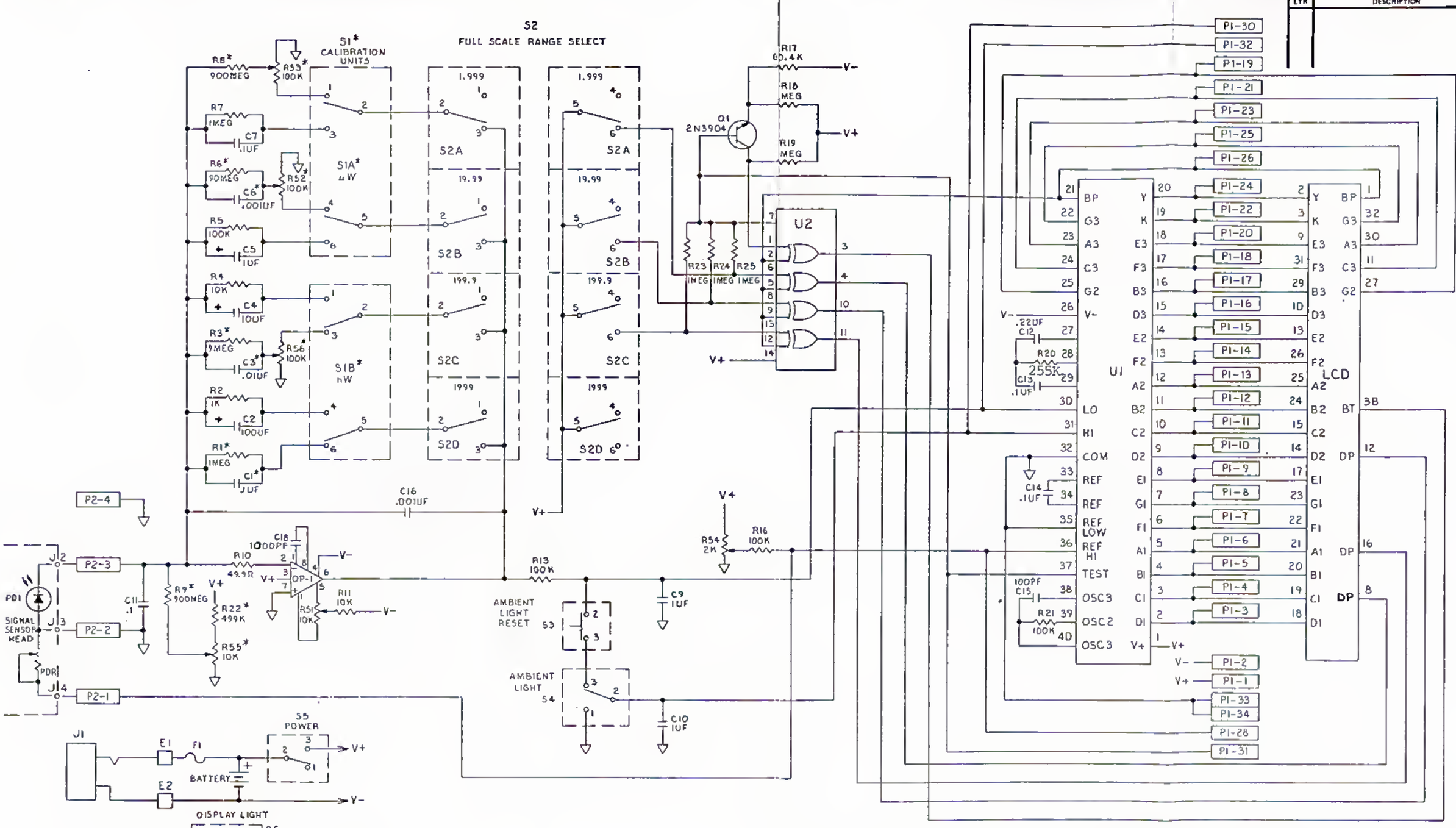


FIGURE 8-2. DIAGRAM OF COMPONENT LAYOUT ON PC BOARD.
VERSION "B"

REVISIONS			
LTR	DESCRIPTION	APPROVED	DATE



4 THE FOLLOWING SHORTS APPEAR ON THE 44XL:
S1A 2→3 5→6.
S1B 1→2 4→5.
3 ASTERISKS DENOTE COMPONENTS DELETED ON 44XL.
2 SWITCHES: 2→1, 5→4 WHEN IN
2→3 5→6 WHEN OUT.
1. PDI AND PDR ARE NOT ON BOARD.
NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ±.03 .XXX ±.010 ANGLES ±30'	DR BY	S. HUSTING	3-3079
	CHK BY		
	APPROVED BY		
DO NOT SCALE PRINT	NEXT USING DRAWING		

PHOTODYNE

TITLE LOGIC DIAGRAM
44/88XL RADIOMETER

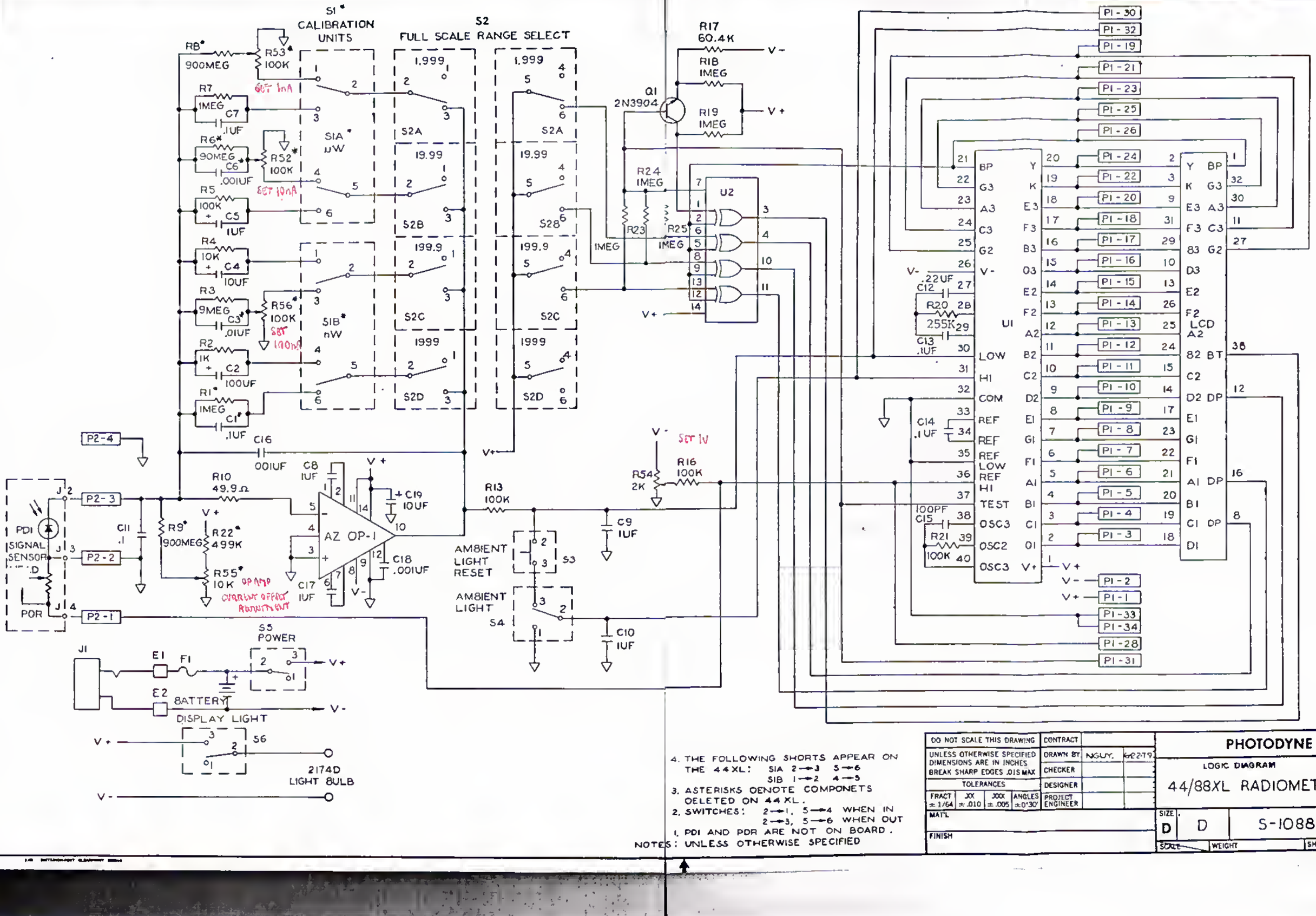
CODE IDENT NO	SIZE	IDENT NO
	D	S-1088-B

SCALE — SHEET 1 OF 1

8	7	6	5	4	3	2	1

REVISIONS

ZONE LTR	DESCRIPTION	DATE	APPR



NOTES: UNLESS OTHERWISE SPECIFIED

1. PDI AND PDR ARE NOT ON BOARD.
2. SWITCHES: 2→1, 5→4 WHEN IN
   2→3, 5→6 WHEN OUT
3. ASTERISKS DENOTE COMPONETS DELETED ON 44XL.
4. THE FOLLOWING SHORTS APPEAR ON THE 44XL: S1A 2→3 5→6
   S1B 1→2 4→5

DO NOT SCALE THIS DRAWING	CONTRACT		
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES BREAK SHARP EDGES .015 MAX	DRAWN BY	NGUY.	6-22-79
	CHECKER		
TOLERANCES	DESIGNER		
FRACT ± 1/64 | XX ± .010 | XXX ± .005 | ANGLES ±0°30'	PROJECT ENGINEER		
MAT'L			
FINISH			

PHOTODYNE

LOGIC DIAGRAM

44/88XL RADIOMETER

SIZE D | D | S-1088-E

SCALE | WEIGHT | SHEET 1 OF

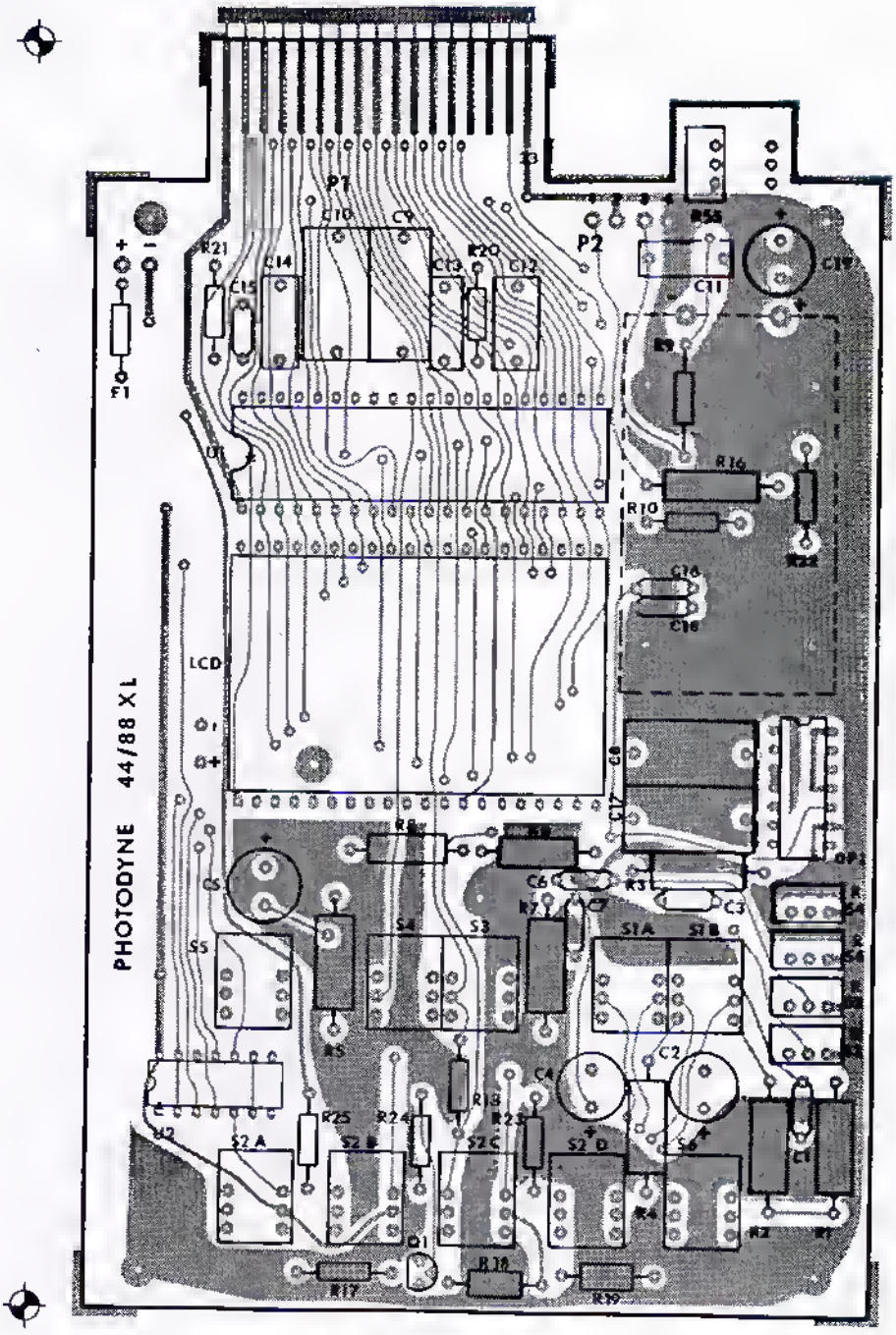


FIGURE 8-4. DIAGRAM OF COMPONENT LAYOUT ON PC BOARD. VERSION "E"

PHOTODYNE INC.
5356 Sterling Center Drive,
Westlake Village, California 91361,
Phone: (213) 889-8770 Telex 18-1159

DATE _____

RMA NO. _____

SERVICE FORM

MODEL NO. _____ SERIAL NO. _____ P.O. NO. _____

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

PHONE NO. ( ) _____ EXTENSION _____

(1) Describe problem and symptoms using quantitative data whenever possible (enclose readings, chart recordings,etc)
_____
_____
_____ (Attach Additional Sheets)

(2) Show a block diagram of your measurement system including all instruments connected (whether power is turned on or or not). Also describe the signal source.

(3) List the positions of all controls and switches on both front and rear panels of the instrument. _____
_____
_____

(4) Describe input signal levels, frequencies, etc. _____
_____
_____

(5) List and describe all cables used in the experiment (length, shielding, etc.). _____
_____

(6) List and describe all other equipment used in the experiment. Give control settings for each. _____
_____
_____

(7) Environment:
Where is measurement being performed? _____
What power line voltage is used? _____
Ambient temperature? _____
°F Variation? _____ °F Rel. Humidity _____
Other _____

(8) Additional information. _____
_____

IMPORTANT NOTICE!!

DUE TO IMPROVEMENTS AND CHANGES IN DESIGN, DISTINCT VERSIONS OF THE MODEL 44XL AND 88XL EXIST. THESE CAN BE DISTINGUISHED BY THE SERIAL NUMBER ETCHED ON THE BOTTOM OF THE PRINTED CIRCUIT BOARD AS "8304-#" WHERE "#" INDICATES THE MODIFICATION CODE. ALL VERSIONS B-C ARE DOCUMENTED BY THE SCHEMATIC AND COMPONENT LAYOUT GIVEN IN FIGURES 8-1 AND 8-2. VERSIONS D-E ARE DOCUMENTED BY FIGURES 8-3 AND 8-4. THE PARTS LIST IN SECTION 8 IS COMPLETE FOR ALL VERSIONS, WHEREAS PARTS UNIQUE TO A PARTICULAR VERSION ARE DESIGNATED AS SUCH.

FURTHER NOTE THAT ALL REFERENCES TO THE VOLTAGE OFFSET ADJUSTMENT AND R51 (ZEROING AND CALIBRATION PROCEDURES) ARE TO BE DISREGARDED FOR VERSIONS D-E FOR BOTH THE MODEL 44XL AND 88XL.

PHOTODYNE INC.
1175 Tourmaline Drive
Newbury Park, California 91320
Phone: (818) 889-8770 Telex: 18-1159