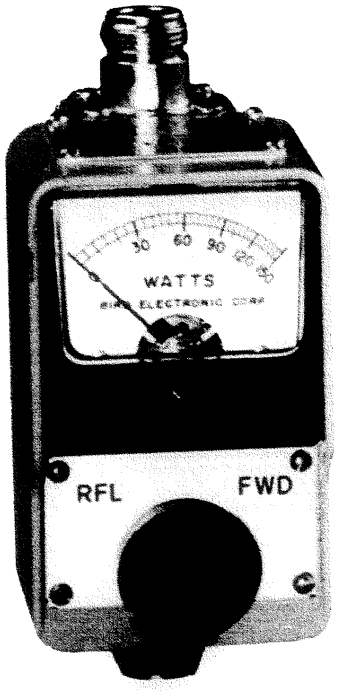
# INSTRUCTION BOOK FOR

# SERIES 4111
# RF DIRECTIONAL
# THRULINE® WATTMETER

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***MODELS COVERED IN THIS INSTRUCTION BOOK***

| | | |
|---|---|---|
| 4111 | 4114 | 4121 |
| 4111-050 | 4114SP | 4123 |
| 4112 | 4115 | 4123-100 |
| 4112-010 | 4116 | 4124 |
| 4112-025 | 4118 | 4125 |
| 4113 | 4120 | 4127 |
| 4113-010 | | |

# SAFETY PRECAUTIONS

The following are general safety precautions that are not necessarily related to any specific part or procedure and do not necessarily appear elsewhere in this publication.

Keep away from live circuits.

Operating personnel must at all times observe normal safety regulations. Do not attempt to replace parts or disconnect an RF transmission or any other high voltage line while power is applied. When working with high voltage always have someone present who is capable of rendering aid if necessary. Personnel working with or near high voltage should be familiar with modern methods of resuscitation.

Warning: Warning notes call attention to a procedure, which if not correctly performed could result in personal injury.

Caution: Caution notes call attention to a procedure, which if not correctly performed could result in damage to the instrument.

The following will appear in the text of this publication and are shown here for emphasis.

**CAUTION**

Though the wattmeter is ruggedly constructed, rough handling, or severe impact can damage the delicate mechanism of the meter. Use reasonable care when handling the unit. Do not use the unit to test equipment which has a higher output than the rated power of the wattmeter.

Continued

**CAUTION**

Do not attempt to remove the center conductor from the line section. Any attempt to remove it will ruin the assembly.

**CAUTION**

Do not attempt to replace parts or components of the line section assembly. The electronic parts of this assembly are carefully selected and matched. Replacement of the parts with standard tolerance parts may disrupt the circuits and result in wrong meter readings.

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FIGURE I-1. MODEL 4111 THRULINE® WATTMETER WITH OPTIONAL FEMALE N CONNECTORS

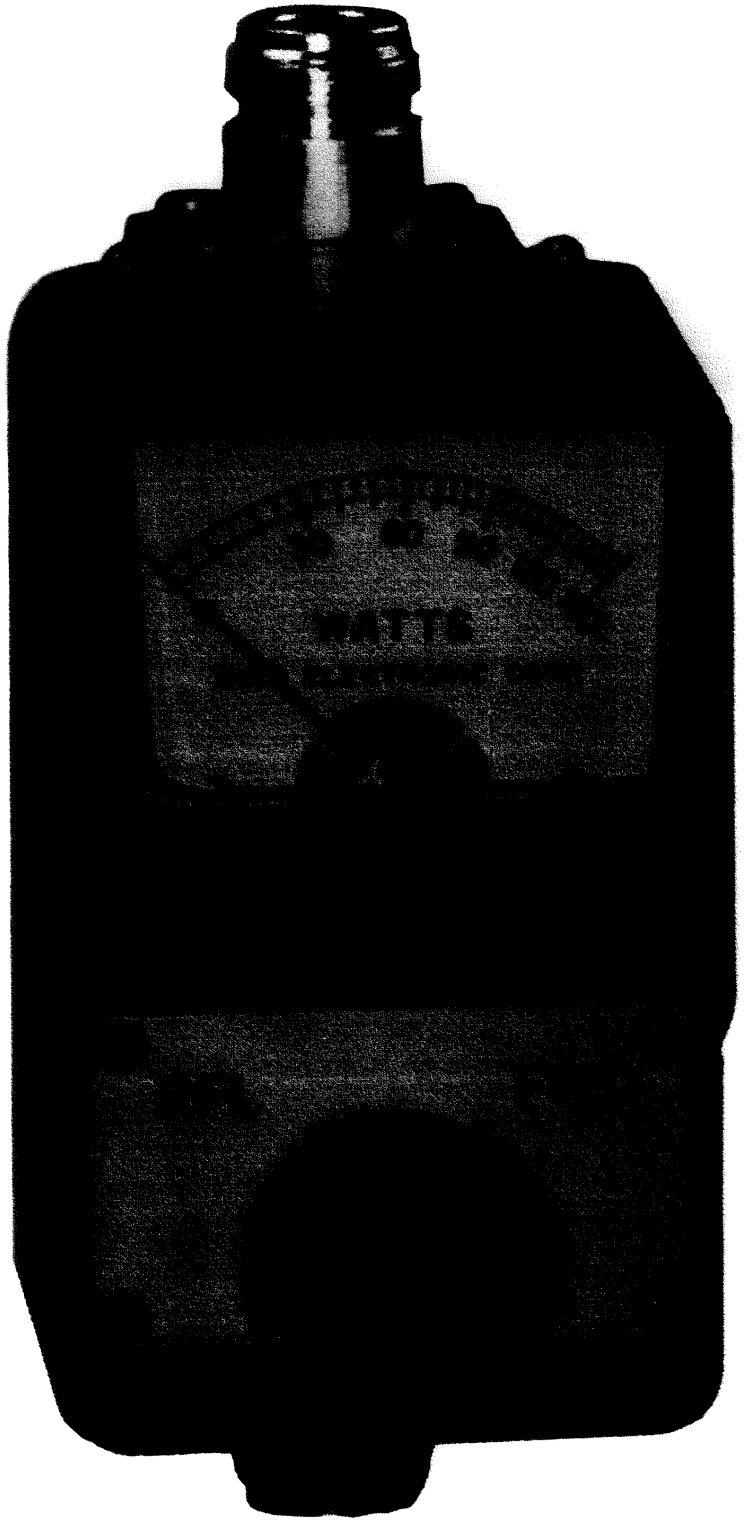
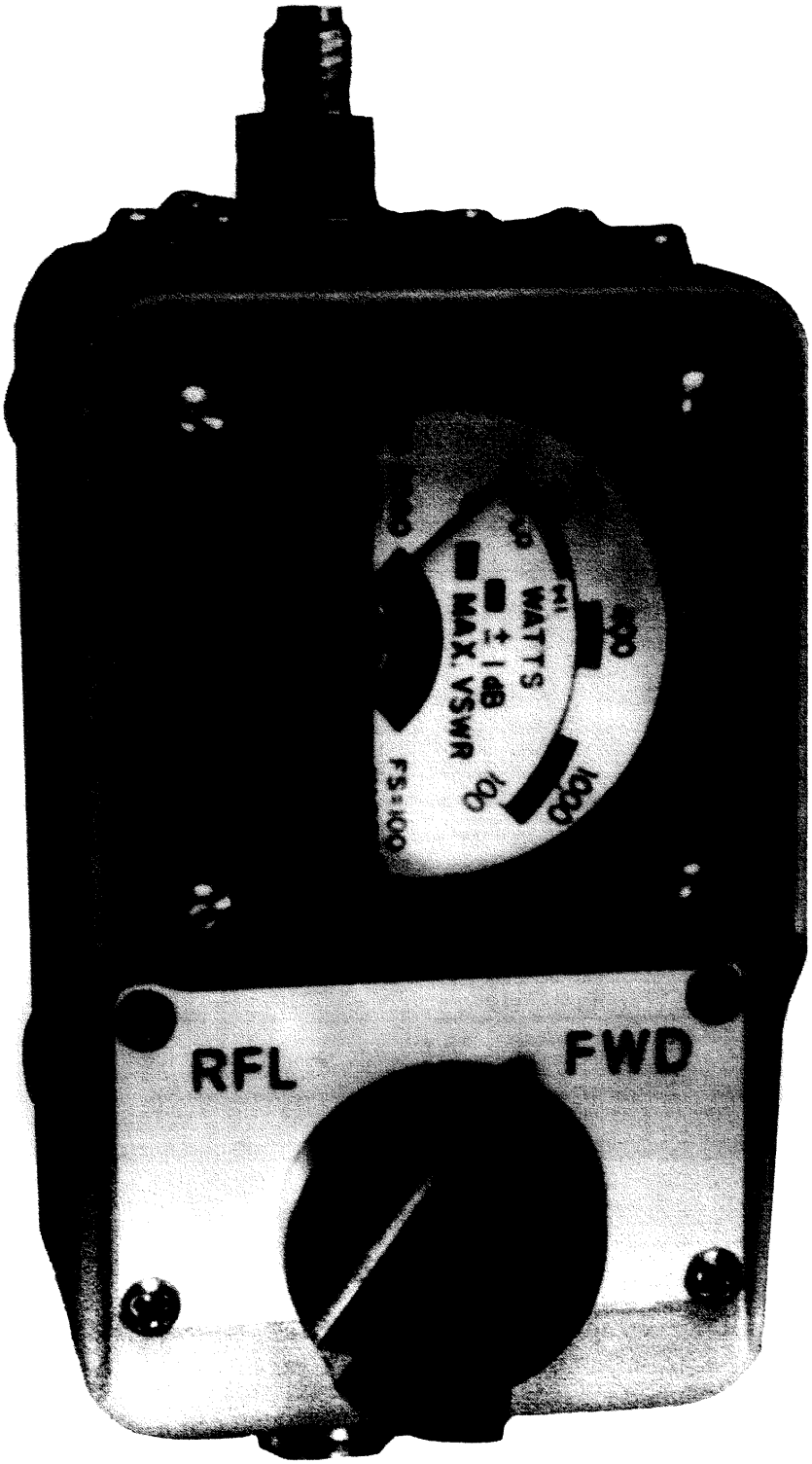


FIGURE I-2. MODEL 4116 THRULINE® WATTMETER WITH OPTIONAL FEMALE N CONNECTORS



# INTRODUCTION

## PURPOSE AND FUNCTION

The series 4111 THRULINE® Directional Wattmeters are insertion type instruments for measuring forward or reflected power in coaxial transmission lines. Each wattmeter consists of a precision machined section of 50 ohm line (contained in the bottom half of the two-part die cast housing), two directional power detectors, and a meter calibrated in watts.

The sensing circuits face in opposite directions and the front panel switch selects the direction of power to be indicated on the meter. With the transmitter connected to the top or meter side and the load connected to the switch or bottom side, the forward (FWD) position is the higher power range, while the reflected (RFL) position selects the lower power range. In case the lower power range is desired for forward power measurement, simply reverse the RF cable connections and turn the switch to the reflected position. On the Models 4116 and 4112-010, the switch is spring-loaded and returns to the forward position when it is released.

An element plate, which is part of the line section assembly, mounts on the line section with screws. The precise position relationship between the line and the sensing detectors of the element plate must be maintained. This is preset at the factory.

# SPECIFICATIONS FOR SERIES 4111 THRULINE® RF DIRECTIONAL WATTMETER

## ELECTRICAL SPECIFICATIONS

| Model | Power Rating FWD | Rating FWD | Frequency MHZ | Connectors SQC Type |
|---|---|---|---|---|
| 4111 | 150 W | 15 W | 25-175 | F-UHF (SO-239)* |
| 4112 | 200 W | 20 W | 2-30 | F-N |
| 4113 | 1000 W | 100 W | 2-30 | F-N |
| 4114 | 50 W | 5 W | 400-512 | F-N |
| 4115 | 50 W | 5 W | 100-225 | F-N |
| 4116 | 1260 W | 100 W | 2-30 | F-N |
| 4118 | 150 W | 15 W | 400-512 | F-N |
| 4120 | 50 W | 10 W | 225-400 | F-N |

* Normally supplied

**Impedance** . . . . . 50 ohms nominal

**Insertion VSWR** . . . . . 1.1 maximum

**Accuracy**

Models 4111/12/13/14/15/18/20/21/23/24/25/27 . . . . . ±5% of full scale

Model 4116 . . . . . ±10% of full scale

Model 4127 . . . . . ±10% of full scale 2 to 4 MHz
±5% of full scale 4 to 76 MHz

# SPECIFICATIONS FOR SERIES 4111 THRULINE® RF DIRECTIONAL WATTMETER [CONT.]

| | |
|---|---|
| Dimensions | 4-21/32"L x 2"W x 2-29/32"H (118 x 51 x 74 mm) |
| **Weight** | |
| All Models except as noted | 1 lb (0.45 kg) |
| Models 4116/19/20 | 1-1/4 lb (0.57 kg) |
| **Finish** | Light navy gray baked enamel |

NOTE - A complete list of specifications covering all units can be found in para 6-12, Difference Data Sheets.

# SECTION I - INSTALLATION

## 1-1. CONNECTION

1-2. The wattmeter is inserted into an RF System having a suitable coaxial cable of 50 ohms impedance only. If cables other than 50 ohms impedance are used, mismatch will occur and introduce inaccuracies in the readings.

1-3. The power source should be connected to the end of the meter marked "Transmitter" on the nameplate. This will result in the forward (FWD) position being the higher power range, while reflected (RFL) selects the lower power range. In case the lower power range is desired for increased resolution in the forward direction, simply reverse the RF cable connections to the wattmeter. Forward power will now be read in the reflected (RFL) position.

1-4. The 4111 Series Wattmeters are normally supplied with two RF connectors: the Models 4111 and 4122 with Female UHF type and all others with Female N. They are made in the Bird Small Quick Change (SQC) Design. Other "SQC" Connectors are available as listed:

| SQC No. | |
|---|---|
| 4100-014 Female N | 4110-014 Female BNC |
| 4100-015 Male N | 4100-021 Female SC |
| 4100-017 Female UHF | 4100-045 Female C |

## 1-5. PORTABILITY

1-6. The Series 4111 Wattmeter is essentially a portable instrument, and the housing is not specifically designed for an attached mounting. However, there are four 6-32 tapped holes 1/4 inch deep on the bottom side that can be used for fastening to a flat surface on .812 x 1.375 inch centers. In this case, the bumper feet on the bottom side can be removed if necessary.

**CAUTION**

**Though the wattmeter is ruggedly constructed, rough handling, or severe impact can damage the delicate mechanism of the meter. Use reasonable care when handling the unit. Do not use the unit to test equipment which has a higher output than the rated power of the wattmeter.**

# SECTION II - THEORY OF OPERATION

## 2-1. TRAVELLING WAVE VIEWPOINT

2-2. The best way to visualize the THRULINE® Wattmeter idea is from the travelling wave viewpoint on transmission lines, which illustrates that the voltages, currents, standing waves, etc., on any uniform line section are the result of travelling waves:

2-3. FORWARD WAVE travels (and its power flows) from source to load, and has RF voltage $E_f$ and current $I_f$ in phase, with $E_f / I_f = Z_o$.

2-4. REFLECTED WAVE originates by reflection at the load, travels (and its power flows) from the load to source and also has an RF voltage $E_r$ and current $I_r$ in phase, with $E_r / I_r = Z_o$.

2-5. Note that each component wave is mathematically simple, and is completely described by a single figure for power, for instance:

$$P_f = \text{Watts Forward} = E_f^2 / Z_o = I_f^2 Z_o = E_f I_f$$

$$P_r = \text{Watts Reflected} = E_r^2 / Z_o = I_r^2 Z_o = E_r I_r$$

2-6. $Z_o$ is the characteristic impedance of the uniform line, and simplifies matters by being a pure resistance, usually 50 ohms, for useful lines. The main RF circuit of the wattmeter is a short piece of uniform air-type line section, whose $Z_o$ is a very accurate 50 ohms, in which correct measurements may be made.

## 2-7. COUPLING CIRCUIT

2-8. In the travelling wave concept, the standing waves which are produced by interference between the forward and reflected travelling waves do not affect the readings on the wattmeter, since the wattmeter indicates only the forward and reflected travelling waves. However, after the forward and reflected power levels are measured, the VSWR can easily be determined by the use of graphs (figs 3-1 and 3-2). The wattmeter may also be used to find the Watts Reflected/Watts Forward ratio.

2-9. The line section contains two separate sensing units (see fig 5-1). One of these units senses the forward power and the other reflected power.

2-10. When the wattmeter is connected into a 50 ohm system, transmitter output is directed through the line section to the antenna (or dummy load). The line section is a short, uniform section of air line that does not impair the impedance of the RF coaxial line into which it is inserted. The RF waves travelling through the line section produce energy in the coupling circuits of both sensing units by inductance and capacitance. Inductor L2 and capacitor C2 sense forward power, while inductor L1 and capacitor C1 sense reflected power. Whether the meter displays the forward or the reflected power is determined by the position of switch S1.

2-11. The output of the coupling circuit is applied to a resistive and capacitive network which has been carefully balanced to its associated coupler. Each sensing unit will provide a current output that will cause the microammeter M to deflect in proportion to the RF power applied to the line section, provided the frequency of the transmission is within the rated range of the element.

# SECTION III - OPERATING INSTRUCTIONS

## 3-1. DETERMINING VSWR

3-2. This unit is not designed to provide direct VSWR (Voltage Standing Wave Ratio) readings. It is felt that VSWR readings are no more valuable than the ratio of forward to reflected power. In fact, most 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 by use of graphs. Refer to the appropriate graph (fig 3-1 or 3-2) to convert the forward power reading and the reflected power reading to VSWR. Note that the graphs convert the readings directly into VSWR values without any intermediate computations.

## 3-3. DETERMINING AVERAGE LOAD POWER

3-4. The Series 4111 Wattmeters provide easy measuring and monitoring of transmitter output power.

a. Position the selector switch in the FWD position and check the indication on the higher power range of the meter. The meter reading observed is the forward power output of the transmitter.

b. Position the selector switch in the RFL position and check the indication on the lower power range. The meter reading observed is the reflected power.

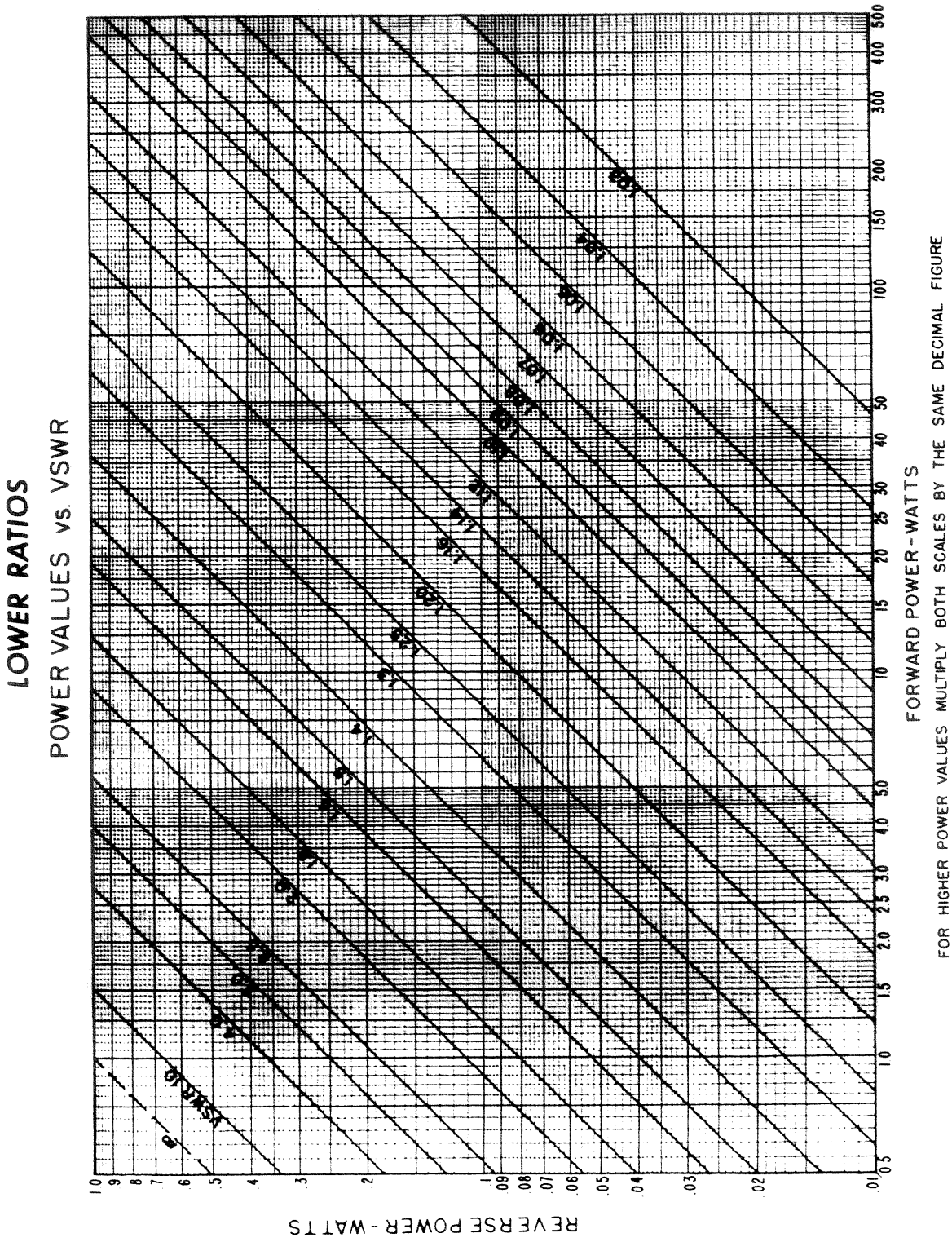
c. To determine the power dissipated in the load, subtract the reflected power reading from the forward power reading as follows: Watts (load) = Watts (forward) minus Watts (reflected).

d. The importance of the amount of reflected power varies, depending upon the load. Where appreciable power is reflected, as with an antenna, the subtraction of reflected power is necessary to obtain accurate radiated or dissipated power readings. This step is not necessary if the load is such as to have a VSWR of 1.2 or less. Good load resistors, such as the Bird TERMALINE® Load Resistor, will thus show negligible or unreadable reflected power.

e. The Model 4116 has a specially marked dial, with color bands, to facilitate operation (see fig I-2). The forward power scale has three cardinal points marked: 100, 400, and 1000 W, as well as red bands, indicating the allowable variation of ±1 dB for each of the three points. The reflected power scale is marked 100 W at full scale, and has a green band from zero up to 7 watts (marked "LO") and also up to 22 watts (marked "HI"). The green areas represent the maximum allowable reflected power for high forward range (1000 W) and low forward range (100 W) power.

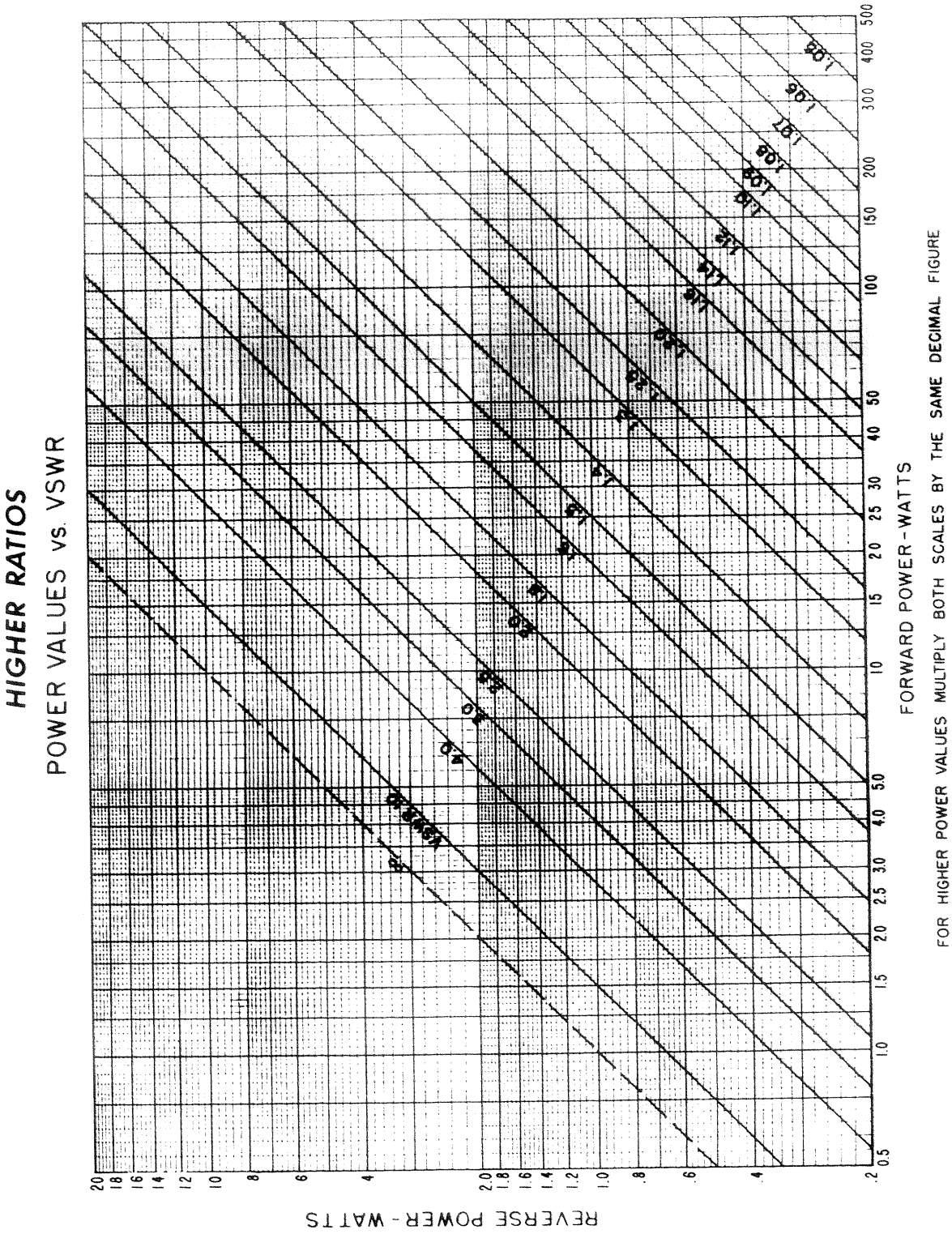
Note: If the forward and reflected power readings are alike, there is an opening in the transmission line beyond the wattmeter.

## FIGURE 3-1. VSWR CONVERSION NOMOGRAPH




Following the vertical and horizontal scales, locate the 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. CLEANING

4-2. Maintenance of the wattmeter is normally limited to cleaning. Clean the exterior of the wattmeter with a clean dry cloth. Clean the meter glass with a damp cloth.

4-3. Check the inside of the connectors for dirt and contamination. Clean reachable portions of the connectors with a cotton swab stick moistened with a self-drying solvent that forms no residue. Blow out dirt if necessary with clean, dry, low-pressure compressed air. Check the ends of the line sections for dirt and contamination after the removal of the connectors.

**CAUTION**

Do not attempt to remove the center conductor from the line section. Any attempt to remove it will ruin the assembly.

## 4-4. TROUBLESHOOTING

4-5. As a brief guide to the operator in isolating occasional difficulties that may occur in the use of the these wattmeters, the following summary is included. The remedies for the same are referenced to the text in this section or are self-evident.

**TABLE 4-1. TROUBLESHOOTING CHART**

| PROBLEM | POSSIBLE CAUSE | REMEDY |
|---|---|---|
| No meter indication | No RF power applied to test set | Check transmitter and cables. |
| | Selector switch wrong position | Change switch in position. |
| | Open or short in test set circuits (refer to Schematic) | Replace defective components. |
| | Line section assembly component burnout in test set | Replace line section (see para 4-8). |
| | Meter burned out or damaged | Replace meter (See para 4-10). |
| Intermittent or inconsistent meter readings | Faulty antenna or dummy load | Replace antenna or load. |
| | Faulty connectors or transmission line | Replace connector or transmission line. |
| | Sticky or defective meter | Replace meter (see para 4-10). |
| High VSWR or high percent of reflected power | Defective load or RF connectors | Replace load or connectors. |
| | Shorted or open transmission line | Replace if necessary. |

## TROUBLESHOOTING [CONT.]

| PROBLEM | POSSIBLE CAUSE | REMEDY |
|---|---|---|
| High VSWR or high percent of reflected power | Foreign material in RF connectors | Clean per para 4-3. |
| | Selector switch in position | Change switch wrong position. |

## 4-6. REPAIRS

4-7. Repair of the Series 4111 THRULINE® Wattmeter generally is limited to soldering loose or broken wires and replacement of damaged parts.

> **CAUTION**
>
> Do not attempt to replace parts or components of the line section assembly. The electronic parts of this assembly are carefully selected and matched. Replacement of the parts with standard tolerance parts may disrupt the circuits and result in wrong meter readings.

## 4-8. LINE SECTION REPLACEMENT

4-9. If the line section assembly is faulty, the entire unit must be returned to the factory for repair or replacement and recalibration. Any repair or replacement to the line section in the field will upset the calibration and change the accuracy. Consult the factory.

## 4-10. METER REPLACEMENT

4-11. Replace a defective meter as follows:

a. Remove the four bumper buttons on the bottom of the line section. This will expose the heads of four screws that are recessed about 13/16 inch below the bottom face of the line. These screws secure the line section to the case assembly.

b. Remove these screws freeing the line section. Carefully separate the parts to prevent breaking wires that connect the line section components to the case components. Place the two sections side by side on a flat work surface.

c. Unsolder the connections to the meter. On some models the leads may be unsoldered, or disconnected, at the meter terminals. On the other models the leads come from within the meter and must be disconnected at the line section terminals. Observe connections and wire the same way when reassembling.

d. Use a 3/16 nut driver to remove the palnuts that secure the meter to the housing. Push on the back of the meter to dislodge it from the housing.

e. A meter is replaced by reversing the procedure above. Be sure to observe correct polarity.

## 4-12. SWITCH REPLACEMENT

4-13. Replace a defective switch as follows:

a. Remove the four screws that secure the line section assembly to the case. Separate the parts carefully to prevent breaking the wires that connect the line section components to the case components.

b. Unsolder the leads from the terminals of the switch. Be sure to note the placement of each wire and attach to the same terminal on reassembly.

c. Use a 5/64 Allen wrench to loosen the setscrew in the switch knob. Pull the knob straight off of the shaft.

d. Remove the nut and lockwasher that secure the switch to the case. The switch is removed from the rear of the case inside.

e. When replacing the switch simply reverse the disassembly procedure. Generally there are two indexing holes in the meter housing next to the switch mounting hole. These holes are for the index tab on the switch. Normally only the uppermost hole is used. After the switch is mounted, reattach the interconnecting wires to the correct switch terminals.

f. After the case is assembled, position the switch knob so that the pointer indexes correctly, then tighten the set screw securely.

## 4-14. CONNECTOR REPLACEMENT

4-15. To change the input and output connectors simply remove the four pan head screws from the corners of the connector flange. The connector can be pulled straight off. A connector is installed by the reverse of this procedure. Be sure the connector's center pin is firmly engaged. Spread pin slightly if necessary.

# SECTION V - REPLACEMENT PARTS LIST

## 5-1. **SERIES 4111**

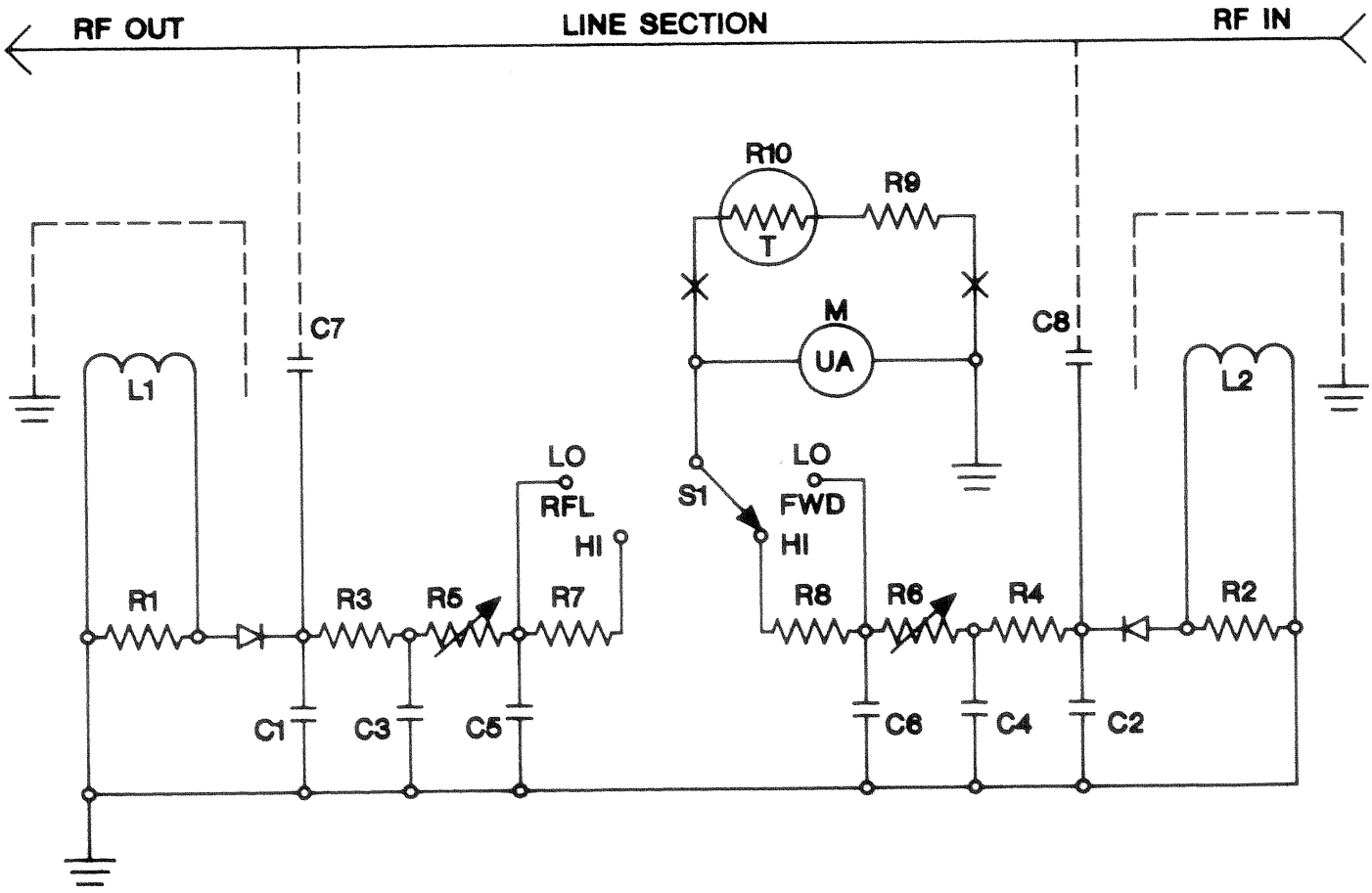
| ITEM | QUANTITY | DESCRIPTION | PART NUMBER |
|---|---|---|---|
| 1 | 1 ea | Meter | |
| | | Models 4111, 4111-050, 4118 | 2160-009 |
| | | Models 4112, 4112-010, 4112-025 | 2160-010 |
| | | Models 4113, 4113-010 | 2160-011 |
| | | Models 4114, 4114SP, 4115 | 2160-023 |
| | | Model 4116 | 2080-025 |
| | | Model 4120 | 4120-004 |
| | | Model 4121 | 2080-041 |
| | | Models 4123, 4123-100 | 2160-035 |
| | | Model 4124 | 2160-036 |
| | | Model 4125 | 2160-037 |
| | | Model 4127 | 2160-038 |
| 2 | 1 ea | Switch | |
| | | Models 4111, 4111-050, 4112-025, 4113, 4113-010, 4114, 4114SP, 4115, 4118, 4123, 4123-100, 4124, 4125 | 4111-007 |
| | | Models 4112-010, 4116 | 4116-002 |
| | | Model 4120 | 4120-007 |
| | | Model 4121 | 4121-004 |
| | | Model 4127 | 4127-007 |

## REPLACEMENT PARTS LIST [CONT.]

| ITEM | QUANTITY | DESCRIPTION | PART NUMBER |
|---|---|---|---|
| 3 | 1 | Knob | 4111-016 |
| 4 | 4 | Bumper Feet | 5-623 |
| 5 | 2 | Connector (See Table 6-1 for individual unit complement.) | |

FIGURE 5-1. SCHEMATIC DIAGRAM OF CIRCUIT (4111-4120 MODELS)

## MODEL 4111 SERIES
## TYPICAL SCHEMATIC DIAGRAM OF CIRCUIT




NOTE: RESISTOR (R9) AND THERMISTER (R10) ARE NOT USED ON ALL MODELS.

OTHER COMPONENTS SHOWN MAY NOT BE APPLICABLE TO ALL MODELS.

# SECTION VI - DIFFERENCE DATA SHEET

6-1. **MODELS 4111-050 AND 4112-025 ONLY**

6-2. **DESCRIPTION** - These MINI-MONITOR® models have been modified to permit calibration of the wattmeters by simple field or base maintenance procedures (see below). Essentially, this modification consists of substituting two adjustable resistors for the previously fixed individually selected calibrating resistors. The resistances, now set by potentiometer adjustment, will be seen on the schematic diagram, fig 5-1, as the two resistor components adjacent to RFL and FWD reading contact points on the Selector Switch, S1.

6-3. **MAINTENANCE**

6-4. **FIELD CALIBRATION** - Equipment required, relatively common, is as follows:

a. "Insertion" type RF Wattmeter - such as Bird Model 43 THRULINE® Wattmeter, or equivalent. The wattmeter should have an accuracy of at least ±5 percent full scale. With a Bird 43 Wattmeter, only two plug-in elements would be required for these calibrations - Type 25A and 250A, i.e. 25 and 250 watts f.s., respectively, in the 25-60 MHz band.

b. Coaxial Line Termination such as Bird Model 8201 or 8135 TERMALINE® load resistor, or acceptable low-loss equivalent.

c. Connectors, as needed - see text following.

d. Small screwdrivers.

6-5. **PREPARATIONS** - Turn the wattmeter over so that its underside is accessible and remove the four push-in type bumper feet, P/N 5-623, at the base of each of the four side ribs of the line section. These can be pried off with fingers or small screwdriver, exposing the deep counterbores in each rib. Now unscrew the four 6-32 x 5/16 inch fillister head machine screws (with lockwashers) in each hole, releasing the base portion of the wattmeter (line section) from the meter housing. Use caution at this stage to avoid pulling or letting the line section fall away - be careful. Lay the base over with the element plate upward. Do not disturb the orientation of the parts. The meter or nameplate end is the input, and is marked "4" at the corner post at this end of line section plate (observe white lead). Keep parts in this relationship. Note however, that the FWD pick-up element is at the opposite end of the plate, marked "1". Meter wire (black) goes to ground post, No. 2.

6-6. **SET-UP** - Attach the MINI-MONITOR® line section to the calibration set-up as shown in fig 6-1. Connect the components as directly as possible, with the fewest adaptors.

6-7. Note that the Model 4111 is fitted with UHF type Female connectors and may need a connector change, or adaptors. Use of Bird "Quick-Change" Male connectors in place of the existing Female connectors may be helpful - P/N 4100-015 for small pattern "QC" on the 4111 Line Section, and P/N 4240-063 for regular "QC" on the Model 43 THRULINE® Wattmeter or Load Resistor (8135 or 8201).

6-8. Calibrate as follows: Set the transmitter frequency close to 25 MHz for either model. Make all calibrations at the full power levels of the wattmeter models, as shown below:

| | **FWD** | **RFL** |
|---|---|---|
| Model 4111 | 150 W | 15 W |
| Model 4112 | 200 W | 20 W |

Insert the 250A element into the socket of the Model 43 Wattmeter and turn it to the position to read forward power. Be sure connections are tight, line termination in place, and Model 4111/12 switch in the FWD position before applying RF transmitter power. Note - if an 8135 TERMALINE® Load Resistor is used as the load, 200 watts power should not be applied for longer than 10 minutes.

6-9. Now tune the transmitter output so that the precise respective full scale forward power reading appears on the comparison wattmeter (Model 43). Use an instrument like a jeweler's type screwdriver to adjust the "FWD" potentiometer (located at the switch end of the element plate). Rotate its slotted yellow center to bring the MINI-MONITOR® reading to 3 or 4 percent below the reading on the Model 43. Clockwise rotation will lower the reading, counter-clockwise will raise it.

6-10. For reflected power calibration, reverse the RF connections of the transmitter and load to the MINI-MONITOR®. The reflected power potentiometer adjustment is at the opposite (input or meter) end of the element plate. Be sure to reduce the transmitter power before turning the selector switch to RFL. Use the 25 watt element in the Model 43. Adjust the RFL potentiometer as described in para 6-9 and set MINI-MONITOR® to read 3 to 4 percent low, as above. The lowered values set are due to calibrations being made at the ends of the respective frequency bands, thus compensating for small fall-off at the band edges.

6-11. Shut off transmitter power and remove the calibrated wattmeter. Reassemble the MINI-MONITOR®, reversing the Set-up Procedure described above. Be careful not to reverse the direction of line section to meter base. Screw the base on tightly and restore the bumper buttons.

## TABLE 6-1. COMPILATION OF UNIT SPECIFICATIONS

| MODEL NO. | FREQ. MHZ | POWER LEVEL FWD | RFL | INPUT CONN. | OUTPUT CONN. | OUTPUT | LOAD IMP. | ACCURACY OFS |
|---|---|---|---|---|---|---|---|---|
| 4111 | 25-175 | 150 | 15 | F-UHF | F-UHF | 100µA | 2000 | ±5% |
| 4111-050 | SAME AS 4111 BUT HAS FIELD CALIBRATION CAPABILITIES. | | | | | | | |
| 4112 | 2-30 | 200 | 20 | F-N | F-N | 100µA | 2000 | ±5% |
| 4112-010 | 2-30 | 200 | *20 | F-N | F-N | 100µA | 2000 | ±5% |
| 4112-025 | SAME AS 4112 BUT HAS FIELD CALIBRATION CAPABILITIES. | | | | | | | |
| 4113 | 2-30 | 1000 | 100 | F-N | F-N | 100µA | 2000 | ±5% |
| 4113-010 | 2-30 | 500 | 100 | F-N | F-N | 100µA | 2000 | ±5% |
| 4114 | 400-512 | 50 | 5 | F-N | F-N | 100µA | 2000 | ±5% |
| 4114SP | 406-420 | 50 | 5 | F-N | F-N | 100µA | 2000 | ±5% |
| 4115 | 100-225 | 50 | 5 | F-N | F-N | 100µA | 2000 | ±5% |
| 4116 | 2-30 | 1000 | *100 | F-N | F-N | 100µA | 1175 | ±10% |
| 4118 | 400-512 | 150 | 15 | F-N | F-N | 100µA | 2000 | ±5% |
| 4120 | 225-400 | 50 | 10 | F-N | F-N | 100µA | 1175 | ±5% |
| 4121 | 7 | 3 | 1 | F-N | F-N | 100µA | 1175 | ±5% |
| 4123 | 400-500 | 250 | 25 | F-N | F-N | 100µA | 2000 | ±5% |
| 4123-100 | 400-500 | 500 | 50 | F-N | F-N | 100µA | 2000 | ±5% |
| 4124 | 400-500 | 25 | 2.5 | F-N | F-N | 100µA | 2000 | ±5% |
| 4125 | 400-500 | 2.5 | 1 | F-N | F-N | 100µA | 2000 | ±5% |
| 4127 | 2-30/ 30-76 | 40/5 | 40/5 | F-BNC | F-BNC | 100µA | 1175 | ±10% 2-4 ±5% 4-76 |

*SPRING LOADED SWITCH FOR MOMENTARY REFLECTED READINGS.

## FIGURE 6-1. MINI MONITOR® CALIBRATION SET-UP