

MEDICAL ELECTRONICS P.N.H. RX10/4/92.
PALMISTON NORTH S/n 58597 CAL'D
HOSPITAL.

DIGITAL ULTRASOUND WATTMETER
Model UW-II

OPERATOR'S MANUAL

NO SUPPORTED



BIO-TEK
INSTRUMENTS, INC.

BIO-TEK^R INSTRUMENTS

**DIGITAL ULTRASOUND WATTMETER
MODEL UW-II
OPERATOR'S MANUAL**

MANUAL PART NUMBER 8920008
FOR SERIAL NUMBERS 100 AND UP

REVISION B

APRIL 1989

BIO-TEK INSTRUMENTS, INC.
HIGHLAND PARK, BOX 998
WINOOSKI, VT 05404-0998 USA
802-655-4040
800-451-5172
800-242-4685 (SERVICE)
TELEX 94-0136 BIO TEK SHVT
FAX 802-655-7941

DOCUMENT REVISION RECORD

Revision, date, and section			Changes
No revision letter			Original version.
A	1/26/87		Manual rewritten.
B	4/16/89	Title Page	Added registered trademark symbol and new Service Department telephone number.
		Document Revision Record	Added registered trademark statement.

^R Bio-Tek is a registered trademark of Bio-Tek Instruments, Inc.

TABLE OF CONTENTS

Page	
0-2	DOCUMENT REVISION RECORD
0-3	TABLE OF CONTENTS
0-5	LIST OF FIGURES
0-5	LIST OF TABLES
0-7	INTRODUCTION TO THE MODEL UW-II OPERATOR'S MANUAL
1-1	1 MODEL UW-II GENERAL INFORMATION
1-1	1.1 Summary of Features
1-1	1.2 Applications
1-1	1.3 Therapeutic Use of Ultrasound
1-1	1.3.1 Definition of Ultrasound
1-2	1.3.2 Physiological Effects of Ultrasound Therapy
1-2	1.3.3 Patient Treatment with Therapeutic Ultrasound
2-1	2 MODEL UW-II DESCRIPTION
2-1	2.1 Model UW-II Specifications
2-1	2.2 Description and Location of Model UW-II Components
2-1	2.2.1 Top Panel
2-3	2.2.2 Back Panel
2-3	2.3 Accessories
2-5	2.4 Optional Accessories
2-5	2.5 Theory of Operation
2-5	2.5.1 Power Supply
2-6	2.5.2 Oscillator
2-7	2.5.3 Low-Pass Filter (2-Pole)
2-7	2.5.4 Reference Amplifier and Low-Pass Filter
2-7	2.5.5 Low-Pass Summing Amplifier
2-9	2.5.6 Display (LCD)
2-9	2.5.7 Linear Variable Differential Transformer (LVDT)
3-1	3 SAFETY, MAINTENANCE, STORAGE, SHIPPING, AND WARRANTY
3-1	3.1 Electrical Safety
3-1	3.2 Maintenance
3-1	3.2.1 Recalibration
3-2	3.2.2 Battery Replacement
3-2	3.2.3 Fluid Replacement (Tank Maintenance)

TABLE OF CONTENTS (CONTENTS)

Page		
3-3	3.3	Storage and Shipping
3-4	3.4	Warranty
4-1	4	INSTALLATION
4-1	4.1	Unpacking and Inspection
5-1	5	OPERATION
5-1	5.1	Overview
5-1	5.1.1	Operating Environment
5-1	5.1.2	Operating Precautions
5-1	5.1.3	Preparation of Deionized and Degassed Water (Coupling Medium)
5-2	5.2	Operating the Model UW-II
5-2	5.2.1	Systems Check
5-3	5.2.2	Ultrasound Power Measurements
5-3	5.2.2.1	Measurements Using Support Rings
5-4	5.2.2.2	Measurements Using the Universal Transducer Clamp Assembly
5-5	5.3	Ultrasound Unit Calibration
5-5	5.3.1	Recordkeeping
5-6	5.3.2	Calibration Using Discrete Values (Method I)
5-6	5.3.3	Calibration Using Exact Meter Settings (Method II)
6-1	6	MODEL UW-II CALIBRATION
6-1	6.1	Linear Variable Differential Transformer (LVDT)
6-1	6.2	Circuit Calibration
6-1	6.2.1	Internal Zero Adjust
6-1	6.2.2	Coarse Gain Adjust
6-2	6.2.3	Fine Gain Adjust
7-1	7	TROUBLESHOOTING
8-1	8	SCHEMATIC, COMPONENT LAYOUT, AND PARTS LISTS

LIST OF FIGURES

Page		
2-2	2.2.1-1	Model UW-II Top Panel
2-4	2.2.1-2	Model UW-II Universal Transducer Clamp Assembly

LIST OF TABLES

Page		
7-3	7-1	Troubleshooting the Model UW-II

INTRODUCTION TO THE MODEL UW-II OPERATOR'S MANUAL

This document is the operator's manual for the Bio-Tek Digital Ultrasound Wattmeter Model UW-II. It contains general information about the Model UW-II, a description of its components and instructions for its use. It does not contain instructions or documentation required to service the unit. **If a problem develops, the user should contact Bio-Tek at: 1-800-451-5172.** The user should never attempt to service the unit before consulting with Bio-Tek service personnel.

The objectives of this manual are to provide:

1. sufficient information about the design of the Model UW-II to enable the user to understand its use (Sections 1 and 2);
2. detailed guidance for maintaining, storing, and shipping the unit (Section 3);
3. procedures for setting up the Model UW-II (Section 4), for operating the unit (Section 5), for calibrating the unit (Section 6), and for troubleshooting (Section 7); and
4. a block diagram, schematics, component layouts, and parts lists (Section 8).

This page intentionally left blank.

1 MODEL UW-II GENERAL INFORMATION

1.1 Summary of Features

Bio-Tek's Digital Ultrasound Wattmeter Model UW-II was designed to calibrate and test the performance of therapeutic ultrasound devices. The Model UW-II:

1. has a resolution of 0.1 W and an accuracy of $\pm 10\%$ of readings from 0 — 30 W,
2. has a liquid crystal display that enables the user to quickly and accurately make power measurements,
3. accommodates a variety of transducer shapes and sizes without interfering with the measurement,
4. is permanently filled with a degassed antifreeze solution so that only a small amount of coupling medium is required to take measurements, and
5. is housed in a sturdy wooden case. The Model UW-II is extremely portable and therefore designed to meet the needs of service groups and biomedical engineers.

1.2 Applications

The Model UW-II provides an accurate means of verifying and calibrating the output of ultrasound devices. The Model UW-II measures output through a linear variable differential transformer (LVDT). After the initial output is verified, the Model UW-II is used to accurately calibrate the ultrasound unit under test according to National Bureau of Standards (NBS) requirements.

1.3 Therapeutic Use of Ultrasound

The therapeutic use of ultrasonic energy is accepted worldwide and most modern hospitals and clinics have ultrasound devices in their physical therapy departments. Ultrasound therapy is used primarily to treat sport-related injuries and is commonly used to treat circulatory disorders and rheumatic diseases of the musculoskeletal system and peripheral nerves. Ultrasound therapy is extremely effective in treating areas with much scar tissue.

1.3.1 Definition of Ultrasound

Human perception of sound waves is limited to frequencies of under 20,000 vibrations per second. Higher frequency vibrations of between 0.7 and 1.1 MHz are used for ultrasound therapy. (Most ultrasound equipment produce an output of approximately 1 MHz.)

An ultrasound unit produces electrical oscillations at a specified frequency that cause the transducer in the ultrasound applicator to generate sound waves. The resulting ultrasonic radiation is transmitted from the ultrasound applicator, or treatment head, through a coupling medium to the patient's tissue.

1.3.2 Physiological Effects of Ultrasound Therapy

It is well documented that ultrasound therapy heals because of thermal, mechanical, and chemical effects.*

The thermal effects include deep tissue heating at depths to 5 cm or more. The thermal effects of ultrasound differ from diathermy (the use of electrical impulses to produce generalized vasodilation) in that the ultrasound beam heats only a small tissue area that approximates the cross-section of the beam. This heating effect is concentrated in muscles, ligaments, nerves, bones, and where the ultrasound beam crosses from one type of tissue to another.

The mechanical effects are best described as *micromassage*, a deep stirring action within the tissue. The benefit of this action would be increased circulation to the damaged tissue. In addition, ultrasound is capable of separating collagen fibers from one another and of changing the tensile strength of tendons, thereby increasing their extensibility.

The physiological benefits from ultrasound therapy are numerous. Ultrasound therapy affects the peripheral nerves by chemically changing the conduction velocity (this has been shown clinically *in situ*). Ultrasound alters the diffusion of Na^+ and K^+ (sodium and potassium) across red blood cell membranes. Ultrasound can also remove some salt deposits from irritated tissues.

1.3.4 Patient Treatment with Therapeutic Ultrasound

The clinician working with ultrasound can ensure successful ultrasound treatment by assessing:

1. the physical condition of the patient,
2. the absorption coefficient of the tissue(s),
3. the energy output of the ultrasound unit (continuous and pulsed),
4. the massivity and location of the affected tissue, and
5. the spread pattern of the beam.

* Physical Agents for Physical Therapists, second edition, James E. Griffin and Terence Karselis, Charles C. Thomas Publishing Company, 1982.

The benefits of therapeutic ultrasound can be tremendous. The most essential assurance that the clinician can have is the verification that his or her ultrasound unit is producing the ultrasound energy for which it was designed. The Bio-Tek digital ultrasound wattmeter enables the clinician to accurately measure this output energy.

2 MODEL UW-II DESCRIPTION

2.1 Model UW-II Specifications

INPUT POWER LEVEL	0 — 30 W
INPUT FREQUENCY	0.5 — 2.0 MHz
RESOLUTION	0.1 W
ACCURACY	±10% of reading
ZERO SHIFT	manual null control provided
ACCEPTABLE TRANSDUCER SIZE	up to 3" (7.6 cm) diameter
OPERATING TEMPERATURE	10° — 30° C (50° — 86° F)
POWER REQUIREMENTS	two 9 V alkaline batteries (Duracell ^R MN1604 or equivalent)
Battery Life	50 h
Battery Test	<u>LOBAT</u> indicator is illuminated at 6.2 V ±0.5 V
DIMENSIONS	10.5" x 9" x 7.25" (26.7 cm x 22.9 cm x 18.4 cm)
WEIGHT	10 lbs (4.5 kg)
CASE	oak

2.2 Description and Location of Model UW-II Components

2.2.1 Top Panel

The top panel of the Model UW-II ultrasound wattmeter is shown in Figure 2.2.1-1. The wattmeter components are located and identified on the figure and described in the following list:

1. **Sight Glass:** Allows the operator to observe the fluid level in the wattmeter. The plug can be removed to vent the tank and to add fluid.

^R Duracell is a registered trademark of Duracell U. S. A.

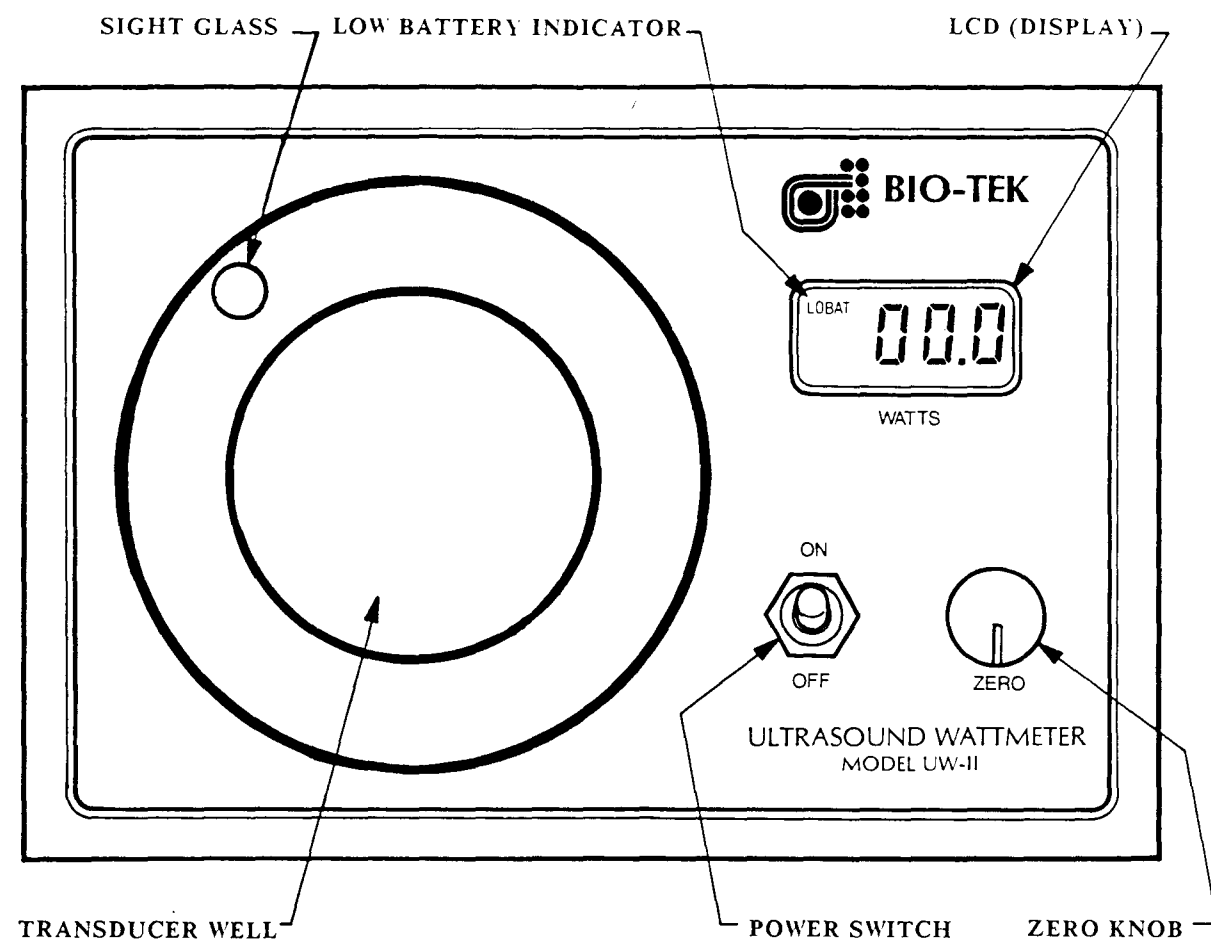
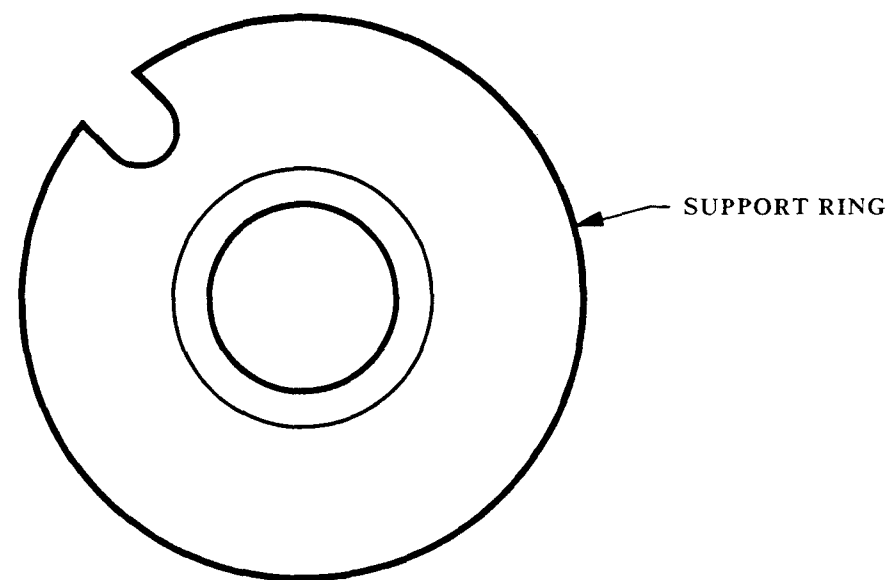


Figure 2.2.1-1. Model UW-II Top Panel



2. **LOBAT Indicator:** Illuminated when the batteries are low.
3. **LCD Display:** Indicates meter reading in watts.
4. **Transducer Well:** Is filled with a small amount of coupling medium (degassed and deionized water) and acts as a receptacle for the ultrasound transducer. **Must be used with appropriate support ring.**
5. **Power Switch:** Controls power provided by 2 alkaline batteries; toggles to **ON** and **OFF** positions.
6. **Zero Knob:** Adjusts the LCD display to 0.00 (the knob can be rotated in both directions for 10 rotations).
7. **Support Rings:** Support the ultrasound transducer in the transducer well (5 different ring sizes are provided with the Model UW-II to accommodate most transducer heads). The support ring provides the proper spacing between the wattmeter membrane and the transducer treatment head of the ultrasound unit. The support ring also provides stationary support of the treatment head and locates the treatment head over the center of the membrane measuring mechanism, thus ensuring repeatable results.
8. **Universal Transducer Clamp (Optional Equipment):** Holds most ultrasound transducer heads in position so that the operator's hands are free. In addition, the clamp performs the same functions as the support ring described in Item 7, preceding. Figure 2.2.1-2 shows the universal transducer clamp that can be ordered with the Model UW-II or ordered separately (refer to Section 2.4: Optional Accessories, to order the clamp).

2.2.2 Back Panel

The back panel of the Model UW-II houses the 2 batteries. Open the hinged plastic battery cover to expose the battery compartment when it is necessary to replace the batteries. Make sure that this cover is closed at all times except when replacing the batteries.

2.3 Accessories

1. **Support Rings:** The Model UW-II is provided with a set of 5 support rings. If the rings become lost or damaged, replacements can be ordered from Bio-Tek; please request Bio-Tek part number 8920016. Contact our customer service representatives at: 1-800-451-5172, TELEX: 94-0136 BIO TEK SHVT, or FAX 802-655-7941.
2. **Performance Record Labels:** The Model UW-II comes with a package of 100 UWR labels for recording wattmeter readings. When you need to reorder these labels, please request Bio-Tek part number 8920014 from our customer service representatives.

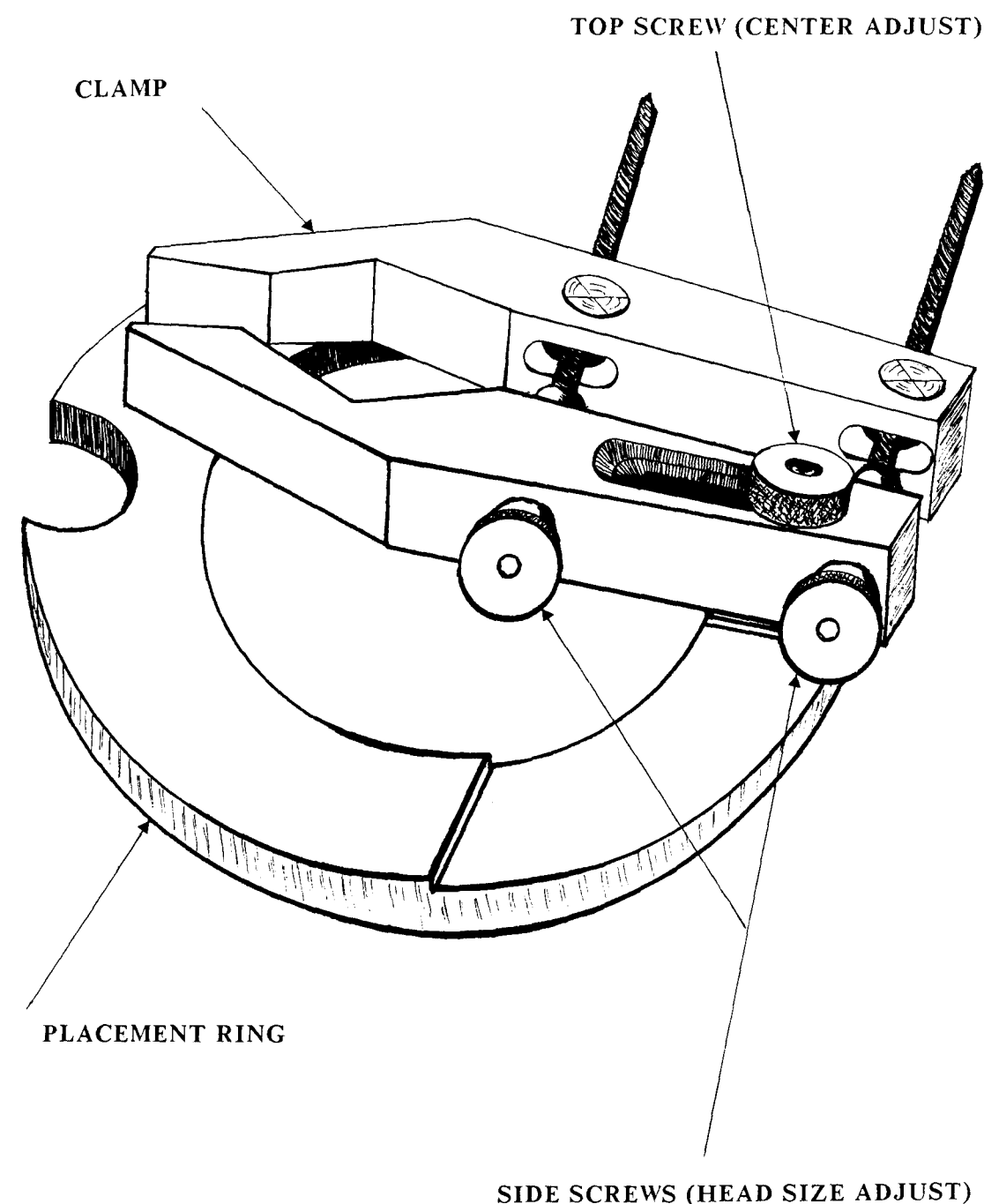


Figure 2.2.1-2. Model UW-II Universal Transducer Clamp Assembly

2.4 Optional Accessories

1. **Universal Transducer Clamp:** Bio-Tek has designed a universal transducer clamp to accommodate most transducer heads; the clamp frees the operator from holding the transducer head in the transducer well during testing. The universal transducer clamp can be ordered from our customer service representatives; please request Bio-Tek part number 8920061.
2. **Dissolved Oxygen Test Kit:** Kits to test the dissolved oxygen content of the degassed and deionized water are available from Bio-Tek; please request Bio-Tek part number 48102 from our customer service representatives.

2.5 Theory of Operation

The circuit power of the Model UW-II is provided by two 9V alkaline batteries. The wattmeter circuit consists of an oscillator and tuned filter that drives a linear variable differential transformer (LVDT). The LVDT measures the deflection of the spring-and-cone assembly in the fluid by means of a movable core. This deflection is a direct measurement of the ultrasonic energy applied to the cone. The LVDT output is differentially rectified and scaled in a summing amplifier to correspond to ultrasonic energy in watts. The output of the summing amplifier is monitored by a 3 1/2 digit ratiometric analog-to-digital (A/D) and liquid crystal display (LCD). The reference to the ratiometric A/D is obtained by monitoring the drive signal to the LVDT, thus ensuring that changes in drive voltage do not affect the reading on the LCD.

A 1.2 V reference is the basis for the ± 5 V used to power the A/D and the oscillator. In addition, this reference voltage is used to detect a low battery condition from either 9 V battery and to display LOBAT on the LCD.

Refer to Section 8: Schematics, Component Layouts, and Parts Lists, for the location of all components discussed the following sections. Section 7: Troubleshooting, provides the information necessary to repair electronic problems.

2.5.1 Power Supply

The standard power supply of the Model UW-II uses only the two 9 V alkaline batteries and has the following characteristics:

1. If the LVDT core is positioned in its normal operating range of ± 0.050 " (1.27 mm) from electrical center, the circuit should draw only 7 mA ± 2 mA from each battery. A fresh set of batteries should therefore provide at least 50 h of operation.
2. The 10 V zener diodes (CR14 & CR15) provide overvoltage protection to the circuit board if the battery common connection is lost.

3. AD589 (Q1) has a stable output voltage of $1.225 \text{ V} \pm 0.025 \text{ V}$ and provides a system reference voltage.
 1. It is this voltage that is used as the input to the inverting amplifier (U3, Pins 1 & 2) with a gain of 4 to provide the -5 VDC for the A/D; the voltage should be $-4.9 \text{ V} \pm 0.3 \text{ VDC}$ on TP6.
 2. Another inverting amplifier with a gain of 1 provides the +5 VDC for the A/D and the oscillator; the voltage should be $+4.9 \text{ V} \pm 0.4 \text{ VDC}$ on TP5 (U3, Pin 14).
 3. The LOBAT detector is also referenced to AD589 (the 1.23 V reference) and monitors both the +9 V and -9 V batteries. The biasing on the comparators is scaled to trip at $6.2 \text{ V} \pm 0.5 \text{ V}$ as the battery voltage drops and will reset at $7 \text{ V} \pm 0.5 \text{ V}$ as the battery voltage rises. The wattmeter accuracy does not degrade until the battery voltage drops below 5.5 V.

2.5.2 Oscillator

The oscillator is a CMOS 4536 chip (U5) that has external components to complete the clock. The oscillator has the following characteristics:

1. The frequency is inversely proportional to the cap value on Pin 4 and the resistor value on Pin 5 as calculated from the following equation:

$$F \cong \frac{1}{(2.15) (R) (C)}$$

where:

$$\begin{array}{llll} F & \cong & 1680 \text{ Hz} & = \text{frequency} \\ 2.15 & = & \text{constant} & \\ R & = & 59\text{K} & = \text{resistance (R1)} \\ C & = & 4700 \text{ pf} & = \text{capacitance (C1)} \end{array}$$

2. The resistor on Pin 3 completes the clock circuit and should be approximately 2.5 times the value of the resistor on Pin 5.
3. The frequency output on Pin 13 is half the oscillator frequency; therefore, a $4.8 \text{ V}_{\text{pp}} \pm 0.5 \text{ V}$ square wave of frequency $850 \text{ Hz} \pm 100 \text{ Hz}$ should appear on TP1.

2.5.3 Low-Pass Filter (2-Pole)

The square wave from the oscillator is rounded off by a low Q, 2-pole low-pass inverting filter with the following characteristics:

1. The Q is approximately 0.85 that provides a nearly constant voltage output over the oscillator frequency range where the cutoff frequency is approximately $800 \text{ Hz} \pm 100 \text{ Hz}$. The filter has a DC gain of 2.5.
2. The output of the filter drives the primary winding of the LVDT through a 10 ohm damping resistor (R7) and a DC blocking capacitor (C5). The LVDT primary is tuned to the capacitor for minimum power consumption at a frequency of 850 Hz.
3. With the core in its normal operating range of $\pm 0.050"$ (1.27 mm) from electrical center, the voltage at TP2 should be $2.5 \text{ V}_{\text{RMS}} \pm 0.4 \text{ V}$ at a frequency of $850 \text{ Hz} \pm 100 \text{ Hz}$. The voltage should appear somewhat sinusoidal; it will have flatter peaks than a true sinusoid because of the low-pass filter although the curve should not have any sharp steps.

2.5.4 Reference Amplifier and Low-Pass Filter

The LVDT primary excitation voltage is rectified and amplified by the reference amplifier that has the following characteristics:

1. The reference amplifier incorporates diode drop compensation in the feedback to minimize temperature effects caused by the voltage drop variation of the rectifying diode.
2. The output of the reference amplifier is approximately -2.28 VDC and provides the negative reference required to offset adjustments of the low-pass summing amplifier.
3. The negative reference signal described in Item 2, preceding, is also inverted and scaled in the low-pass filter to provide the $\pm 1 \text{ VDC}$ reference required for the radiometric A/D.

2.5.5 Low-Pass Summing Amplifier

The output of the LVDT is differentially rectified and summed by the low-pass summing amplifier with the following characteristics:

1. The gain in the low-pass summing amplifier circuit contains that scaling to match the spring constant of the cone assembly in the fluid and can be adjusted $\pm 20\%$ by the coarse gain adjust pot (R23). Specifically, the 3 resistors (denoted by R17, R20, & R21 on the schematic 890004-SC) are chosen to match the the spring constant.

1. **Feedback Resistor:** The feedback resistor (from the coarse gain adjust wiper to the amplifier input) is calculated as follows:

$$R_{FB} = \frac{40}{\alpha} \text{ ohms}$$

where:

$$\begin{aligned} R_{FB} &= \text{feedback resistor} \\ 40 &= \text{constant (inches x second}^2/\text{columns}^2) \\ \alpha &= \text{spring constant (inches/watt)} \end{aligned}$$

2. **Offset Resistors:** The resistors (from both zero adjust pot wipers to the amplifier input) are equal and are calculated as follows:

$$R_o = \frac{140}{\alpha} \text{ ohms}$$

where:

$$\begin{aligned} R_o &= \text{offset resistor} \\ 140 &= \text{constant (inches x second}^2/\text{columns}^2) \\ \alpha &= \text{spring constant (inches/watt).} \end{aligned}$$

This configuration will maintain the ± 7.5 W of adjustment on both zero adjust pots so that the required 30 W span will be centered around the electrical zero of the LVDT when both zero adjust pots are also centered.

2. The voltage on TP4 should be 0.15 ± 0.04 VDC with the LVDT at its electrical center and both zero adjust pots and the coarse gain adjust pot at the approximate center.
3. The voltage at TP4 should be 0 ± 0.05 VDC and the display should read 0 ± 5.0 W with the core moved 0.0075" (0.19 mm) away from electrical zero and towards the top of the LVDT with all 4 adjust pots approximately centered.
4. When the A/D functions properly, the display reading is as follows:

$$\text{Display Reading} = \frac{100(\text{TP4 voltage})}{\text{TP3 voltage}}$$

2.5.6 Display (LCD)

When the LCD is functioning properly and the LVDT core is moved slowly, all digits form complete numbers.

2.5.7 Linear Variable Differential Transformer (LVDT)

The LVDT is a Robinson-Halpern Model 225A-050 with the following characteristics:

1. The LVDT has an output voltage differential of $0.008 V_{RMS}$ per 0.001" (0.025 mm) of core displacement and for each volt of primary excitation.
2. The LVDT has a linear operating range of ± 0.050 " (1.27 mm) from the electrical center.

The electrical center can be located using the wattmeter circuit by jumping terminals 1 and 3 of the panel zero adjust pot together and adjusting the LVDT core position for a zero display.

3 SAFETY, MAINTENANCE, STORAGE, SHIPPING, AND WARRANTY

3.1 Electrical Safety

1. When using the Model UW-II to test ultrasound devices, follow the safety precautions specified by the ultrasound manufacturer.
2. **Do not use any coupling medium other than degassed and deionized water.**
3. Do not spill water on the front panel.
4. **Do not apply more than 30 W of input power to the Model UW-II.**
5. Do not operate the Model UW-II for more than 1 h during testing. Allow a minimum of 20 minutes between the hour-long tests.

3.2 Maintenance

The mechanical assembly of the wattmeter has no parts that can be serviced by the user. The unit should be returned to Bio-Tek for repair. The alignment and adjustment parameters are critical to the performance of the Model UW-II.

The electronics of the Model UW-II can be serviced by users knowledgeable in electronics repair. Refer to Section 2.5: Theory of Operation, Section 7: Troubleshooting, and Section 8: Schematics, Component Layouts, and Parts Lists, for the information necessary to repair the electronics.

For service, pack the Model UW-II according to the procedures provided in Section 3.3: Storage and Shipping; address the unit to:

Service Department
Bio-Tek Instruments, Inc.
Highland Park, Box 998
Winooski, VT 05404-0998

Please call 1-800-451-5172 if you have any questions on maintaining and servicing the Model UW-II.

3.2.1 Recalibration

We recommend that the Model UW-II be recalibrated annually. If the user does not have the equipment necessary for recalibration, return the unit to Bio-Tek and request calibration traceable to the FDA's Bureau of Radiological Health.

For recalibration, pack the Model UW-II according to the procedures provided in Section 3.3: Storage and Shipping, and address the box as in Section 3.2, preceding. For those who wish to recalibrate their own wattmeter, refer to Section 6: Calibration.

3.2.2 Battery Replacement

When **LOBAT** is indicated on the LCD of the Model UW-II, the 2 alkaline batteries (9 V Duracell MN 1604 or equivalent) must be replaced. Open the hinged plastic battery cover to expose the battery compartment, replace the 2 batteries, and close the battery cover.

3.2.3 Fluid Replacement (Tank Maintenance)

The sight glass of the Model UW-II is used to monitor the liquid level in the tank and it serves as a port for adding fluid to the tank, if necessary. The fluid tank is designed so there can be no air under the membrane if there is fluid present in the sight glass. (Air under the membrane will affect the accuracy of the Model UW-II readings.)

1. If no green fluid is visible in the sight glass, or if the transducer membrane is convex, air must be bled from the tank as follows:

1. Unplug the sight glass.

NOTE: Open the plug on the sight glass **only** when necessary for maintenance.

2. Press lightly on the transducer membrane to vent the fluid tank.

NOTE: Tapping on the side of the case will bring any air bubbles into the sight glass.

3. Tighten the plug when the sight glass is full of fluid.

NOTE: Tighten the plug as soon as possible to prevent air from entering the tank and increasing the oxygen content of the fluid.

2. If the sight glass does not fill with fluid, or if the transducer membrane touches the internal mechanism (the cone assembly), then add fluid to the tank as instructed in Step 3.
3. Obtain a fresh bottle of degassed and deionized water (prepared as in Section 5.1.3).
4. Remove the plug on the top of the sight glass.

5. Add enough degassed and deionized water through the sight glass to bring the fluid level to the top of the sight glass.
6. Replace the plug and tighten.
7. Tilt the Model UW-II so that the sight glass is the highest point of the tank. (This will cause any remaining air in the tank to be vented into the sight glass.)
8. If there is still air in the sight glass or if the transducer membrane is convex, repeat Steps 4 — 7, preceding. If there are no bubbles and the membrane is flat or *slightly* concave, then the fluid level is correct.

NOTE: Any air bubbles left in the tank will jeopardize the reliability of the Model UW-II when it is used for calibrating ultrasound devices. Any air bubbles left in the tank will increase the oxygen content of the fluid and adversely affect all wattmeter readings.

3.3 Storage and Shipping

STORAGE

The Model UW-II **must** be stored in an upright position. The Model UW-II should be stored on a flat surface that is relatively free of vibration. The storage environment should be free of dust and other foreign particles. The Model UW-II can be stored under the following environmental conditions:

1. temperature: 0° — 30° C (32° — 86° F), and
2. humidity: to 90% relative humidity.

NOTE: The Model UW-II should be protected from freezing because freezing can damage the measurement mechanism. When shipped from Bio-Tek, the fluid in the tank contains antifreeze and should not freeze until below -18° C (0° F). Users in cold climates should not leave the Model UW-II where the temperatures are below -18° C (0°).

The Model UW-II should be protected from temperature extremes that can cause condensation within the unit and from corrosive fumes and vapors.

The support rings or universal transducer clamp assembly **must** be removed from the unit during storage. The cover should always be closed and latched.

SHIPPING

When the Model UW-II is shipped to Bio-Tek for service or repair, the unit **must** be shipped in the original packing; other forms of commercially available packing are not recommended and can void the warranty. If the original packing has been damaged or lost, contact Bio-Tek for replacement packing (call: 800-451-5172, telex: 94-0136 BIO TEK SHVT, or FAX: 802-655-7941).

The Model UW-II must be repacked according to the following procedures:

1. Remove any support ring or the universal transducer clamp from the transducer well.
2. Close and latch the cover of the wattmeter.
3. Pack the Model UW-II in its original packing material and shipping box.

Before the Model UW-II is returned to Bio-Tek, make sure you have addressed each item in the following checklist:

1. Obtain a **Return Authorization Number** from Bio-Tek's customer service representatives (call: 800-451-5172, TELEX: 94-0136 BIO TEK SHVT, or FAX: 802-655-7941).
2. Include a statement of what is required of the Bio-Tek service department (state whether the unit requires calibration, cleaning, or repair).
3. Include a tag that specifies the return authorization number, the full model number, and the serial number.
4. Provide Bio-Tek with the name and telephone number of whom Bio-Tek should contact with any questions.
5. Insure the UW-II for full value.
6. Mark the shipping box as FRAGILE.

The Model UW-II can be shipped under the environmental conditions stated within this section under STORAGE.

3.4 Warranty

Bio-Tek warrants the Model UW-II to the original purchaser for a period of 1 year from the original purchase date. The warranty is for normal use and service, against defective materials or workmanship. If the customer ships the Model UW-II to

Bio-Tek, postage prepaid, and Bio-Tek determines the defect to be in materials or manufacturing, Bio-Tek shall either repair or replace the unit at Bio-Tek's option, without cost to the customer.

This warranty is void if the digital ultrasound wattmeter has been visibly damaged by accident, misuse, or has been repaired or altered by persons or stations not authorized by Bio-Tek, or has had the serial number altered, defaced, or removed.

Bio-Tek Instruments reserves the right to discontinue the Model UW-II at any time and to change the specifications, price, or design without notice and without incurring any obligation.

Bio-Tek will continue to stock service parts for up to 5 years after the manufacture of the unit has been discontinued. Parts shall include all materials, charts, instructions, diagrams, and accessories that are furnished with the unit.

The purchaser agrees to assume liability for any damages or bodily injury that may result from the use or misuse of the unit by the purchaser, his employees, or customers.

4 INSTALLATION

4.1 Unpacking and Inspection

When you receive the Model UW-II, inspect the shipping carton for damage. If the shipping carton is damaged, unpack the instrument and note any dents and scratches on the Model UW-II. **Immediately notify Bio-Tek that the Model UW-II was damaged in shipping.** Bio-Tek will arrange repair or replacement of your instrument without waiting for settlement of the claim against the carrier. **Retain the damaged shipping carton and packing material for the carrier's inspection.**

Save the box and packing material; they will be needed when you return the Model UW-II to Bio-Tek for recalibration or future service. (Refer to Section 3.3 for shipping instructions.)

Check the shipping carton for the following accessories that are shipped with every Model UW-II:

1. Model UW-II Operator's Manual (1),
2. warranty card (1),
3. FDA certificate of calibration (1),
4. support rings in a variety of sizes (5), and
5. calibration labels (100), Bio-Tek Form UWR.

The Model UW-II must be allowed to adjust to room temperature before operating.

5 OPERATION

5.1 Overview

When operated according to the instructions given in this section, the Bio-Tek Model UW-II digital ultrasound wattmeter will quickly and accurately measure the energy output of ultrasound devices.

5.1.1 Operating Environment

The Model UW-II must be allowed to adjust to room temperature before the unit can be operated. The relative humidity in the room should not exceed 90%.

5.1.2 Operating Precautions

Refer to Section 3.1: Electrical Safety and Section 3.3: Storage and Shipping, to ensure safe, reliable operation of the Model UW-II.

5.1.3 Preparation of Deionized and Degassed Water (Coupling Medium)

Deionized and degassed water should be used as the coupling medium to obtain stable and accurate readings with the Model UW-II Digital Ultrasound Wattmeter. Use the following procedure to obtain the best coupling medium:

1. Use a deionizer to deionize tap water or distilled water. The deionizer must:
 1. have a minimum purity capability of 50,000 ohms/cm, and
 2. use a cartridge for anion and cation removal with a typical resistivity of 2,000,000 ohm-cm in the pH range of 6.8 to 7.2.
2. Ensure that at least 3 l of deionized water drains through the system before collecting the water in a clean inert container. (This ensures that there is no contamination from the tubes, hoses, and container used.)
3. Boil the deionized water for 30 minutes in a clean glass flask; this forces the oxygen from the water. The water should actually boil for 30 minutes to remove all of the dissolved gases.
4. Select some small glass bottles with good seals for storing the water.
5. Siphon the boiling degassed water into the bottles and fill each bottle to the brim. **Leave no air space in the bottle.**

6. Cap the bottles immediately.
7. Allow the water to cool in the bottles. As the water cools, it will contract and a vacuum will be formed if the bottles have been properly sealed. Allow the water to cool to room temperature.
8. Label and date each bottle.

NOTE: The Bureau of Radiological Health of the FDA recommends that degassed water be disposed of after two weeks.

9. Test the bottles for oxygen content when they are to be used. The oxygen content should be less than 2 ppm. Dissolved oxygen test kits are available from Bio-Tek; please request Bio-Tek part number 48102 when ordering these kits.

NOTE: When the bottle is opened and exposed to air, it can be used during the following 45 minutes. Exposure to air makes this water lose its excellent coupling property; therefore, the bottles should not be opened until tests with the Model UW-II are ready to begin.

5.2 Operating the Model UW-II

Refer to Figure 2.2.1-1 for the location and description of the top panel of the Model UW-II.

5.2.1 Systems Check

1. Allow the Model UW-II to adjust to room temperature.
2. Open the unit.
3. Inspect the transducer well membrane; it should be flat or slightly concave. If the membrane is convex, refer to Section 3.2.3.
4. Inspect the sight glass; a green liquid should be visible. If the liquid is visible, continue to the next Step 5; if not, refer to Section 3.2.3.
5. Turn the power switch ON; the LCD display should be lit. If LOBAT appears, refer to Section 3.2.2.

5.2.2 Ultrasound Power Measurements

5.2.2.1 Measurements Using Support Rings

1. Prior to testing, rinse the transducer well of the Model UW-II to remove any foreign particles.
2. Use a bottle of the deionized and degassed water prepared following the procedures in Section 5.1.3.
3. Open a bottle of the degassed and deionized water. When the vacuum seal is broken you should be able to hear it.
4. Use a dissolved oxygen test kit to ensure that the oxygen content of the water is less than 2 ppm.
5. Add approximately 55 ml of the deionized and degassed water to the left side of the transducer well (as you are facing the Model UW-II). **Do not spill water of the panel of the wattmeter.**
6. Replace the cap on the coupling water immediately following use.
7. Turn the Model UW-II ON using the toggle switch on the top panel.
8. Adjust the digital reading to 0.00 by rotating the ZERO adjustment knob. (If the unit cannot be adjusted, refer to Section 7: Troubleshooting.
9. If one of the 5 support rings is to be used for testing, proceed to the following Step 10; if the universal transducer clamp is to be used, refer to Section 5.2.2.1.
10. Select the support ring that best accommodates the ultrasound transducer head. Place the ring in the transducer well taking care not to splash the coupling water onto the Model UW-II top panel.
11. Place the transducer on the support ring with the treatment head facing directly downward. The transducer head should be completely coupled with the deionized and degassed water and there should be no bubbles beneath the radiating head of the transducer.

NOTE: The support ring fits in the well only one way as it clears the sight glass.

NOTE: The coupling water in the transducer well must be changed every 15 minutes or when readings become unstable. A bottle of opened deionized and degassed water will be usable for approximately 45 minutes if it is re-capped after every use.

12. Turn on the ultrasound unit following the manufacturer's instructions. Adjust the ultrasound unit to the desired level.
13. Read the actual output power in WATTS on the LCD of the Model UW-II.

CAUTION

It is extremely important to minimize the total ultrasonic energy entering the Model UW-II wattmeter. Avoid extended application of this energy to the

wattmeter; 2 — 3 minutes of ultrasonic energy suffices to completely calibrate the ultrasound unit. The power to the ultrasound unit should be shut OFF after this 2 — 3 minutes.

14. If the ultrasound unit is to be calibrated, proceed to Section 5.2.3 for more specific instructions on calibration methods using the Model UW-II.
15. Remove the water from the transducer well when measurements are complete. Completely dry the well with a soft, clean cloth. **Water should not be left in the transducer well for more than 8 hours to prevent the accumulation of foreign matter and bacterial growth.**
16. Shut OFF the ultrasound unit.
17. Shut OFF the Model UW-II. Close and latch the cover.
18. Dispose of any water left in the opened bottle at the end of the day. The opened bottle of degassed and deionized water will absorb oxygen during the night and therefore be useless the next day.

5.2.2.2 Measurements Using the Universal Transducer Clamp Assembly

The universal transducer clamp assembly (see Figure 2.2.1-1) frees the operator from holding the transducer treatment (radiating) head in the coupling water.

NOTE: When the universal transducer clamp assembly is used alone, some of the reading accuracy may be compromised (up to 1 W). Whenever possible, a support ring should be used in conjunction with the clamp assembly to ensure optimal ultrasound treatment head placement and wattmeter accuracy.

1. Ensure that the transducer clamp assembly is clean before placing it in the coupling water. Wet a soft, clean cloth with some of the coupling water and wipe the entire assembly. Lightly dry the assembly with another soft, clean cloth.
2. If a support ring is to be used with the clamp assembly, place the ring in the transducer well.

3. Place the transducer clamp assembly in the transducer well containing the coupling water. **Do not splash water on the Model UW-II.** The assembly is designed so that the slot on the assembly placement ring clears the sight glass on the wattmeter.

NOTE: If the clamp interferes with the ON/OFF toggle switch or the sight glass of the wattmeter, loosen the top screw on the assembly and rotate the clamp so that it clears the switch and the sight glass.

4. Loosen the top screw of the assembly (loosen so that clamp rotation is easy) and roughly center the clamp opening with the transducer well.
5. Open the clamp by turning the 2 side screws counterclockwise to fit the desired transducer head or handle. (Typically, both arms of the clamp should be opened equally, although some applications may require differing arm positions.)
6. Tighten the 2 side screws to effectively grab the transducer head or handle. Make sure that the transducer radiating head (or crystal) remains completely submerged in the coupling water.
7. Re-center the clamp holding the transducer head directly over the middle of the transducer well for accurate readings.

NOTE: This can be done by carefully lifting the entire transducer clamp assembly up and out of the transducer well, orienting the entire assembly to the desired position, and carefully replacing the assembly in the transducer well.

8. Refer to the preceding Section 5.2.2, Step 11, to continue ultrasound testing.
9. Remove the transducer clamp assembly before emptying the water in the transducer well and closing the wattmeter cover.

NOTE: Do not transport the wattmeter with the transducer clamp assembly within the unit. Damage to the unit will result and the warranty will be void.

5.3 Ultrasound Unit Calibration

5.3.1 Recordkeeping

Use the performance record labels (Form UWR) that are supplied with the Model UW-II (see Figure 5.3.1-1a) for recordkeeping during testing. Refer to Section 2.3: Accessories, for part numbers and ordering instructions for these labels.

NOTE: The test labels have a light adhesive that allows the label to be affixed to the ultrasound unit being tested. When the test is complete, the label can be easily removed from the unit and another label affixed for further testing.

5.3.2 Calibration Using Discrete Values (Method I)

1. Follow the procedures in Section 5.2: Operating the Model UW-II, and review Section 5.1.2: Operating Precautions.
2. Affix a record performance label to the ultrasound unit.
3. Set the ultrasound wattmeter on discrete values such as: 5, 10, 15, 20.
4. Record these values under Ultrasound Setting on the label (see Figure 5.3.1-1b).
5. Measure the output on the Model UW-II.
6. Record the Model UW-II reading under Actual Output in Watts on the performance label (see Figure 5.3.1-1b).

5.3.3 Calibration Using Exact Meter Settings (Method II)

When this method is used, an exact meter setting is obtained for each power desired. This enables the physical therapist to select exactly the ultrasound output that the patient requires.

1. Follow the procedures in Section 5.2: Operating the Model UW-II, and review Section 5.1.2: Operating Precautions.
2. Affix a performance label to the ultrasound unit.
3. Adjust the ultrasound unit to read a desired value on the wattmeter.
4. Record the adjusted reading and the wattmeter reading on the label (see Figure 5.3.1-1c).

6 MODEL UW-II CALIBRATION

All components discussed in this section can be located in the Model UW-II by referring to Section 8: Schematic, Component Layout, and Parts Lists. If the wattmeter cannot be calibrated, refer to Section: Troubleshooting, to isolate the problem.

6.1 Linear Variable Differential Transformer (LVDT)

The LVDT in the fluid tank is calibrated and needs no adjustment. If there is a problem with the LVDT isolated by following the troubleshooting procedures in Table 7.1, then the wattmeter must be returned to Bio-Tek.

6.2 Circuit Calibration

The calibration of the Model UW-II circuit card includes:

1. setting the internal zero adjust (R16) so that the panel zero adjust is centered, and
2. adjusting the internal coarse gain (R23) and the fine gain adjust (R15).

NOTE: The coarse gain and fine gain adjustments must match the circuit gain to the spring constant of the cone assembly in the fluid. (Refer to equations in Section 5.2.5: Low-Pass Summing Amplifier, for spring constant.)

NOTE: A precision ultrasonic power source must be carefully applied to the fluid to accomplish the gain adjust.

6.2.1 Internal Zero Adjust

1. Set the panel zero adjust knob to approximately the center of its travel; that is, 5 turns from either end.
2. Adjust the internal zero adjust pot (R16) for a LCD reading of 0 ± 0.5 W.

6.2.2 Coarse Gain Adjust

1. Adjust the internal fine gain adjust pot (R15) to approximately the center of its travel; that is 12 turns from either end.

NOTE: The end is denoted by the *clicking* sound of the overrun clutch.

- 2. Adjust the panel zero adjust for a 0 ± 0.1 W LCD reading.
- 3. Carefully apply a known, calibrated ultrasonic power source to the fluid chamber.

NOTE: The power source should be set to any known value between 15 — 25 W.

- 4. Adjust the coarse gain (R23) so that the LCD reading is within ± 0.5 W of the source value.

6.2.3 Fine Gain Adjust

- 1. Adjust the fine gain pot (R15) so that the best fit is obtained between the LCD reading and the known, calibrated ultrasound source value at 3 different scale points between 5 — 20 W.

These values should be within 10% of the LCD reading at all 3 scale points.

- 2. Record the values as follows:

Ultrasound Source Value	LCD Reading
_____	_____
_____	_____
_____	_____

7 TROUBLESHOOTING

Table 7.1 provides troubleshooting procedures for the user. If the problem cannot be fixed by following these procedures, the user should first call the Bio-Tek Service Department for additional instructions (1-800-451-5172). The Bio-Tek service technician will then help the user decide if the wattmeter should be returned to Bio-Tek for repair. (If the Model UW-II is to be returned, follow the procedures specified in Section 3.3: Storage and Shipping.)

Table 7.1. Troubleshooting the Model UW-II*

PROBLEM DURING OPERATION	CHECK	REFERENCES	NOTES
1. Unstable readings.	1. a. Standing water in transducer well. b. How long Model UW-II has been continuously running. c. Check fluid level in the tank.	Sections 3.1, 3.2.3, 5.1.3, 5.2.1, 5.2.2	1. a. Replace water in transducer well with fresh degassed and deionized water. Standing water accumulates oxygen. b. Allow unit to rest before applying more ultrasonic energy. c. Add fluid or release air. If continued problem, call Bio-Tek Service Department.
2. LCD not lit or <u>LOBAT</u> appears on LCD.	2. a. Batteries b. <u>LOBAT</u> display by jumping TP7 to TP5.	Sections 2.5.1, 3.2.2, 5.2.1	2. a. Replace batteries. b. If <u>LOBAT</u> fails to come on, a problem exists with the: - 4054 segment driver - LCD - PC board or LCD connections to board.
3. <u>LOBAT</u> on, battery voltage on TP7 is high (5 V).	3. Output of both comparators on Pins 8 & 14 to isolate which one drives high. When isolated, check resistors in the input scaling.		3. Replace if bad.
4. Constant <u>LOBAT</u> but batteries are good.	4. a. If TP7 = 0 V b. If TP7 = 5 V		4. a. Replace U2. b. Replace one of the U3's.
5. Segments missing from digits shown on LCD.		Section 2.5.6	5. Refer to troubleshooting for <u>DISPLAY</u> under <u>SERVICE OR CALIBRATION</u> in this table.

* Components are found in Section 8: Schematic, Component Layout, and Parts Lists.

Table 7.1. Troubleshooting the
Model UW-II (Continued)

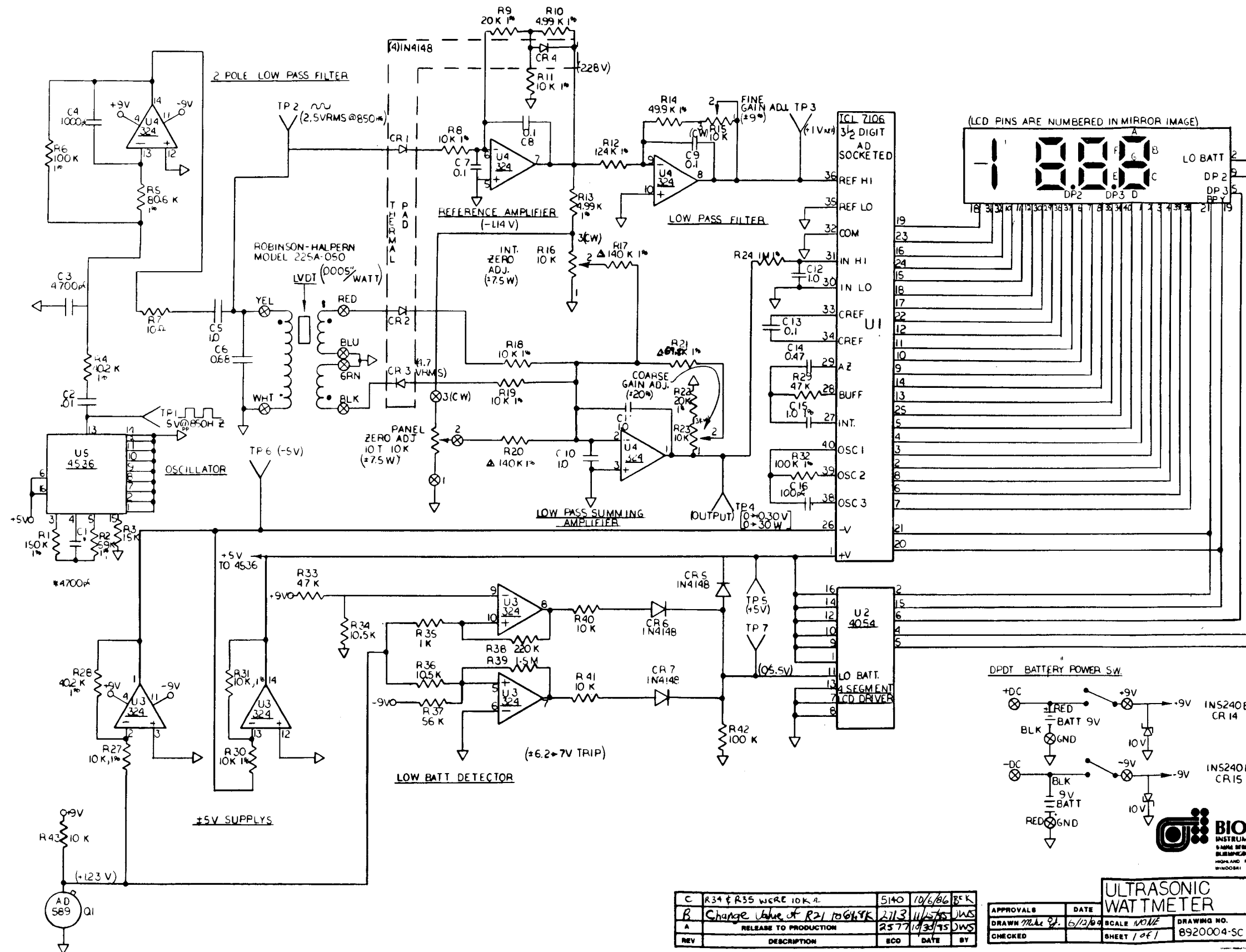
PROBLEM DURING	CHECK	REFERENCES	NOTES
SERVICE OR CALIBRATION			
Power Supply			
1. When AD589 device (1.23 V reference) input to inverting amplifier and: a. Voltage is not $-4.9 \text{ V} \pm 0.4 \text{ VDC}$ on TP5, or b. Voltage is not $\pm 4.9 \text{ V} \pm 0.4 \text{ VDC}$ on TP5.	1. a. Batteries. b. AD589 device output voltage that should be $1.225 \pm 0.025 \text{ V}$. c. Gain resistors (R27, R28, R30, & R31) around $\pm 5 \text{ V}$ inverting amplifier. d. Amplifying chip 324 (U3). e. Solder on PC board.	Section 2.5.1	1. a. $\pm 9 \text{ V}$ is missing, replace or insert batteries. b. Device is out of tolerance, return to Bio-Tek.
Oscillator			
1. Clock not running or running at wrong frequency.	1. a. TP1, should be $850 \pm 100 \text{ Hz}$. b. If not U5, check capacitor (C1). c. If not C1, check resistors (R1 & R 2).	Section 2.5.2	1. a. Replace U5. b. If bad, replace C1. c. If bad, replace R1 or R2.
2. Clock is running, but output on Pin 13 is missing.	2. a. Ground connection to ground pins. b. CMOS 4536 chip (U5). c. Pin 15.		2. a. Make good connection. b. If bad, replace U5. c. Ensure that Pin 15 is grounded through a 15K resistor.
Low Pass Filter (2-Pole)			
1. Voltage out of tolerance or has sharp steps in wave form.	1. a. Components in filter circuit (try capacitors first). b. Output load (tuning of LVDT).	Section 2.5.3, 2.5.7, 6.1	1. a. Replace bad component. If it not fixed, return to Bio-Tek. b. Replace bad resistor or replace bad diode. NOTE: Gain of low-pass filter can be adjusted $\pm 90\%$ by fine gain adjust pot.

Table 7.1. Troubleshooting the
Model UW-II (Continued)

PROBLEM DURING	CHECK	REFERENCES	NOTES
SERVICE OR CALIBRATION			
Reference Amplifier & Low-Pass Filter			
1. Voltage out of tolerance with fine gain adjust pot approximately centered.	1. Voltage at TP3, should be +1 VDC ± 0.25 VDC. a. Check resistors. b. Check diodes CR1 & CR4.	Section 2.5.4	1. a. Replace bad resistor. b. Replace bad components of U4.
Low-Pass Summing Amplifier			
1. Voltage on TP4 is out of tolerance (0.15 ± 0.04 VDC) with LVDT at electrical center & both zero adjust pots & coarse gain adjust pot at approximate center.	1. a. Resistor in low-pass summing amplifier circuit. b. U4 (Pins 1, 2, 3, & associated components).	Sections 2.5.5, 2.5.7	1. a. Replace any bad resistors in amplifier circuit. b. Replace any bad components of U4.
2. Voltage on TP4 is out of tolerance (0 ± 0.05 VDC & display reads 0 ± 5.0 W) when LVDT core is moved 0.0075" (0.19 mm) away from electrical zero towards top of LVDT & all 4 adjust pots are approximately centered.	2. a. Input diodes (CR2 & CR3). b. 10K resistors (R18 & R19) in LVDT secondary.		2. a. Replace any bad input diodes. b. Replace any bad 10K resistors.
3. Display reading is out of tolerance.	3. A/D (U1) by measuring voltage on TP3 & TP4.		3. The LCD reading should be: $\text{Readings in W} = \frac{100(\text{TP4 voltage})}{\text{TP3 voltage}}$
Display			
1. Missing segments in digits on LCD.	1. Connection between U1 & LCD. 2. U1. 3. LCD.	Section 2.5.6	1. Make good connection. 2. Return to Bio-Tek. 3. Return to Bio-Tek.

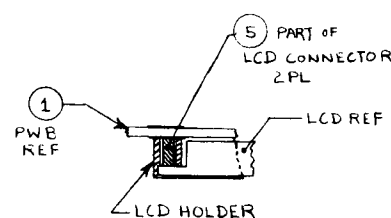
8 SCHEMATIC, COMPONENT LAYOUT, AND PARTS LISTS

This section contains the schematic, component layout, and parts lists that enable the user to follow the procedures in Section 5: Operation, Section 6: Model UW-II Calibration, and Section 7: Troubleshooting.



NOTES:

1. ASSEMBLE AND SOLDER PER MIL-STD-275 OR WAVE SOLDER PER MIL-STD-454, REQ'T 5.
2. SYMBOL • DENOTES PIN 1.
3. FOR ELECTRICAL SCHEMATIC, SEE DRAWING UMA .



3 #2 SCR

2 40 PIN DIP SOCKET

4 LCD

5 PART OF LCD CONN. KIT
LCD MASK

U1 REF

5 LCD HOLDER

SECTION A-A

APPROVALS		DATE	UW-II MAIN PC BOARD ASSEMBLY	
DRAWN		4/23/85	SCALE	2/1
CHECKED			SHEET	1 OF 1
			DRAWING NO. 89200004-A	

QTY REQD	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	PART OR IDENTIFYING NO.	SPECIFICATION	MATERIAL OR NOTE	UNIT WT	ZONE	ITEM NO.
LIST OF MATERIALS OR PARTS LIST									
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES			DRAWING STARTED DATE		BOWLES CORP.				
MATERIAL:			DRAWN <i>Weg</i> 23 APR 84		PRINTED WIRING ASSY				
			CHECKED <i>Weg</i>		ULTRASONIC WATTMETER				
			ENGR <i>Weg</i> 5/84		BIOTEK: 8920004A				
FINISH:					SIZE	CODE IDENT NO.	UMA127		
					D				
					SCALE 2/1	SHEET 1 OF 1			

12/04/86

BILL OF MATERIAL

PAGE 1

KITTING LIST

8920004 892 UW-II PCB ASBY

RUN #

QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	D 09-30-86	99	.00	.00	
04005	DISPLAY LCD 3.5 PINLESS	4	12	1.00	1.00	
12039	SCR PAN #2x1/4 ST SS SLOT 3		2	2.00	2.00	
21004	DIODE 1N4148 SIGNAL	CR1-7	2	7.00	7.00	
22001	DIODE 1N5240B ZENER 10V	CR14,15	6	2.00	2.00	
23007	OP AMP 324 QUAD	U3,4	8	2.00	2.00	
25025	IC 4054 4-SEG LCD DRIVER	U2	8	1.00	1.00	
25042	IC 7106 A/D CONV 3.5 DGT	U1	8	1.00	1.00	
25065	IC 4536 PROGRAMBL COUNTR	U5	8	1.00	1.00	
28003	VOLT REF 1.235	Q1	8	1.00	1.00	
31100	RES 10.0 OHM 5% 1/4W	R7	2	1.00	1.00	
31102	RES 1.0K OHM 5% 1/4W	R35	2	1.00	1.00	
31103	RES 10.0K OHM 5% 1/4W	R43	2	.00	.00	
31103	RES 10.0K OHM 5% 1/4W	R40,41	2	3.00	3.00	
31104	RES 100.0K OHM 5% 1/4W	R42	2	1.00	1.00	
31153	RES 15.0K OHM 5% 1/4W	R3	2	1.00	1.00	
31155	RES 1.5M OHM 5% 1/4W	R39	2	1.00	1.00	
31224	RES 220.0K OHM 5% 1/4W	R38	2	1.00	1.00	
31473	RES 47.0K OHM 5% 1/4W	R29,33	2	2.00	2.00	
31563	RES 56.0K OHM 5% 1/4W	R37	2	1.00	1.00	

12/04/86

BILL OF MATERIAL

PAGE 2

KITTING LIST

8920004 892 UW-II PCB ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
32019	RES 40.20K OHM 1% 1/4W	R4,28	2	3.00	3.00	
32028	RES 49.90K OHM 1% 1/4W	R14	2	1.00	1.00	
32030	RES 100.00K OHM 1% 1/4W	R6,32	2	2.00	2.00	
32033	RES 140.00K OHM 1% 1/4W	R17,20	2	2.00	2.00	
32039	RES 1.00M OHM 1% 1/4W	R24	2	1.00	1.00	
32042	RES 10.00K OHM 1% 1/4W	R27,30,31	2	.00	.00	
32042	RES 10.00K OHM 1% 1/4W	R8,11,18,19	2	7.00	7.00	
32044	RES 20.00K OHM 1% 1/4W	R9,22	2	2.00	2.00	
32061	RES 150.00K OHM 1% 1/4W	R1	2	1.00	1.00	
32067	RES 80.60K OHM 1% 1/4W	R5	2	1.00	1.00	
32072	RES 69.80K OHM 1% 1/4W	R21	2	1.00	1.00	
32108	RES 59.00K OHM 1% 1/4W	R2	2	1.00	1.00	
32175	RES 124.00K OHM 1% 1/4W	R12	2	1.00	1.00	
32222	RES 4.99K OHM 1% 1/4W	R10,13	2	2.00	2.00	
35008	TRIMPOT 10K 25T	R15,16,23	6	3.00	3.00	
36013	POT 10K OHM 10T		8	1.00	1.00	
42058	TIE WRAP 3"		2	3.00	3.00	
42123	CONN LCD DUAL INLINE KIT 5		6	1.00	1.00	
47005	BATTERYCLIP 9V		6	2.00	2.00	
49056	SOCKET I.C. 40-PIN DIP 2		6	1.00	1.00	

12/04/86

BILL OF MATERIAL

PAGE 3

KITTING LIST

8920004 892 UW-II PCB ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
49088	SPACER TEFLON 1/16"		2	2.00	2.00	
55014	SW TOGGLE DPDT		12	1.00	1.00	
71005	WIRE HOOK-UP 22 AWG	BLACK A/R	2	.00	.00	
71005	WIRE HOOK-UP 22 AWG	BLUE A/R	2	.00	.00	
71005	WIRE HOOK-UP 22 AWG	GREEN A/R	2	.00	.00	
71005	WIRE HOOK-UP 22 AWG	RED A/R	2	.00	.00	
71005	WIRE HOOK-UP 22 AWG	WHITE A/R	2	.00	.00	
71005	WIRE HOOK-UP 22 AWG	YELLOW A/R	2	.00	.00	
71019	CABLE FLAT 10-COND 24 AWG A/R		2	.00	.00	
83002	CAP 100 pF 1000V DISC C16		8	1.00	1.00	
83007	CAP .01 uF 50V DISC C2		2	1.00	1.00	
83021	CAP 1000 pF 200V DISC C4		8	1.00	1.00	
83028	CAP 4700 pF 100V DISC C1,3		8	2.00	2.00	
83031	CAP 1uF 50V C12		8	1.00	1.00	
84002	CAP .1 uF 100V FILM C7-9,13		8	4.00	4.00	
84008	CAP .47 uF 100V FILM C14		8	1.00	1.00	
84009	CAP 1 uF 100V FILM C5,10,11		8	3.00	3.00	
84010	CAP .68 uF 35V MYLR C6		8	1.00	1.00	
85007	CAP 1 uF 100V 1% C15		8	1.00	1.00	
8920002	PCB UW-II	1 REV B	8	1.00	1.00	

12/04/86

BILL OF MATERIAL

PAGE 4

KITTING LIST

8920004 892 UW-II PCB ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
32180	RES 10.50K OHM 1% 1/4W	R34,36	99	2.00	2.00	

12/04/86

BILL OF MATERIAL

PAGE 1

KITTING LIST

8920005 892 UW-II FINAL ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	C 05-09-86	99	.00	.00	
14004	NUT HEX 6-32 STEEL		2	6.00	6.00	
16009	LKWSHR #6 INT TOOTH STEEL		2	6.00	6.00	
44108	ACCESSORY POUCH		6	2.00	2.00	
45021	KNOB W/ LINE BLACK		6	1.00	1.00	
47002	BATTERY 9V ALKALINE		6	2.00	2.00	
49225	SWITCH BOOT		6	1.00	1.00	
49242	SPACER THRU #6x.375 AL RD		6	6.00	6.00	
71020	SHRINK TUBE 3/32"	A/R	2	.00	.00	
8920001	UW-II MECHANICAL SUB-ASBY		12	1.00	1.00	
8920004	892 UW-II PCB ASBY		1	1.00	1.00	
8920006	892 UW-II SHIPPING LIST		1	1.00	1.00	
8920007	892 UW-II PARTS FR BOWLES		1	1.00	1.00	
8920016	UW-II SUPPORT RING SET		10	1.00	1.00	
8920017	LABEL UW-II WARNING		8	1.00	1.00	
93047	LABEL SER# UW-II		2	1.00	1.00	

12/04/86 BILL OF MATERIAL PAGE 1

KITTING LIST

8920007 892 UW-II PARTS FR BOWLES RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	A 11-19-84	99	.00	.00	
12032	SCR PAN 8-32x1/2 SS SLOT		2	5.00	5.00	
49064	FOOT RUBBER 3/16"SQ BLK		2	4.00	4.00	
49066	GASKET NEOPR 601,901 CASE 3' DROP SHIP		6	3.00	3.00	
8920003	OVERLAY UW-II PANEL		8	1.00	1.00	
8920009	OVERLAY 892 INSTRUCTION		8	1.00	1.00	

12/04/86 BILL OF MATERIAL PAGE 1

KITTING LIST

8920006 892 UW-II SHIPPING LIST RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	A 11-19-84	99	.00	.00	
8920008	MANUAL UW-II		4	1.00	1.00	
8920014	TAG UMR 100/PKG		6	1.00	1.00	
8920015	CERTIF OF CALIBRATION FDA		2	1.00	1.00	
91004	FOAM PEANUT PACKING LOOSE A/R		2	.00	.00	
91058	BOX UW-II PACKING SET		2	1.00	1.00	
94001	CARD WARRANTY REPLY		2	1.00	1.00	
98011	BAG ZIP-LOCK SMALL		4	1.00	1.00	
98084	BAG POLY 18x20 2 MIL		4	1.00	1.00	