

**INSTRUCTION BOOK FOR**

**BIRD**

**MODEL 4410**

**RF DIRECTIONAL  
THRULINE® WATTMETER**

## LIMITED WARRANTY

We are proud of the high quality of our product and we warrant to the original purchaser that each new instrument of our manufacture will for a period of one year after original shipment be free from defects in material and workmanship under normal and proper operating conditions and that properly used during such period it will perform in accordance with our applicable specifications.

Our obligation and the purchaser's exclusive remedy for any defect or failure to meet specifications shall be limited, at our option, to repair or replacement, or if we determine said defect or failure to be so defective as to preclude remedying by repair or replacement, the purchaser's sole and exclusive remedy shall be limited to refund of the purchase price. We shall have no obligation if defects result from improper use, operation above rated capacities, repairs not made by us, or misapplication of the equipment. Our warranty does not extend to the failure of semiconductor devices and batteries, or to equipment and parts made by others except to the extent of the original manufacturer's warranty to us. No other warranty is expressed or implied. Bird Electronic Corporation is not liable for consequential damages.

Warranty returns must be first authorized by the factory office and are to be shipped prepaid.

**INSTRUCTION BOOK FOR**  
**MODEL 4410**  
**RF DIRECTIONAL**  
**THRULINE® WATTMETER**



**BIRD**

**Electronic Corporation**

30303 Aurora Road, Cleveland (Solon) Ohio 44139-2794

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## SAFETY PRECAUTIONS

Always remember that when working with equipment that involves the use of high electrical power, extreme caution must be taken. Observe all safety precautions and never work alone. It is always good practice to have someone near by that is proficient in modern methods of resuscitation.

Below is a list of warnings and cautions to be observed while using this equipment. They may also be found in the text of this book where applicable.

```
*****
*                               W A R N I N G                               *
*                               *                                           *
* Exposure to RF power radiation and the possibility of *
* RF shock or burns is possible with some operating con- *
* ditions. Always be sure to turn off transmitter when *
* connecting or disconnecting wattmeter. Be sure trans- *
* mission line is terminated into a load or antenna. *
* When Plug-In Element is removed from the RF line sock- *
* et, the line section center conductor is exposed. Do *
* not put fingers or other objects into this Plug-In Ele- *
* ment socket when RF power is on. *
*****
```

```
*****
*                               C A U T I O N                               *
*                               *                                           *
* Do not drop the instrument or Plug-In Elements as *
* damage could result to the meter or accuracy of the *
* elements could be impaired. *
*****
```

```
*****
*                               W A R N I N G                               *
*                               *                                           *
* When using dry cleaning solvents or pressurized spray *
* cleaner, take necessary precautions and supply adequate *
* ventilation. Avoid breathing fumes. *
*****
```

Continued

## SAFETY PRECAUTIONS

```
*****  
*                               C A U T I O N                               *  
*                               *                                           *  
* If other than Female N type connectors are used, limit *  
* power and frequency to the capabilities of the RF *  
* coaxial cable or connectors used. Damage to connectors *  
* or errors in reading could result. *  
*****
```



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## 4410 THRULINE® WATTMETER

### INTRODUCTION

#### PURPOSE AND FUNCTION

The Model 4410 THRULINE® Wattmeter is an insertion type RF wattmeter, designed to measure power flow and load match in 50 ohm RF coaxial transmission lines. Its use is intended for CW unmodulated or FM signals only. When used in a 50 ohm application with N type connectors it has an insertion VSWR of less than 1.05 for frequencies up to 1000MHz. The meter has two scales, a 0 to 1 scale and a 0 to 3 scale. Power is read in multiples of the values indicated by the pointer, depending on the range switch setting and by the factor on the Plug-In Element. Several of these Plug-In Elements may be selected to give this instrument a broad band spectrum of various power ranges, see Specifications.

#### DESCRIPTION

The Model 4410 THRULINE® Wattmeter is a portable unit contained in a die cast aluminum housing, with a formed sheet aluminum back closure. The unit is equipped with a leather strap for carrying, four rubber shock feet on the base, and four rubber bumpers on the back, which allow the unit to stand vertical or on its back in a horizontal position when used. For additional protection, the microammeter is specially shock mounted. A slotted screw is provided on the lower front face of the meter for zeroing the pointer. Below the meter, the RF line section face protrudes slightly from the wattmeter housing with the Plug-In Element socket in the center. Mounted on the line section, inside the housing, is the circuit module with an attached phosphor bronze spring contact finger, which protrudes through a lateral hole and into the Plug-In Element socket of the RF line section. The finger has a button on its end which mates with the contacts of the Plug-In Element. The silver plated brass RF line section is precision made to provide the best possible impedance match to the coaxial RF transmission line in which the Model 4410 is inserted. At each end of the line section are Bird Quick-Change type RF connectors, which may be quickly interchanged with any other Bird "QC" connectors.

#### PERFORMANCE CHARACTERISTICS AND CAPABILITIES

To make measurements, the cylindrical shaped Plug-In Element is inserted into the line section socket and rotated against one stop. A small catch in the lower left hand corner of the casting face presses on the shoulder of the Plug-In Element to keep it in proper alignment and assure a good contact with the dc jack and between the lower edge of the element and seat of the line section body. On

Continued



diametrically opposite sides of the Plug-In Element body are contacts to provide dc pickup in either direction. These contacts make connection with the spring finger of the line section only when the Plug-In Element is in the precise forward or reverse position.

SPECIFICATIONS FOR MODEL 4410 THRU LINE® WATTMETER

Impedance.....	50 ohms nominal
Insertion VSWR.....	1.05 maximum, 0-1GHz equipped with F-N connectors (32.3dB return loss)
Connectors.....	Bird Quick Change "QC" type Female N normally supplied
Over Ranging.....	120% of element power rating regardless of selector switch setting (Certain connector types limited to rating of connector)
Power and Frequency Range†	
0-10,000W.....	.2-30MHz
0-1,000W.....	30-1000MHz
0-100W.....	25-1000MHz
Accuracy*.....	±5% of reading above 20% of full scale of selected power range
Dimensions.....	3-3/8"L x 4"W x 6-7/8"H (85.7 x 101.6 x 174.6mm)
Temperature Range	
Operating.....	0°C to 50°C (32° to 122°F)
Storage.....	-25°C to 65°C (-13°F to 149°F)
Relative Humidity Range.....	5% to 90% noncondensing
Weight.....	3 lbs. (1.4kg)
Power Requirement.....	9V dc alkaline battery
Battery Life.....	24 hours continuous use

† Power and frequency range is determined by 4410 type Plug-In Elements used.

\* Exception - Element P/N 4410-1 0.200-0.535MHz has an accuracy of ±10% of reading.

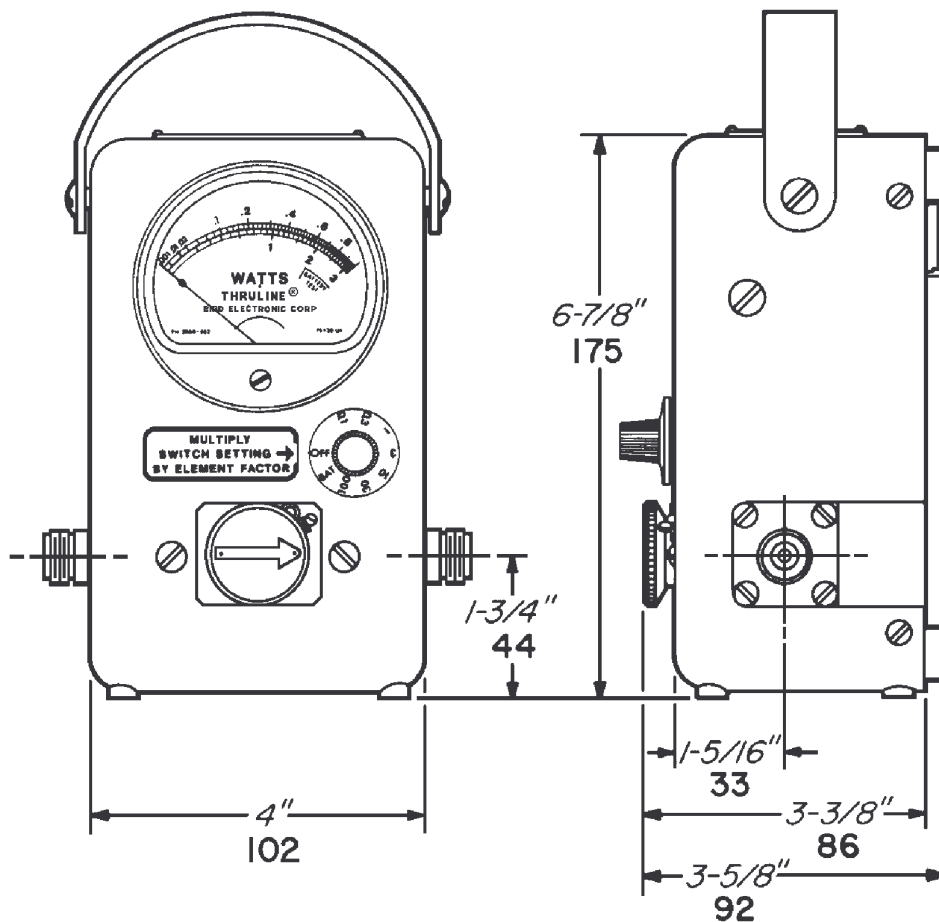
SECTION I - INSTALLATION

1-1. PORTABILITY

\*\*\*\*\*  
\* CAUTION \*  
\* Do not drop the instrument or Plug-In Elements as \*  
\* damage could result to the meter or accuracy of the \*  
\* elements could be impaired. \*  
\*\*\*\*\*

1-2. The Model 4410 is a portable instrument, and the housing is not designed for fixed mounting, see Figure 1-1. A leather strap is provided for carrying purposes.

Figure 1-1. Outline Drawing.



1-3. When transporting the THRULINE® be sure the range switch is in the off position. In any other switch position there is a slight drain on the 9V battery. If the unit is to be inactive for an appreciable amount of time, it is good practice to remove the battery to avoid damage from possible battery leakage. Handle the Plug-In Element with care at all times. Calibration could be disturbed if they are dropped or subjected to hard blows.

#### 1-4. CONNECTIONS

1-5. Insert the Model 4410 THRULINE® in coaxial transmission lines of 50 ohms nominal impedance. It makes no difference which side of the THRULINE® the power source and the load connections are made. Use coaxial transmission line fitted with suitable mating RF connectors. If cables other than 50 ohms are used a mismatch will occur causing probable serious inaccuracies in readings. We strongly urge that you avoid this condition.

1-6. The Model 4410 is normally supplied with two Female N type connectors which are of the Bird Quick-Change "QC" design. Other "QC" connectors are available as listed in Section IV - Replacement Parts List.

## SECTION II - THEORY OF OPERATION

### 2-1. GENERAL

2-2. On any uniform RF line section there are voltages, currents and standing waves present when RF power is applied. These are the results of two travelling waves, forward and reflected. The characteristic impedance of these lines is a pure resistance, usually 50 ohms, for useful lines.

2-3. The main RF circuit of the THRULINE® is a short piece of uniform air type line section whose characteristic impedance is a very accurate 50 ohms, in which correct measurements may be made.

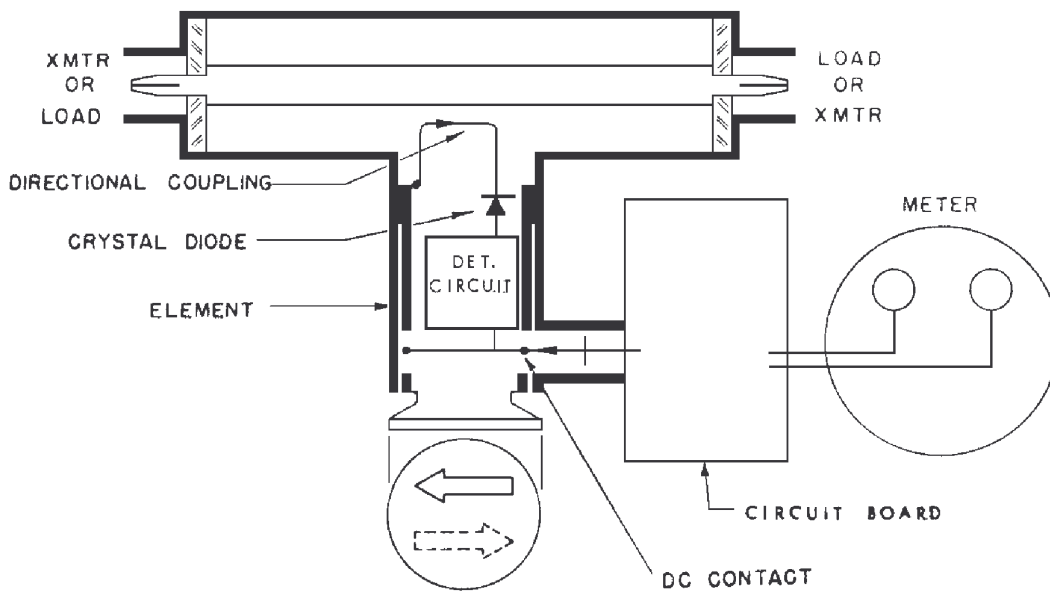
### 2-4. COUPLING CIRCUIT

2-5. The coupling circuit which samples the travelling waves is in the Plug-In Element. The circuitry of the element and its relationship to the other components of the THRULINE® are illustrated in, Figure 2-1. Energy will be absorbed in the coupling circuit of the element both by mutual inductance and capacitance from the travelling RF waves of the line section. The inductive currents within the line section will flow according to the direction of the travelling waves producing them. The capacitive portion of these currents is independent of the travelling waves. It is, therefore, apparent that the current produced from the waves travelling in one direction will add in phase, while the current produced from the waves travelling in the opposite direction will subtract in phase. The ARROW on the Plug-In Element indicates the additive direction of wave travel. The element is so designed that the wave components travelling in the opposite direction of the ARROW will cancel each other out almost completely, making the element highly insensitive to the reverse wave direction. This signal which is to be measured, is detected and through the use of a self-balancing bridge circuit, an accurate power reading is obtained. The nonlinearity and temperature instabilities of the detector diode are avoided by using a secondary balancing detector diode connected in opposition to the principal detector diode. These two diodes are selected for similar characteristics so they are nearly identical and diode variables are virtually eliminated. Also, the two diodes are mounted close to each other in the same enclosure and subjected to the same thermal environment almost eliminating thermal effects. Because of the highly directional characteristics of the element, the resultant direct current which is sensed by the microammeter indicates the power level of only the RF waves travelling in the ARROW direction.

2-6. Reflected power readings - The Plug-In Element is designed so that it can be rotated 180° in its socket in the line section. When it is rotated, the meter will indicate the power in a direction

opposite that of the initial reading, so that if the forward direction power was read first, then the reflected direction power will be read after the Plug-In detector element is rotated. The energy resulting from the inductively coupled component of the forward wave will bring about cancellation as described above.

Figure 2-1. Schematic Diagram.





## SECTION III - OPERATING INSTRUCTIONS

### 3-1. GENERAL

```
*****
*                                     *
*                               W A R N I N G                               *
*                                     *
* Exposure to RF power radiation and the possibility of                    *
* RF shock or burns is possible with some operating con-                 *
* ditions. Always be sure to turn off transmitter when                   *
* connecting or disconnecting wattmeter. Be sure trans-                 *
* mission line is terminated into a load or antenna.                      *
* When Plug-In Element is removed from the RF line sock-                 *
* et, the line section center conductor is exposed. Do                   *
* not put fingers or other objects into this Plug-In Ele-                 *
* ment socket when RF power is on.                                        *
*****

*****
*                                     *
*                               C A U T I O N                               *
*                                     *
* Do not drop the instrument or Plug-In Elements as                       *
* damage could result to the meter or accuracy of the                   *
* elements could be impaired.                                           *
*****
```

3-2. Installation and apparent features of the Model 4410 have been discussed in previous sections. RF power measurements are made with the insertion of the Plug-In Elements previously mentioned. With the element inserted in the line section receptacle, forward power is indicated when the ARROW on the element plate points in the direction of power flow; i.e., from transmitter to load. Reflected power measurements are made with the element rotated 180° with the ARROW on the plate pointing toward the transmitter. When power measurements are being made, make sure the element is rotated fully so that the index pin protruding from the element's cylindrically shaped body rests against the stop on the line section, either in the forward or reflected position. Also be sure that the small catch in the lower left hand corner of the casting face presses on the shoulder of the Plug-In Element to keep it in proper alignment and assure a good contact with the dc connection and between the lower edge of the element and line section body.

3-3. Before any power measurements are made, be sure the pointer rests on the 0 mark. If it is not, adjust the zero adjustment screw, with the range switch in the OFF position, clockwise or counterclockwise until the pointer rests at the zero mark. This adjusting screw is located at the bottom center of the meter bezel face.

### 3-4. FREQUENCY RANGE

3-5. The elements are selected for the frequency range being used. Each element is marked with its frequency range. The transmitter frequency must be within the band of the element used. Several of these elements will cover a very wide frequency range.

Table 3-1. Element Table

Full-Scale Power Ranges (Watts)	Frequency Bands (MHz)						
	0.200-0.535	0.45-2.5	2-30	25-80	50-200	144-520	200-1000
1/3/10/30/100/300/1000			4410-3	4410-5	4410-6	4410-7	4410-8
10/30/100/300/1000/3000/10000	4410-1	4410-2	4410-4				

Table of additional Elements recently made available.

Full-Scale Power Ranges (Watts)	Frequency Bands (MHz)				
	25-80	50-125	100-250	200-500	400-1000
0.1/0.3/1/3/10/30/100	4410-10	4410-11	4410-12	4410-13	4410-14

### 3-6. POWER RANGE COVERAGE

3-7. Each element is marked with its maximum power range capability, usually 1kW or 10kW. Also stamped on the element nameplate is a factor number. The power range switch on the Model 4410 determines the full scale power range to be used. This switch when set on a numbered position and multiplied by the element factor number, gives the full scale power value. For example, if the element factor is 10 and a switch setting of 30 is opposite the ARROW on the front face of the unit, 30 multiplied by 10 gives you 300W. This is the full scale value the unit is to be used. In this case the lower scale on the meter face will be used. If the number opposite the ARROW is 10 and the element factor is 10, thus  $10 \times 10 = 100$ , and 100W will be the full scale reading and the upper scale will be used.

3-8. For reflected power readings the element is rotated 180° in the element socket and the same system is used, however, a much lower switch setting maybe advantageous for better resolution.

### 3-9. LOAD POWER

3-10. Where appreciable power is reflected, as with an antenna, it is necessary to subtract the reflected from forward power to obtain load power. Power delivered to and dissipated in an antenna is given by:

$$W_l = W_f - W_r$$

Where:  $W_l$  = power into load  
 $W_f$  = forward power  
 $W_r$  = reflected power

3-11. This correction is negligible, less than 1% if the load is such as to have a VSWR of 1.2 or less. A good resistor such as our TERMALINE® Load Resistors will show this negligible or unreadable reflected power.

3-12. The THRULINE® used with a Bird TERMALINE® Load Resistor of proper power rating forms a highly useful absorption wattmeter. Since the reflected power will be negligible, it will be unnecessary to rotate the element from the forward direction.

### 3-13. DETERMINING VSWR

3-14. The Model 4410 THRULINE® Wattmeter is not designed to provide direct VSWR readings. It is felt that VSWR readings are no more useful than the ratio of forward to reflected power. In most cases operators find that in transmitter tune up, antenna matching and similar problems dealing with RF circuits, the forward power to reflected power ratio is a highly useful tool. However, VSWR readings can be determined very easily by the use of the provided graphs as follows:

- a. Determine the forward and reflected power as described above.
- b. Refer to the appropriate graph, Figure 3-1 or 3-2, to convert the forward and reflected power readings to VSWR. Note that the graphs convert the readings directly to VSWR without any intermediate computations.

### 3-15. SHUTDOWN

3-16. When all measurements are completed be sure to turn the power range switch to the OFF position. Leaving the switch on one of the power ranges will not be detrimental to the circuit in any way other than the fact that it will shorten battery life. Note that there is a battery test position on the range selector switch. This battery test position is provided to conveniently check the condition of the battery occasionally to assure accuracy of the unit.

3-17. Always be sure the transmitter power is off before disconnecting the unit from the transmission line.

### 3-18. PERFORMANCE NOTES

3-19. The Model 4410 THRULINE® is sensitive to a modulated signal which effects the accuracy. However, small amounts of AM (up to 10%) are tolerable, but for every 1% of AM the reading may increase up to 1% beyond the rated accuracy. Use above 10% AM is not recommended.

3-20. The stated accuracy does not include effect of less than infinite directivity of the element used. This is generally insignificant except for reflected power measurements where VSWR is low.

3-21. Although the Model 4410 is equipped with Quick-Change connector types, it must be remembered that the power rating and insertion loss may be affected if other than the "N" type connectors are used. Power limits must be governed by the type of connector or transmission line used. For other types of Quick-Change connectors see Section VI - Replacement Parts List.

3-22. The accuracy of the unit may be affected by a weak battery. Check the condition of the battery occasionally by use of the battery test position on the selector switch. If the pointer on the meter indicates below the battery test zone, it must be replaced.

3-23. When the range switch of the Model 4410 is set in one of the numbered positions; i.e., other than OFF or BAT, it is normal for the meter to drift or deviate off the zero setting. This condition occurs when an element is out of the line section socket or if the element is rotated 90° in the line section in a shorting position.

Figure 3-1. VSWR Conversion Nomograph.

Following the vertical and horizontal grid, determine intersection of forward and reverse power values. Slanted lines passing closest to this point indicate VSWR.

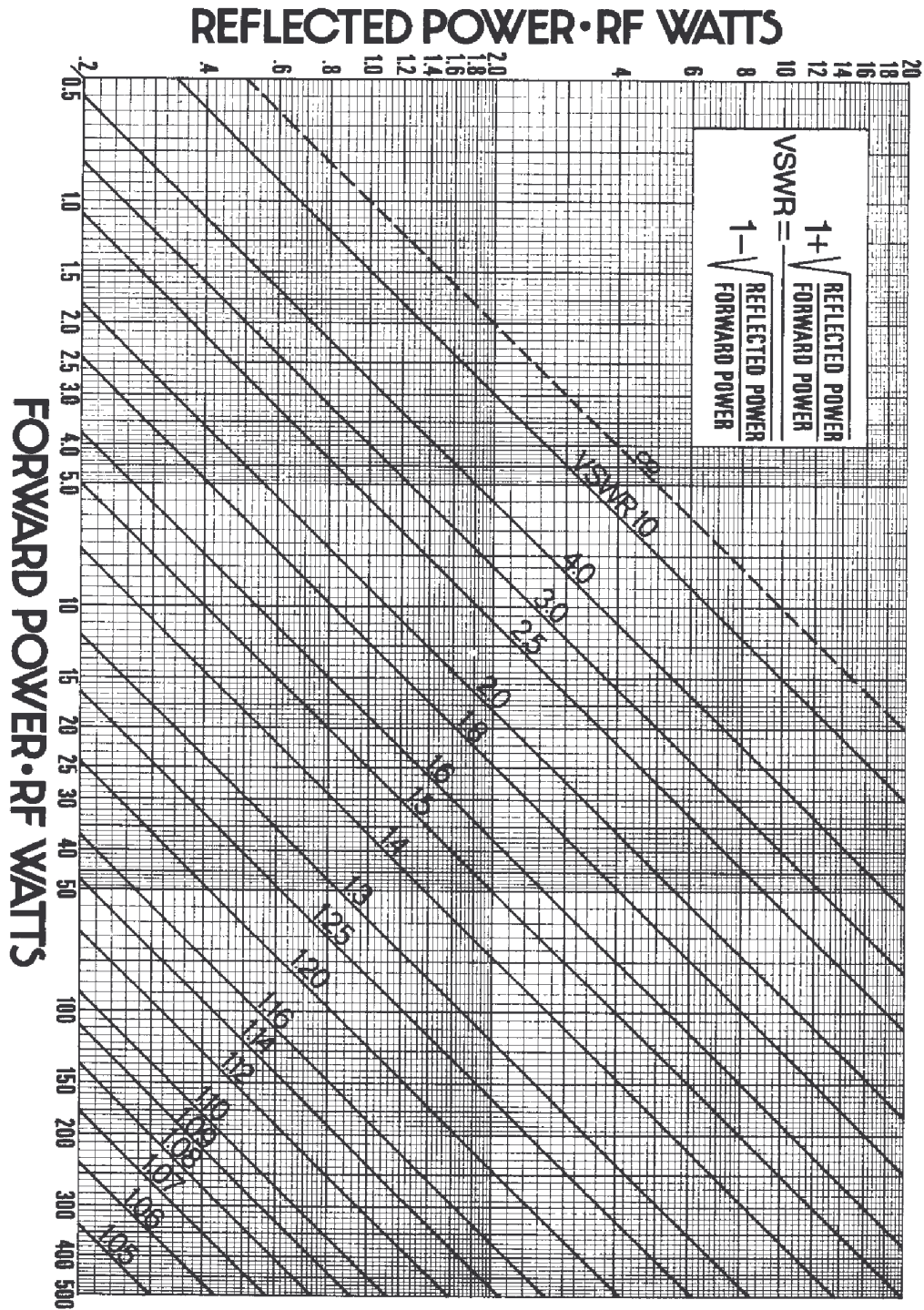
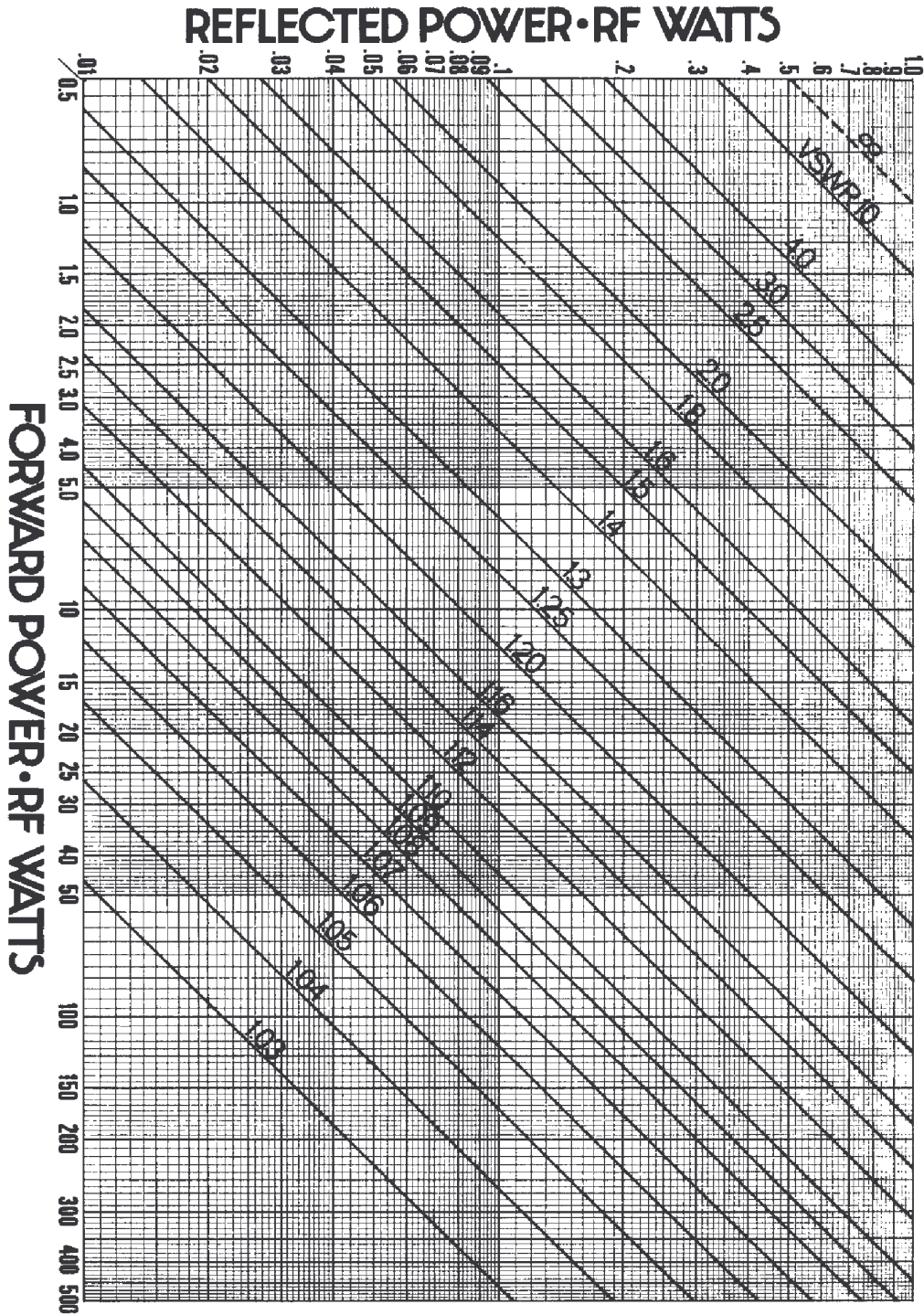




Figure 3-2. VSWR Conversion Nomograph.





## SECTION IV - MAINTENANCE

### 4-1. GENERAL

4-2. The Model 4410 THRULINE® Wattmeter is of very rugged construction and requires very little care and maintenance except for battery replacement. Maintenance of the wattmeter, is normally limited to cleaning. The amount of cleaning necessary can be minimized by keeping the Plug-In Element in the socket of the line section as much as possible. This serves as an effective seal against the entry of dust and dirt. Cover the socket opening when the element is removed. Also, protect the RF connectors on the line section against the entry of dust and dirt by keeping them connected to the line or by covering them when the line is disconnected.

### 4-3. CARE AND CLEANING

```
*****  
*                               W A R N I N G                               *  
*                                                                                   *  
* When using dry cleaning solvents or pressurized spray *  
* cleaner, take necessary precautions and supply adequate *  
* ventilation. Avoid breathing fumes. *  
*****
```

4-4. All contacts must be kept clean to assure low resistance connections to and within the unit.

4-5. RF Connectors - Clean RF connectors with a cotton swab stick dampened with alcohol, freon or any acceptable dry cleaning solvent.

4-6. Clean the inside of the line section socket bore and the entire circumference of the Plug-In Element with a cotton swab stick dampened with dry cleaning solvent. Pay particular attention to the cleaning of the bottom rim of the element body and to the seat of the socket in the line section. When cleaning the socket bore, take care not to disturb the spring finger of the dc contact. If necessary, the spring finger of the dc contact can be adjusted manually. The button must be positioned out far enough to make good contact with the element body, but it must not restrict the entry of the element body. Check the inside of the line section for dirt and contamination. Clean the reachable portions of the line section with a cotton swab stick. Blow out the remaining dirt with low pressure, dry compressed air. Do not attempt to remove the RF line conductor from the line section. Any attempt to remove it will ruin the assembly.

4-7. Clean the meter and meter housing using a cloth dampened with a mild detergent solution. Do this only when necessary and take care not to allow water to enter any of its circuitry as damage may result.

#### 4-8. BATTERY REPLACEMENT

4-9. The battery holder is located on the back of the unit near the top of the meter housing cover.

4-10. To replace the battery, pry open the battery compartment cover. Use your fingernail, coin or any other flat object to snap open the cover from the left or ribbed side. Manipulate the battery out of the compartment, a small screwdriver or knife may be useful for this purpose.

4-11. When the battery is free, remove the snap-on battery plug and replace battery with a fresh one. When reinserting the battery in its compartment, feed the connecting wires through the hole in the back of the compartment to provide room for the battery.

4-12. The Model 4410 THRULINE® Wattmeter is especially designed for independent, long term, trouble free operation. Regular mechanical maintenance, other than routine checks and cleaning care described previously, are not required. In case of malfunction of the unit or replacement of a major component the entire unit may be returned to the factory. This applies especially to any THRULINE® still under the one year warranty. Consult with the factory. Do not tamper with calibration settings or do other unauthorized maintenance work during the first year, it could be cause to void the warranty. Test and calibration in the field may be performed as described in Section V. Other replacements that might be needed are given in this section. A Troubleshooting Chart listing some of the most common problems that might occur is provided.

#### 4-12. TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	REMEDY
No Meter Indication	No RF power	Check RF source.
	ARROW on Plug-In Element pointing in wrong direction	Reposition element.
	No pick-up from dc contact finger	Adjust, see Paragraph 4-6.
	Open or short circuit in dc meter leads	Replace defective leads.
Intermittent or Inconsistent Meter Readings	Meter burned out or damaged	Replace or return wattmeter to the factory for meter replacement and recalibration.
	Faulty transmission line or load	Inspect line connections, antenna or load.
	Dirty dc contact on elements	Clean, see 4-3, Care and Cleaning.
High Percentage of Reflected Power	Sticky or defective meter	Replace or return wattmeter to the factory for meter replacement and recalibration.
	Bad load or poor connectors	Replace load, antenna or connectors.
	Shorted or open transmission line	Service or replace line.
	Foreign material in line section or in RF connector bodies	See 4-3, Care and Cleaning.

#### 4-13. METER REPLACEMENT

4-14. If it becomes necessary to replace the meter, the back cover must first be removed. The cover is removed by first unscrewing the four #8-32 Phillips flat head screws that secure the cover. These screws are located two on each side of the meter housing near the

back edge at the top and bottom of the sides. When these screws are removed the cover may be pulled straight off. Then follow the steps below:

- a. On the back of the meter loosen two #8-32 nuts that secure the meter leads and remove the leads.
- b. Remove the two #10-32 oval head Phillips screws that secure the meter shock ring. These screws are located on each side of the meter housing just opposite the meter.
- c. With the screws that secure the meter removed, the meter may be pulled out of the meter housing from the back. Now the meter retaining ring and shock mount may be removed.
- d. Replace the meter by reversing the procedure above. Be sure to observe polarity when replacing the leads to the meter, black to negative, etc.

#### 4-15. INSTRUMENTATION MODULE REPLACEMENT

4-16. When removing the instrumentation module the back cover must be removed as above in meter removal. The instrumentation module contains the line section and circuit board chassis as an integral part and is removed as such by the following steps:

- a. Using a .050 Allen wrench, loosen the set screw in the range switch knob by turning in a counterclockwise direction. Then pull the knob straight off.
- b. Unsolder the leads from the connections on the top of the circuit board chassis. Take note of the color coding when unsoldering so that they are connected to their original position when reinstalling.
- c. Remove the two oval head Phillips screws located on the front face of the unit on either side of the line section element port. These are removed by twisting in a counterclockwise direction.
- d. The instrumentation module may now be pulled straight out from the back of the unit.
- e. Replace the instrumentation module by reversal of the above procedure. Be sure to reconnect the wire to their original position.

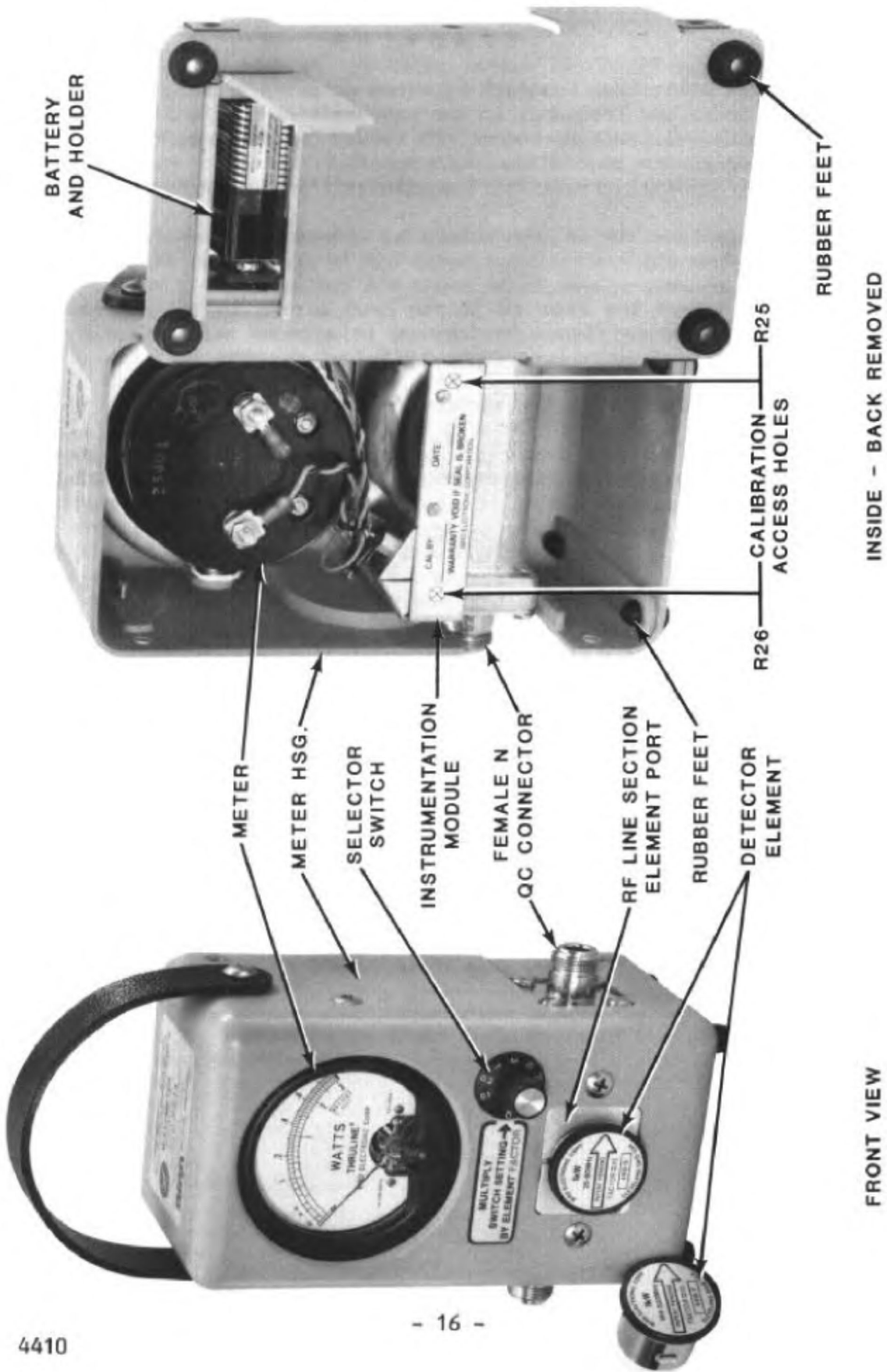
4-17. RF CONNECTORS REPLACEMENT

```
*****  
*                               C A U T I O N                               *  
*                               *                                           *  
* If other than Female N type connectors are used, limit *  
* power and frequency to the capabilities of the RF *  
* coaxial cable or connectors used. Damage to connectors *  
* or errors in reading could result. *  
*****
```

4-18. To replace the RF connectors or change to another Bird "QC" type proceed as follows:

- a. Remove the four #8-32 pan head screws in the corners of the connector flange by turning in a counterclockwise direction.
- b. Carefully pull the connector straight off.
- c. Replace the connector by reversing the procedure above. See Section VI - Replacement Parts List for other available connectors.

Figure 4-1. Parts Illustration





## SECTION V - CALIBRATION AND TEST PROCEDURE

### 5-1. REQUIRED TEST EQUIPMENT

<u>ITEM</u>	<u>QTY</u>	<u>TYPE UNIT</u>	<u>RECOMMENDATION</u>
1	1	Sine wave generator	Hewlett Packard Model 329A
2	1	Precision digital multimeter	Data precision Model 3500
3	1	Plug in calibration element	Bird Model 4410-070
4	1	Field strength meter	Bird Model 43 equipped with Bird Model 4030 relative field strength element
5	1	BNC adapter tee	Kings Connectors (UG274 A/U)

### 5-2. GENERAL

5-3. This procedure provides a means for complete calibration of the Model 4410 THRULINE® Meter Assembly. The calibration of the 4410 type elements is not covered by this procedure.

### 5-4. EQUIPMENT NOTES

a. The sine wave generator must be able to produce a stable 1000Hz  $\pm 00$ Hz symmetrical sine wave at various RMS output voltages between 0.05 and 1.6 volts RMS into an impedance of approximately 600 ohms resistive. Its output level adjustment must be such that these various specific output levels can be conveniently adjusted to within  $\pm 0.03\%$  of their stated value. Total harmonic distortion must be less than 0.2%.

b. The digital multimeter must have an ac voltmeter range capable of measuring the RMS voltage amplitude of the sine wave within  $\pm 0.1\%$ , with a resolution of at least 3-1/2 significant digits.

c. The Bird Plug-In calibration element requires no adjustment. However, care should be taken to avoid damage to the unit from rough handling or exposure to voltages greater than those specified.

d. The field strength meter should be set on its maximum sensitivity.

e. Connect the sine wave generator and voltmeter to a BNC T adapter as shown in Figure 1. with 50 ohm coaxial cables, such as RG-58-U, no more than three feet long (1 meter).

#### 5-5. CALIBRATION ENVIRONMENT

5-6. In order to assure the best results obtainable, the following environmental conditions must be provided to the utmost degree practical.

a. The work space must be free from electrical noise and radiated signals. The area in which the calibration is to be performed may be checked for spurious radiation with a Bird Model 43 THRULINE® Wattmeter equipped with a Model 4030 relative field strength element. Calibration should not be performed in areas where spurious radiation is present as indicated by any meter deflection on the Model 43/4030 combination. Be sure the gain on the Model 4030 is set at maximum.

b. The work space and equipment must be in a uniform and stabilized ambient temperature between 20°C and 25°C (68°F to 77°F).

c. The relative humidity of the work space must be no greater than 50% and must be noncondensing.

#### 5-7. CALIBRATION PROCEDURE

5-8 Allow all the equipment and the instrument to be calibrated to completely stabilize with respect to the environment of the work area (specified above). The Bird Model 4410 instrument to be calibrated and the Bird Model 4410-070 calibration element may require up to 24 hours for complete environmental stabilization if brought from an extreme storage environment (65°C, 90% relative humidity) into the work-space environment (20°C, 50% relative humidity). Remove the dust plug or any element from the 4410's line section during this environmental stabilization period.

5-9 With the Model 4410 selector switch in the OFF position, carefully turn the zero adjust screw on the face of the meter for a zero setting. Using the BAT and OFF positions on the switch, repeat this process until a repeatable zero setting is obtained.

5-10 The access holes for the calibration potentiometers, R25 (electrical zero adjust) and R26 (full scale calibration) are sealed with a protective label. This label, which is signed and dated showing the original calibration date, must not be disturbed until recalibration becomes necessary and certainly not within the warranty period. Disturbing this label voids the warranty. If the unit is to be field calibrated, after the warranty period, access to the calibration potentiometers, R25 and R26, is provided by piercing the protective label at the points shown by a circle with an X in it " X ", see Figure 5-2 for reference. Follow the steps below to calibrate:

a. Connect the sine wave generator to the calibration element, P/N 4410-070, and voltmeter as shown in Figure 5-1.

- b. Turn on the ac voltmeter and sine wave generator. Adjust the output to  $1.591 \pm 0.0005$  volts RMS at  $1000\text{Hz} \pm 100\text{Hz}$ . Make sure that the generator's "symmetry", "offset", and "waveform" controls are set to provide a symmetrical sine wave with zero dc offset. Leave the equipment in this condition to stabilize for the period of time recommended by the manufacturers but not less than five minutes.
- c. Turn the 4410 on to it's "100" position and allow it a minimum of five minutes to stabilize. The 4410 does not need to be connected to the calibration set up for the five minute warm-up period.
- d. After the equipment has stabilized, check the battery in the 4410 by momentarily placing its switch in the BAT position. The meter pointer should travel well into the "BATTERY TEST" region of the meter scale. If necessary, turn the unit off and replace the battery. Return the switch to the "100" position. Allow the unit's internal circuitry to stabilize for another five minutes if the battery was replaced.
- e. Insert the calibration element into the 4410 and rotate it in either direction until it stops.
- f. Recheck the sine wave generator for the proper  $1000\text{Hz} \pm 100\text{Hz}$  output settings, then readjust the amplitude as necessary, until the voltmeter reads a stable  $1.591 \pm 0.0005$  volts.
- g. Rotate the calibration device approximately  $90^\circ$  so as to short the contact in the socket to the line section body. If the meter needle does not come to rest at exactly zero, then adjust R25 counterclockwise, very slowly, just until it does. The location of R25 is shown in Figure 5-2. If the pointer already rests at exactly zero, then go on to step 5-10h.
- h. Rotate the calibration element in either direction until it stops.
- i. Adjust R26 until the meter pointer is at "1", full scale on the uppermost scale. The location of R26 is shown in Figure 5-2.
- j. Rotate the calibration element  $90^\circ$  so as to short circuit the spring contact in the socket to the line section body. Simultaneously measure the time required for the meter pointer to travel from its full scale position to ZERO. Adjust R25 and repeat steps 5-10h and i. until the time required for the meter pointer to travel from a full scale reading to ZERO is  $4.0 \pm 1.0$  seconds.
- k. Turn the 4410-070 calibration element  $90^\circ$  to short circuit the spring contact in the line section to the line section body. Set the 4410 range switch to the ONE position. Now

adjust the sine wave generator's output to 0.1591 volts RMS. Rotate the calibration element in either direction until it stops. Then Adjust R26 until the meter pointer rests at "1" on the upper scale.

5-1. Calibration Set-Up

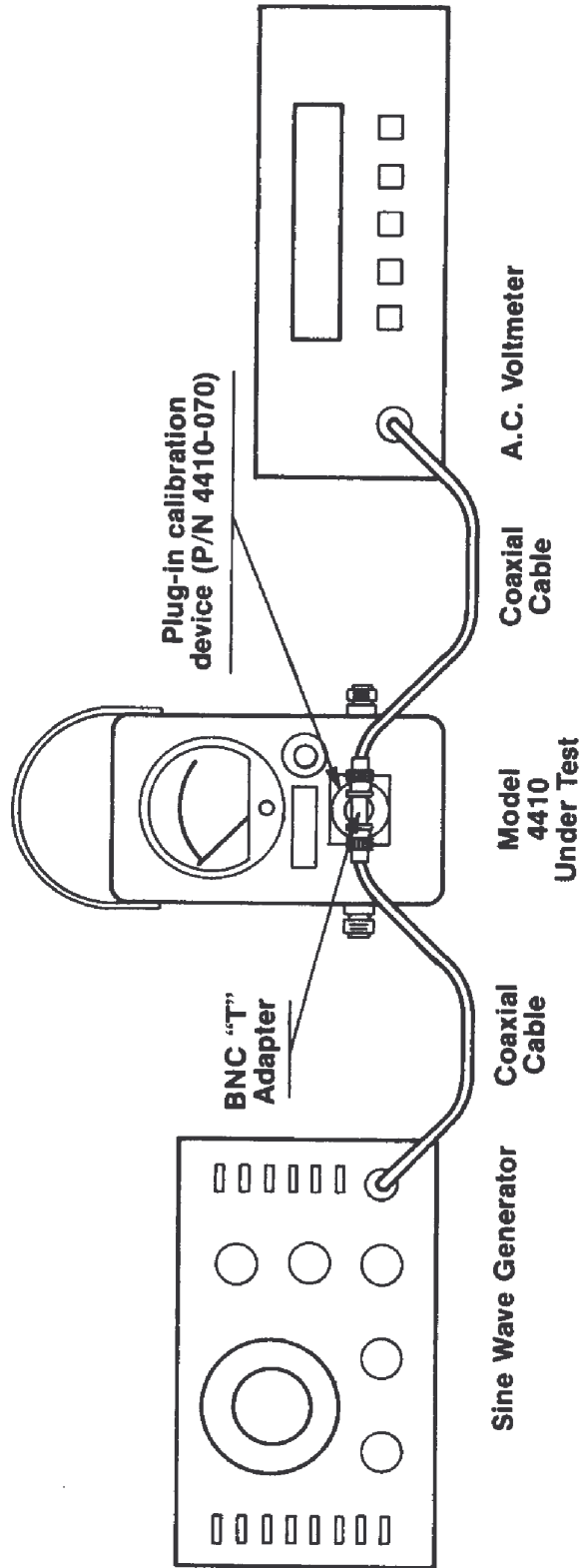
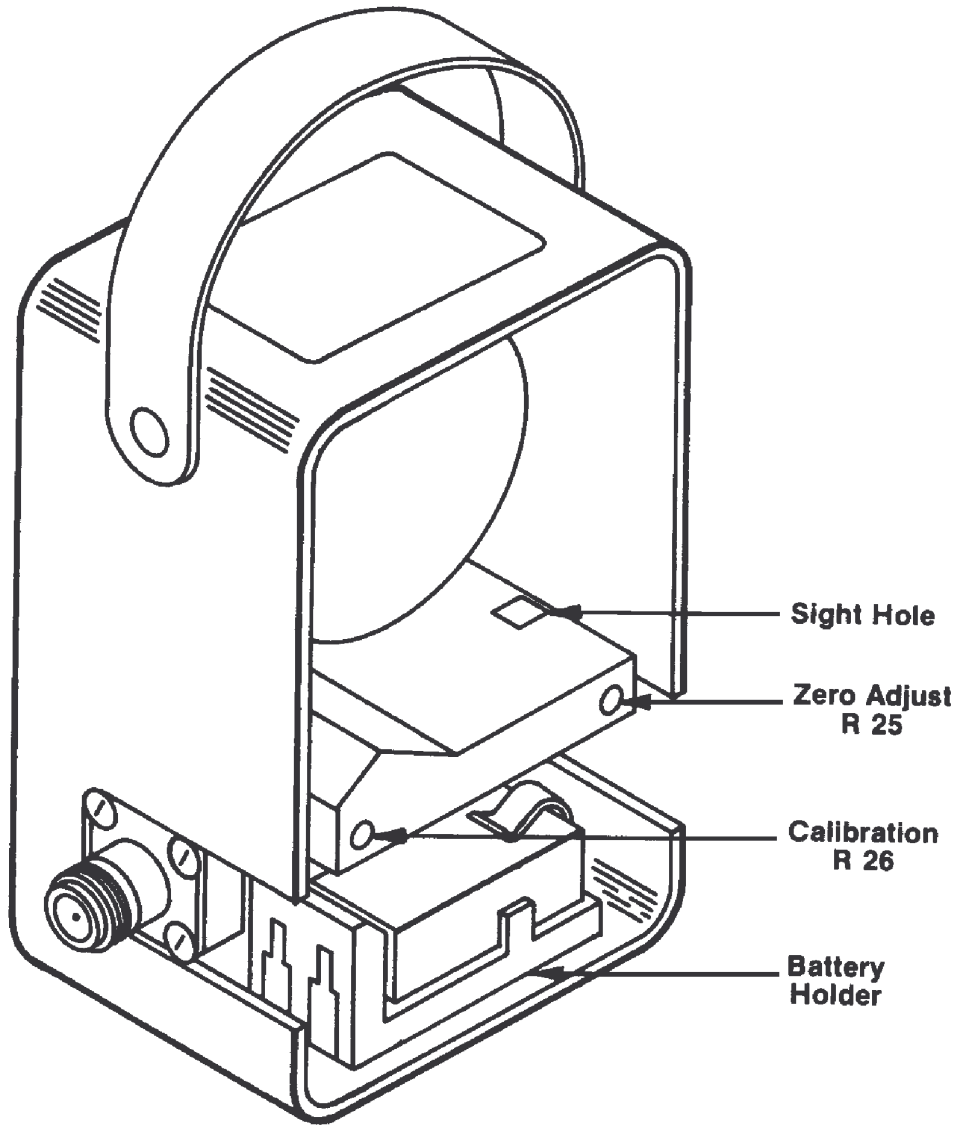


Figure 5-2. Calibration Potentiometers.





SECTION VI - REPLACEMENT PARTS LIST

6-1. MODEL 4410

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	Meter, dc	2080-052
2	1	Assembly, Instrumentation Module (Includes line section and instrumentation)	4410-021
3	1	Assembly, Meter Housing	4410-003
4	1	Assembly, Meter Housing Cover	4410-039
5	1	Knob, Selector Switch	4410-015
6	1	Strap, Carry (Included in 4410-003)	8580-003
7	1	Battery (Standard 9V Alkaline, Duracell, Mallory No. 1604 or Equivalent)	5-1375
8	1	Plug-In Calibration Element (Optional Item)	4410-070
9	2	"QC" Connectors (F-N normally supplied)	*See Below

\*Available "QC" Type Connectors

N-Female	4240-062	LT-Female	4240-018
N-Male	4240-063	LT-Male	4240-012
HN-Female	4240-268	C-Female	4240-100
HN-Male	4240-278	C-Male	4240-110
LC-Female	4240-031	UHF-Female(SO-239)	4240-050
LC-Male	4240-025	UHF-Male(PL-259)	4240-179
	7/8" EIA Air Line 4240-002		

— NOTES —



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