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ULTRASOUND POWER METER
Model UPM-30



OPERATOR'S MANUAL

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2006

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INTRODUCTION

The Ultrasound Power Meter, Model UPM-30, is a time-tested instrument designed to measure the ultrasonic power output of diagnostic or therapeutic transducers up to 30 watts using the radiation force balance method. The UPM-30 consists of a precision mechanical balance which measures from 0.01 to 10.00 grams, a conical target suspended on a bracket, a water tank, a transducer support rod with clamp, and a carrying case. The transducer to be tested is center-mounted over the conical target with the transducer's radiating area immersed face-down in the water medium.

The Model UPM-30 Ultrasound Power Meter measures the average ultrasonic power by measuring the radiant force exerted by the transducer on the conical target. This target is coupled to the precision mechanical balance which is used to measure the gram-mechanical force due to the ultrasonic radiation. The gram force is directly proportional to the ultrasound power in watts when multiplied by a constant of 14.65. Therefore, a 2.05 gram force would be equal to 30 watts of ultrasound radiation.

The heart of the UPM-30 system is its air-filled conical target. The weight of this target is nulled to a minimum by using its own buoyancy. Incident ultrasound energy is mechanically transferred from the target to the precision balance where it is manually measured. Reflected ultrasound energy is absorbed by a rubber wall inside the water test tank. This system provides a sturdy instrument with good measurement accuracy and low cost.

SETTING UP THE UPM-30

1. Remove the lid from the test tank.
2. Remove and carefully unpack the conical target stored in the test tank. Set the target aside until the tank is filled.
3. Slowly pour recently degassed water into the test tank and avoid any turbulence which might produce air bubbles. Fill the test tank to approximately $\frac{1}{2}$ inch from top of tank. The water must be at room temperature. If degassed water is not available, sterilized or distilled water may be used; however, a small error of approximately 3 to 5% may be introduced above the 10 to 15 watt output level.
4. Immerse the conical target into the test tank at an angle to avoid any air bubbles from being trapped under the target. Shake the target gently to release any attached air bubbles. Position the cone target so it is pointed upright in the center of the tank.
5. A bracket is attached to the conical target using nylon cord. Place this bracket on the upper (or lower) hook of the precision balance. Verify that the cone target is centered in the test tank and does not touch the sides of the tank.
6. Release the spring lock on the precision balance.
7. Balance the scale with the target in place and no ultrasound power applied. Each UPM-30 system is set up and balanced at the factory before shipping. The weight of the conical target, when suspended in the test tank, is measured, recorded, and marked on the balance. This is a "zero" or "null" reading and is approximately 1.5 grams. This weight is a constant which must be subtracted from all readings when measuring with this system. If a new target is ordered, be sure to indicate this null reading so an equivalent target can be supplied.
8. To verify the scale's accuracy, weigh the supplied 1-gram standard (located on the base plate below the short instruction notes) by placing it on the cone bracket or on one of the scale hooks and rebalancing the scale. The reading should be 1.00 gram higher than the null reading.
9. When the UPM-30 is not in use, store the target and bracket inside the test tank and replace the water-tight lid. The lid will restrain the water during transit, reduce the absorption of air into the water, and prevent water contamination from foreign particles. *Note: If the unit will not be used for an extended period of time, it is highly recommended that the water be removed from the tank and replaced when use is required.*

OPERATING PROCEDURE

1. Place the UPM-30 on a level and stable surface.
2. Remove the carrying case cover and the lid from the water tank.
3. Pull the cone bracket out of the water in the test tank and hang it on the upper (or lower) scale hook. The conical target should not touch the rubber wall and the axis of the target cone should be perpendicular to both the surface of the water and the surface of the transducer under test (TUT).
4. Unhook the scale spring lock from the balance arm. *Note: Always replace the spring lock when the UPM-30 is in transit.*
5. Periodically verify the accuracy of the precision balance by finding the null (or zero) value and then weighing the 1-gram standard weight by placing it on the cone bracket (or the upper or lower scale hook) and rebalancing the scale. A 1 gram difference should be measured between this reading and the null reading.
6. Place the handle of the transducer under test (TUT) into the positioning clamp with the transducer's radiating surface centered above the cone target and immersed about 1/8 to 1/4 inch into the water and parallel to the water surface. Wipe across the transducer surface with your finger to remove any trapped air bubbles.
7. With no ultrasound power applied, balance the scale (to null value), then record this null reading (for example, 1.5 grams). For convenience, this null reading may be adjusted to an even number within the 0 to 10-gram range by using the balance compensator (a knurled nut) located at the left of the balance arm.
8. Apply power to the TUT. Set the TUT to the desired power output (for example, new reading is 2.25 minus the null reading of 1.50 grams which gives a difference reading of 0.75 total gram force). Multiply this difference in gram readings by the constant, **14.65**. The formula for total radiated power in watts is equal to the total gram force on the precision balance (in grams) multiplied 14.65 watts/gram. To obtain watts per square centimeter, divide the total radiated power by the effective radiating cross-sectional area of the transducer (usually, 90% to 95% of the total transducer surface area).
9. For increased measurement accuracy, repeat the power measurement procedure a few times and take the average reading.
10. *Reading the Main and Vernier dials.* Each incremental graduation on the **Main** dial has a value of 0.1 gram. The **Vernier** dial is above the Main dial and sub-divides the 0.1 Main dial increment down to 0.01 increments. To obtain total gram weight, first record the number of grams and tenths of grams indicated on the Main dial at the zero vernier graduation. See Figure 1 below. To obtain the hundredths of grams, read the value on the Vernier scale whose increment line most closely aligns with a Main dial graduation. Add the vernier hundredths value to the Main dial grams and tenths of grams to find the total gram force. The reading shown in Figure 1 is 6.74 grams.

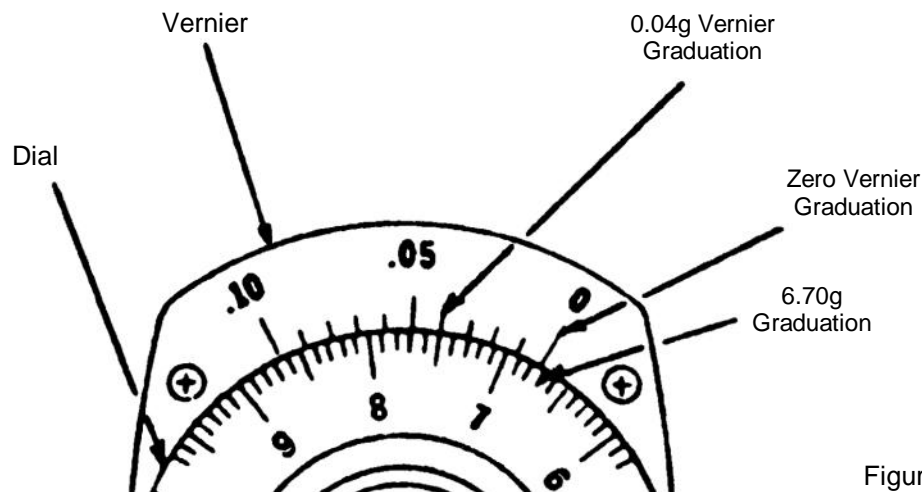


Figure 1

WATER, TANK SIZE, TRANSDUCER PLACEMENT & TEMPERATURE CONSIDERATIONS

Water as a Measurement Medium: The measurements are to be performed in de-gassed water because ultrasound propagation in water closely approximates that in tissues (see UL-1-1981, AIUM/NEMA Standard Publication). The ultrasonic attenuation in water can be taken as a lower limit on the attenuation which will be encountered in the body. Large areas in the body can consist of low attenuating material such as urine and amniotic fluid. The use of water prevents measurements in a more highly attenuating material such as liver equivalent gels from representing the highest possible intensities which might be encountered in the body. A measurement temperature of $24^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($75^{\circ}\text{F} \pm 5^{\circ}$) is chosen for convenience.

De-Gassed Water: Ultrasound power measurement accuracy is affected (by lowering the power reading) if the water contains more than five parts per million of air. To de-gas, boil distilled water for one half-hour, then pour into a suitable container, seal tightly and place in refrigerator. This process will give the required quality. The container should be heat resistant glass; or thick plastic may be used **after** the water has been cooled. Before testing, pour water into tilted test tank to minimize turbulence. The test tank water surface will absorb oxygen and a change of de-gassed water is recommended before each test. An alternative method of de-gassing water is to heat the water to the boiling point, then put a vacuum to it for five minutes.

Water temperature affects accuracy; use a testing temperature of 21 to 24°C (70° to 75°F) ambient. Sonic energy agitates the water surface through heating and scattering. Testing time should be limited to a few minutes; prolonged testing, particularly at higher power levels, will drive out dissolved air and air bubbles will be visible on surfaces in the tank. These bubbles can be gently brushed off.

Transducer Wetting and Placement: After tilting the transducer into the water at a 45° angle, verify that the surface is uniformly wetted; if not, wipe the surface clean. The transducer should be positioned above the cone target. Small variations will occur due to placement. Try various positions above target to obtain a maximum power reading.

ULTRASOUND RADIATION LEVELS

There are no maximum limits in the U.S. for therapy power, only the verification of the displayed setting accuracy to $\pm 20\%$ of actual output is required. Exposure levels for physical therapy applicator heads range from $100\text{mW}/\text{cm}^2$ to $3\text{W}/\text{cm}^2$. Total power requires multiplication by the radiated cross sectional area in cm^2 .

The power limits shown in the following table for diagnostic ultrasound have been extracted from FDA Section 510(k) guidance to manufacturers on submissions and clearance as of February 1993. Refer to the AIUM and FDA publications for complete and up to date testing standards and interpretations. Measurements are done in all standard modes of operation. Power intensity is rated as Spatial Peak Temporal Average (I_{SPTA}) and Spatial Peak Pulse Average (I_{SPPA}). The values in mW/cm^2 are derated for tissue and in parenthesis for the water medium (use this chart):

PRE-AMENDMENT ACOUSTIC OUTPUT LIMITS

| Use | I_{SPTA} Tissue | (mW/cm^2) Water | I_{SPPA} Tissue | (mW/cm^2) Water |
|-------------------------|-----------------------------|--------------------------------------|-----------------------------|--------------------------------------|
| Peripheral Vessel | 720 | 1500 | 190 | 350 |
| Fetal Imaging & Other * | 430 | 730 | 190 | 350 |
| Cardiac | 94 | 180 | 190 | 350 |
| Ophthalmic | 17 | 68 | 28 | 110 |

* Abdominal, intra-operative, pediatric, small organ (breast, thyroid, testes, etc.), neonatal cephalic, adult cephalic

THEORY OF MEASURING ULTRASOUND POWER WITH THE RADIATION FORCE METHOD

Sound is a form of energy that sets the particles in the isonated medium into vibrational motion. The particles then possess a kinetic energy. If dP_m is the rate of the flow of this energy about an area dA , then the mean acoustic energy is:

$$\text{Eq. 1} \quad I = dP_m/dA \quad I = \text{Acoustic intensity at a point in that area, Watts/cm}^2$$

When a plane sound wave propagates through a uniform non-absorbent medium, the intensity must be the same for all points in the wave. Let E represent the energy density, i.e., the energy per unit volume. When the sound energy passes through a unit cross-sectional area with a speed c , the intensity is:

$$\text{Eq. 2} \quad I = cE \quad \begin{array}{l} E = \text{Energy density per unit volume, ergs/cm}^3 \\ c = \text{Ultrasound wave velocity, cm/sec} \end{array}$$

The radiation pressure effect can be explained by analogy to the application of an alternating electric voltage to a non-linear load. With the non-linear load it appears that both AC and DC components are present. In ultrasonics the non-linear element is the density of the fluid and hence acoustic impedance (load) varies in the same periodical manner as the density. Therefore in ultrasound the two components of pressure, one alternating and the other direct are present. The average AC pressure per cycle is zero, but the DC pressure of radiation is:

$$\text{Eq. 3} \quad P_r = I/c \quad P_r = \text{Pressure of Radiation, ergs/cm}^3$$

Therefore, from the above two equations, the pressure of radiation (P_r) is equal to the energy density (E).

$$\text{Eq. 4} \quad P_r = E$$

It is this DC pressure of radiation that can be measured. At low frequencies, below 100KHz, a standard high frequency hydrophone can be used. For higher frequencies, generally used in medical applications, 1-15 MHz, hydrophones are not available. At these frequencies the force can be measured using a precision balance and a radiation force target that is perfectly absorptive. The conversion from force to power can be accomplished using the equation:

$$\text{Eq. 5} \quad p = Wgc \quad \begin{array}{l} W = \text{measured force, grams} \\ g = \text{acceleration, dynes} \\ c = \text{velocity of ultrasound, cm/sec} \\ p = \text{power, ergs/sec} \end{array}$$

By combining all constants together and converting from ergs/sec to watts, we obtain a simplified equation that is used to calculate the ultrasonic power once the force is measured:

$$P = w(14.65) \quad \begin{array}{l} P = \text{Ultrasonic power in watts} \\ w = \text{Ultrasonic force in grams} \end{array}$$

To determine the ultrasonic watt density (watts/cm² or watts/in²) of a given transducer the P is divided by the cross sectional area of the transducer.

SPECIFICATIONS

| | |
|-------------------------------|--|
| Power Range | 0-30 Watts |
| Resolution | ± 150mW (± 0.01g) |
| Frequency Range | 0.5 to 10MHz |
| Accuracy | 5% |
| Display | Vernier Dial |
| Zeroing Method | Manually Adjusted |
| Test Tank Lining | 0.5" (12.7mm) neoprene rubber |
| Test Medium | Degassed water |
| Test Tank Liquid Capacity | 1,200 ml. |
| Test Tank Dimensions: Outside | 5.75" (146mm) dia. x 5.55" (140mm) height |
| Inside | 4.5" (114mm) dia. x 5.25" (133mm) deep |
| Cone Target | 3.25" (89mm) dia. x 1.625" (51mm) height |
| Carrying Case | 19" H (483mm) x 17" L (432mm) x 7" W (178mm) |
| Shipping Weight | 18 pounds |

CONVERSION CHART—FROM GRAMS TO WATTS

| Measurement Difference | Watt Output | Measurement Difference | Watt Output | Measurement Difference | Watt Output |
|------------------------|-------------|------------------------|-------------|------------------------|-------------|
| 0.10 | 1.47 | 0.58 | 8.50 | 1.06 | 15.53 |
| 0.11 | 1.61 | 0.59 | 8.64 | 1.07 | 15.68 |
| 0.12 | 1.76 | 0.60 | 8.79 | 1.08 | 15.82 |
| 0.13 | 1.90 | 0.61 | 8.94 | 1.09 | 15.97 |
| 0.14 | 2.05 | 0.62 | 9.08 | 1.10 | 16.12 |
| 0.15 | 2.20 | 0.63 | 9.23 | 1.11 | 16.26 |
| 0.16 | 2.34 | 0.64 | 9.38 | 1.12 | 16.41 |
| 0.17 | 2.49 | 0.65 | 9.52 | 1.13 | 16.55 |
| 0.18 | 2.64 | 0.66 | 9.67 | 1.14 | 16.70 |
| 0.19 | 2.78 | 0.67 | 9.82 | 1.15 | 16.85 |
| 0.20 | 2.93 | 0.68 | 9.96 | 1.16 | 16.99 |
| 0.21 | 3.08 | 0.69 | 10.11 | 1.17 | 17.14 |
| 0.22 | 3.22 | 0.70 | 10.26 | 1.18 | 17.29 |
| 0.23 | 3.37 | 0.71 | 10.40 | 1.19 | 17.43 |
| 0.24 | 3.52 | 0.72 | 10.55 | 1.20 | 17.58 |
| 0.25 | 3.66 | 0.73 | 10.69 | 1.21 | 17.73 |
| 0.26 | 3.81 | 0.74 | 10.84 | 1.22 | 17.87 |
| 0.27 | 3.96 | 0.75 | 10.99 | 1.23 | 18.02 |
| 0.28 | 4.10 | 0.76 | 11.13 | 1.24 | 18.17 |
| 0.29 | 4.25 | 0.77 | 11.28 | 1.25 | 18.31 |
| 0.30 | 4.40 | 0.78 | 11.43 | 1.26 | 18.46 |
| 0.31 | 4.54 | 0.79 | 11.57 | 1.27 | 18.61 |
| 0.32 | 4.69 | 0.80 | 11.72 | 1.28 | 18.75 |
| 0.33 | 4.83 | 0.81 | 11.87 | 1.29 | 18.90 |
| 0.34 | 4.98 | 0.82 | 12.01 | 1.30 | 19.05 |
| 0.35 | 5.13 | 0.83 | 12.16 | 1.31 | 19.19 |
| 0.36 | 5.27 | 0.84 | 12.31 | 1.32 | 19.34 |
| 0.37 | 5.42 | 0.85 | 12.45 | 1.33 | 19.48 |
| 0.38 | 5.57 | 0.86 | 12.60 | 1.34 | 19.63 |
| 0.39 | 5.71 | 0.87 | 12.75 | 1.35 | 19.78 |
| 0.40 | 5.86 | 0.88 | 12.89 | 1.36 | 19.92 |
| 0.41 | 6.01 | 0.89 | 13.04 | 1.37 | 20.07 |
| 0.42 | 6.15 | 0.90 | 13.19 | 1.38 | 20.22 |
| 0.43 | 6.30 | 0.91 | 13.33 | 1.39 | 20.36 |
| 0.44 | 6.45 | 0.92 | 13.48 | 1.40 | 20.51 |
| 0.45 | 6.59 | 0.93 | 13.62 | 1.41 | 20.66 |
| 0.46 | 6.74 | 0.94 | 13.77 | 1.42 | 20.80 |
| 0.47 | 6.89 | 0.95 | 13.92 | 1.43 | 20.95 |
| 0.48 | 7.03 | 0.96 | 14.06 | 1.44 | 21.10 |
| 0.49 | 7.18 | 0.97 | 14.21 | 1.45 | 21.24 |
| 0.50 | 7.33 | 0.98 | 14.36 | 1.46 | 21.39 |
| 0.51 | 7.47 | 0.99 | 14.50 | 1.47 | 21.54 |
| 0.52 | 7.62 | 1.00 | 14.65 | 1.48 | 21.68 |
| 0.53 | 7.76 | 1.01 | 14.80 | 1.49 | 21.83 |
| 0.54 | 7.91 | 1.02 | 14.94 | 1.50 | 21.98 |
| 0.55 | 8.06 | 1.03 | 15.09 | 2.00 | 29.30 |
| 0.56 | 8.20 | 1.04 | 15.24 | 2.50 | 36.63 |
| 0.57 | 8.35 | 1.05 | 15.38 | | |

| ULTRASONIC THERAPY UNIT INSPECTION RECORD | | | ACTION | | | WORK ORDER NO. |
|--|-----------------------|---------------------|--------------|---|------------------------|----------------|
| | | | NOT NEEDED | NEEDED | TAKEN | |
| LOCATION | MANUFACTURER | DATE OF INSPECTION | | CARD COLUMNS | WORK ORDER TRANSACTION | |
| UNIT MODEL | TRANSDUCER MODEL | NEXT INSPECTION DUE | | 1-15 | STOCK NO. | |
| UNIT SERIAL NO. | TRANSDUCER SERIAL NO. | TECHNICIAN | | 18 | DETACHMENT | |
| 1. PREVENTIVE MAINTENANCE INSPECTION | | SAT. | UNSAT. | 20-24 | INDEX NO. | |
| REMARKS | | | | 26-29 | PM MANHOURS | |
| | | | | 30 | PM MINUTES | |
| 2. FUNCTIONAL/OPERATIONAL CHECKOUT | | SAT. | UNSAT. | 32-35 | REPAIR HOURS | |
| REMARKS | | | | 36 | REPAIR MINUTES | |
| 3. LEAKAGE CURRENT - | | CHASSIS - 100µA | SAT. | UNSAT. | 38-43 | CONTRACT COSTS |
| | | TRANSDUCER - 50µA | | | | |
| TEST CONDITION | POWER | CHASSIS | TRANSDUCER | 45 | REPAIRMAN'S CODE | |
| GROUNDED NORMAL POLARITY | ON | | | 47-50 | DATE COMPLETED | |
| | OFF | | | 51-52 | ACTION CODE | |
| GROUND LIFTED NORMAL POLARITY | ON | | | 53-60 | WORK ORDER NO. | |
| | OFF | | | 61-66 | RC/CC | |
| GROUND LIFTED REVERSE POLARITY | ON | | | 67-69 | DOWN DAYS | |
| | OFF | | | 70-75 | QUANTITY INSPECTED | |
| 4. GROUND WIRE RESISTANCE (150 milliohms max.) | | | _____ m ohms | 78-80 | TRANSACTION CODE | |
| 5. TIMER | TOL. | SELECTED | TIMED | | | |
| < 8 MIN. | ± 0.8 MIN. | | | 6. ANNUAL INSPECTION REQUIREMENTS COMPLETED | | DATE |
| 8 M. - 10 MIN. | ± 10% | | | 7. IS UNIT SUBJECT TO 21CFR1050 REQUIREMENTS? | | YES NO |
| > 10 MIN. | ± 1.0 MIN. | | | 8. COMBINED MUSCLE STIMULATOR INSPECTED? | | YES NO |
| REMARKS | | | | | | |
| WORK PERFORMED BY | | | | LABEL AFFIXED: | | |
| | | | | USER MAINTENANCE: | | |

9. CONTINUOUS WAVE MODE CERTIFICATION (Average Power)

| WATTS SELECT | POWER | | DIFF. | WATTS | ALLOWABLE RANGE | | WATTS SELECT | POWER | | DIFF. | WATTS | ALLOWABLE RANGE | | |
|-----------------------|-------|-----|-------|-------|-----------------|-----------------------|--------------|-------|-----|-------|-------|-----------------|--------|--------|
| | ON | OFF | | | SAT. | UNSAT. | | ON | OFF | | | SAT. | UNSAT. | |
| 5 | 1 | | | | 3.7 - 6.3 | | 10 | 1 | | | | 7.4 - 12.6 | | |
| | 2 | | | | | | | 2 | | | | | | |
| | 3 | | | | SAT. | UNSAT. | | 3 | | | | | SAT. | UNSAT. |
| Average of 3 Readings | | | | | | Average of 3 Readings | | | | | | | | |
| 15 | 1 | | | | 11.1 - 18.9 | | 20 | 1 | | | | 14.8 - 25.2 | | |
| | 2 | | | | | | | 2 | | | | | | |
| | 3 | | | | SAT. | UNSAT. | | 3 | | | | | SAT. | UNSAT. |
| Average of 3 Readings | | | | | | Average of 3 Readings | | | | | | | | |
| | 1 | | | | | | | 1 | | | | | | |
| | 2 | | | | | | | 2 | | | | | | |
| | 3 | | | | SAT. | UNSAT. | | 3 | | | | | SAT. | UNSAT. |
| Average of 3 Readings | | | | | | Average of 3 Readings | | | | | | | | |

| | |
|--|--|
| | |
|--|--|

10. PULSED MODE CERTIFICATION (Amplitude Modulated Waveform)

| MAX. PULSE MODE | POWER | | DIFF. | WATTS | CALCULATIONS | |
|-----------------------|------------------|--|--|--|--------------|---------|
| | ON | OFF | | | | |
| (Pp) | | | | | | |
| | | | | | | |
| | | | | | | |
| Average of 3 Readings | | | | = Measured Average Power (Av) | | |
| Pp | R _{TPA} | CALC. AVERAGE POWER (Pp / R _{TPA}) | Difference Between Measured AV And Calculated AV | Is Difference < ± 0.6% Of (Pp / R _{TPA}) | | REMARKS |
| | | | | YES NO | | |

11. SHORT TERM LIFE TEST COMPLETE? YES NO

12. ADDITIONAL TEST (Describe in Detail):

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive.

Ohmic Instruments Company warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses or any product or parts which have been subjected to misuse, neglect, accident, or abnormal conditions of operation.

In the event of failure of a product covered by this warranty, Ohmic Instruments Co. will repair and recalibrate an instrument returned within 1 year of the original purchase: provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. OHMIC INSTRUMENTS COMPANY SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify Ohmic Instruments Co. giving full details of the difficulty, and include the model, type, and serial numbers (where applicable). On receipt of this information, service data, or shipping instructions will be forwarded to you.

2. On receipt of shipping instructions, forward the instrument, transportation prepaid. Repairs will be made and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of Ohmic Instruments Co. instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton, or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon delivery to purchaser. All material in the shipping container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact Ohmic Instruments.) Final claim and negotiations with the carrier must be completed by the customer.

Ohmic Instruments Company will be pleased to answer all application or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: Ohmic Instruments Company, 508 August St., Easton, Maryland 21601, ATTN: Technical Support. Or call Ohmic Technical Support at 410-820-5111.

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