

HAM-MATE™
RF DIRECTIONAL
WATTMETERS
SERIES 4350



Fig. 1



BIRD

ELECTRONIC CORPORATION

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HAM-MATE SPECIFICATIONS

	Models		
	4350	4351	4352
Forward Power Range	0-200/2000W	0-200/1000W	0-40/400W
Reflected Power Range	0-200/2000W	0-200/1000W	0-40/400W
Impedance Z_0	All Models 50 ohms *		
Frequency Range	1.8-30 MHz	1.8-30 MHz	50-150 MHz
Insertion VSWR	All Models 1.1 to 1.0 max.		
Accuracy	All Models \pm 8% of Full Scale		
Directivity	All Models 20 dB min.		
Dimensions	All Models 5-3/4" H x 4" W x 3-5/8" deep		
Weight	All Models 1-3/4 lbs.		
Connectors – Input & Output	All Models - both Female UHF (SO-239)		

* May be used with 50 - 52 ohm cable.

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SECTION 1

GENERAL DESCRIPTION

1. PURPOSE AND APPLICATION

The Models 4350 and 4351 HAM-MATE RF Wattmeters are designed specifically for amateur radio service in the 1.8 - 30 MHz range. The Model 4352 is for use in the 50 - 150 MHz range. The design of the HAM-MATE is basically that of all Bird THRULINE® Wattmeters, except that the sensing element is built into the equipment, and is rotatable from the front panel to provide the choice of reading the forward or reflected power. One of the two power ranges can be selected by a front panel slide switch. Models 4350 and 4351 have a 0-200 watts (low range) scale, with the high range of the Model 4350 being 0-2000 watts, and the Model 4351, 0-1000 watts. The Model 4352 has ranges of 0-40 and 0-400 watts. The meter reads directly in watts, with the high range being read on the upper arc, and the low range on the lower arc. The down scale portion of each range is expanded for easier reading. These wattmeters will measure the average power output of CW, AM, FM, and SSB transmitters. The HAM-MATE Wattmeters are useful in tuning all types of antennas and are accurate instruments for continuous monitoring of power output of amateur transmitters. The HAM-MATE can help ensure maximum radiated RF power, as well as reduction of VSWR, with the added dividends of reduced TVI and less adjacent channel interference to other amateurs.

2. DESCRIPTION

The HAM-MATE is housed in a sloping panel case for convenient meter reading. The case is cast aluminum with a removable rear cover. A solid coaxial line is used - to prevent the stress of connecting cables affecting the accuracy of the readings. The input and output connectors are female UHF (SO-239). The line section (coupler), through which the RF power flows, is a 4-inch length of rigid air type coaxial line, whose Z_0 is a very accurate 50 ohms. VSWR conversion nomograph charts, furnished in this handbook, will provide a quick method of determining the VSWR on the antenna feed system.

3. DIRECTIVITY

One of the most important requirements of any insertion type RF wattmeter is the directivity, or the capability of differentiating between power flowing in opposite directions in the coaxial transmission line. All Bird THRULINE RF Wattmeters have this capability to a high degree, and the HAM-MATE is no exception. It has a minimum directivity of 20 dB - i.e. a ratio of 100 to 1 - against detecting the power flowing in the opposite direction from the power being measured. This feature is especially important when adjusting the antenna to match the transmission line, as it is vital to know the magnitude of the reflected power accurately. The user can be sure, if the HAM-MATE does not indicate any reflected power, there just isn't any.

and the driving and final stages of the transmitter are adjusted for maximum power output. When these adjustments have produced the maximum power output, readings should be taken of the reflected power. A zero reading is gratifying but is usually obtained only at the antenna's resonant frequency. A small percentage of reflected power is usually indicated, and reference to the power ratio nomographs in this handbook will readily provide the VSWR (see APPENDIX).

Interpreting readings

While every effort should be made to reduce the reading of reflected power to the lowest possible value, it is useless to try to attain perfection. This is illustrated by the fact that a VSWR of 1.225:1 would only cause a loss of 1% of the forward power. The compromises present in the popular multiband antennas make it impossible to attain unity VSWR between the antenna, the feed line, and the transmitter across an entire band. The HAM-MATE will accurately indicate if and how much reflected power is present, and with this information it is up to the user to obtain the best possible operation of the transmitter and the antenna system.

Continuous monitoring

The HAM-MATE can be left in the transmission line as a constant indicator of the power output. Occasional checks should be made of the reflected power, especially during periods of severe weather. Damage to an antenna caused by high winds, heavy rain, or icing, can upset the impedance of the antenna, causing a severe mismatch between the antenna and coaxial feed line. In turn, the transmitter can also sustain damage if operated into a severely mismatched load. The accuracy of the HAM-MATE is affected by the magnitude of harmonics of the fundamental signal. If strong harmonics are present in the signal, the HAM-MATE will add the power in the harmonics to that of the main signal, as long as the harmonics fall within the frequency range of the HAM-MATE. Many amateurs use low pass RF filters as a precaution against radiating harmonics, and where this is done the filter should be placed between the transmitter and the Wattmeter.

SECTION 2

INSTALLATION

The HAM-MATE is designed for use as an integral unit. It is not possible to separate the indicating meter from the rest of the unit, or to remove the line section from the case. Select a convenient location close to the transmitter, so that the transmitter can be adjusted while reading the meter. Cables are not supplied with the HAM-MATE, but it is important that all connecting cables be 50 - 52 ohms impedance. If cables other than 50 ohm impedance are used, the resulting mismatch may cause serious inaccuracies in the readings.

CAUTION

It is important that the cable coming from the transmitter be attached to the connector marked "TRANS". This will prevent damage to the meter, and avoid confusion when the readings are being taken during tune-up. Be sure that the connecting cables are tightened securely to the HAM-MATE connectors. To safeguard the Wattmeter, the range selector knob should be turned to the "High" position (particularly in the event that the initial power output is expected to exceed 200 watts).

SECTION 3

OPERATION

Tuning-Up

It is strongly recommended that the initial tune-up include a reliable 50 ohm dummy load able to handle the average power output of the transmitter. In this way it can be established that the transmitter is operating correctly. If the maximum legal input of 1000 watts DC is being used, the dummy load should be capable of dissipating at least 900 watts of RF power. The Bird Model 8401 Dummy Load is recommended (although rated for 600 watts continuous operation, it will dissipate 900 watts safely for a period of 15 minutes). With the HAM-MATE properly connected between the transmitter and the dummy load, and the knob turned to "FWD", the transmitter should be adjusted to its maximum allowable power output. At this point the knob should be turned to the "RFL" position, and a zero reading will indicate that the dummy load is operating properly. The transmitter is now switched off, and the HAM-MATE is disconnected from the dummy load and reconnected to the coaxial cable feeding into the antenna. The knob is now turned to the "FWD" position and the transmitter switched on. A preliminary reading should be taken of both the "FWD" and "RFL" positions, and if there is an indication of excessive reflected power, it is recommended that the tune-up be discontinued until recheck can be made of all connections and of the transmitter itself. If, however, there is only a minor reading of reflected power, tune-up may proceed. The directional knob is now returned to the "FWD" position

SECTION 4

Maintenance service

The Bird HAM-MATE Wattmeters are relatively simple and rugged, and with proper care should give long-time trouble-free service. The warranty clause shown at the front of this handbook gives a full 12 months warranty on new Bird equipment. If the HAM-MATE fails to perform within the published specifications during the 12-month period after shipment from the factory, it will be repaired at the factory free-of-charge. Each unit is adjusted, balanced, and calibrated at the factory and is ready for use. While certain parts such as the meter, and the RF connectors are easily replaced, the HAM-MATE is not basically intended for general maintenance work by the user. This is not meant to imply that the amateur operator who has the requisite accessory equipment and techniques is not capable of servicing the HAM-MATE Wattmeter. However, when it is understood that recalibration of the HAM-MATE requires an accurate RF wattmeter, a variable RF power source, and a 50 ohm dummy load capable of dissipating at least 900 watts of power, it will be realized that all these items are not usually available to the average amateur operator. In the event that a malfunction or accidental fall disables the HAM-MATE, it is strongly recommended that it be returned to the factory for service. If the HAM-MATE is suspected of inaccuracies, it can be returned to the factory for recheck and recalibration, at a cost not to exceed 10% of the current list price of a similar new HAM-MATE. For the amateur who does have access to equipment needed to check and recalibrate the HAM-MATE, we have included the information later in this section.

RF connectors

The RF connectors at each end of the line section (coupler) are Female UHF, and may be easily removed by unscrewing the four number 4-40 screws on the flange, and pulling the connector straight out. The center rod of the line section will not be affected, as it is independently supported, and permanently fitted in place. Replace the connector by simply reversing the above. If it is intended to use the HAM-MATE only for periodic checking of the RF output, it is recommended that the connectors be checked before use for dust accumulation, and cleaned if necessary with a dry solvent such as trichloroethylene or rubbing alcohol.

Meter

Although the meter is ruggedly constructed and will withstand a reasonable overload, the user should exercise care while it is in use. When the power output of the transmitter is not expected to exceed 200 watts on the Models 4350 and 4351 (40 watts on the Model 4352), no precaution against overloading is necessary. However, where the power output exceeds the full scale value of the low range, the user should develop the habit of always switching back to the high range, after making an

observation on the low range. Repeated overloading will result in a bent meter pointer and consequently erroneous readings. When the user has reason to doubt the accuracy of the meter, it can be easily checked with an accurate DC microammeter standard. The full scale value is 50 ± 1 microamperes, and this measurement should of course be made with the meter disconnected from the other circuitry in the wattmeter. Replacement of the meter is relatively simple, and should present no problems. In the event it must be replaced, proceed as follows: Remove the back cover of the wattmeter, which is attached by three pan-head screws. Loosen and remove the two terminal nuts on the back of the meter, and slide the terminal strip off the meter studs. Lay the terminal strip down in the bottom of the case, do not unsolder from the wires, and then proceed to loosen the three screws holding the meter to the case. Reassemble the replacement meter to the case, making sure that the rubber cushion gasket is replaced between the meter flange and the case. Tighten the three mounting screws with care so that even pressure is applied to all the screws, otherwise the meter flange may fracture. Next, reassemble the terminal strips to the studs on the meter, and tighten carefully. Now reassemble the cover to the back of the case. Incidentally, for the information of the enterprising amateur who feels capable of repairing the meter, it should be noted that the meter movement cannot be taken out of the plastic case. For all practical purposes the meter must be considered as non-repairable, and should not be returned to the factory, except under the warranty provisions of the instrument. If the meter becomes defective after the warranty period expires, a new one can be ordered from the factory. Replacement of the meter does not affect the overall accuracy of the HAM-MATE, and it would therefore not be necessary to recheck calibration after replacing the meter.

Calibration

1. Calibration or recheck of the calibration of the HAM-MATE wattmeters is relatively simple, provided the user has access to the required test equipment listed below.

a. RF Standard Wattmeter, 50 ohms impedance, having at least 5% accuracy at the power levels and frequency ranges shown below.

For Model:	Freq. MHz	Watts Low Power	Watts High Power
4350	1.8 - 30	160	1600
4351	1.8 - 30	160	800
4352	50 - 150	32	320

b. Dummy Load, 50 ohms impedance, capable of dissipating the appropriate High Power level, with low VSWR across the range of 1.8 - 150 MHz, preferably no higher than 1.1 to 1.

- c. RF power sources to supply the power outputs listed in paragraph "a". These power sources must be substantially free from harmonics and distortion products, otherwise erroneous readings will result. It is strongly recommended that an RF low pass filter be used between the power source and the HAM-MATE, to insure purity of the power output.
 - d. Alignment screwdriver, non-metallic, with 1/8" wide bit.
2. Remove the back cover of the HAM-MATE, which is attached by three screws.
 3. Connect the power source to the RF Standard Wattmeter, which is then connected to the HAM-MATE, and in turn to the Dummy Load. If the RF Standard Wattmeter has different coaxial connectors, such as type N, adapters may be used without seriously affecting the validity of the readings.
 4. As long as the calibration is done within the frequency range of the HAM-MATE, the exact frequency is unimportant. However, for the Models 4350 and 4351, it is recommended that the 14.0 - 14.35 MHz (20 meters) be used, and 144.0 MHz for the Model 4352, for optimum calibration across the entire specified frequency range.
 5. Turn the directional knob to "FWD" and the slide switch to "LOW". Adjust input to RF power source, so that the RF Standard Wattmeter reads 160 watts (for Models 4350 and 4351) or 32 watts (for Model 4352). Using the alignment screwdriver, adjust R5 (see figure 2) until the HAM-MATE meter agrees with the RF Standard Wattmeter. If desired, other points (full scale, half-scale, etc.) may be checked.
 6. Now reverse the directional knob to "RFL". If meter indicates any reflected power, again using the alignment screwdriver, adjust C1 (the recessed screw in the center of the rear face of the line section). Adjust the screw carefully to obtain a minimum or zero reading. **Caution** — do not use a metallic screwdriver for this purpose, as it will seriously damage the HAM-MATE, and invalidate the warranty.
 7. Calibration of the high power range is accomplished exactly as outlined in paragraph 5, except that the slide switch is placed in "HIGH", that R4 is the adjustment resistor, and the power from the source must be increased. Again, checks can be made at several points of the meter scale, providing that a variable source of RF power is used.

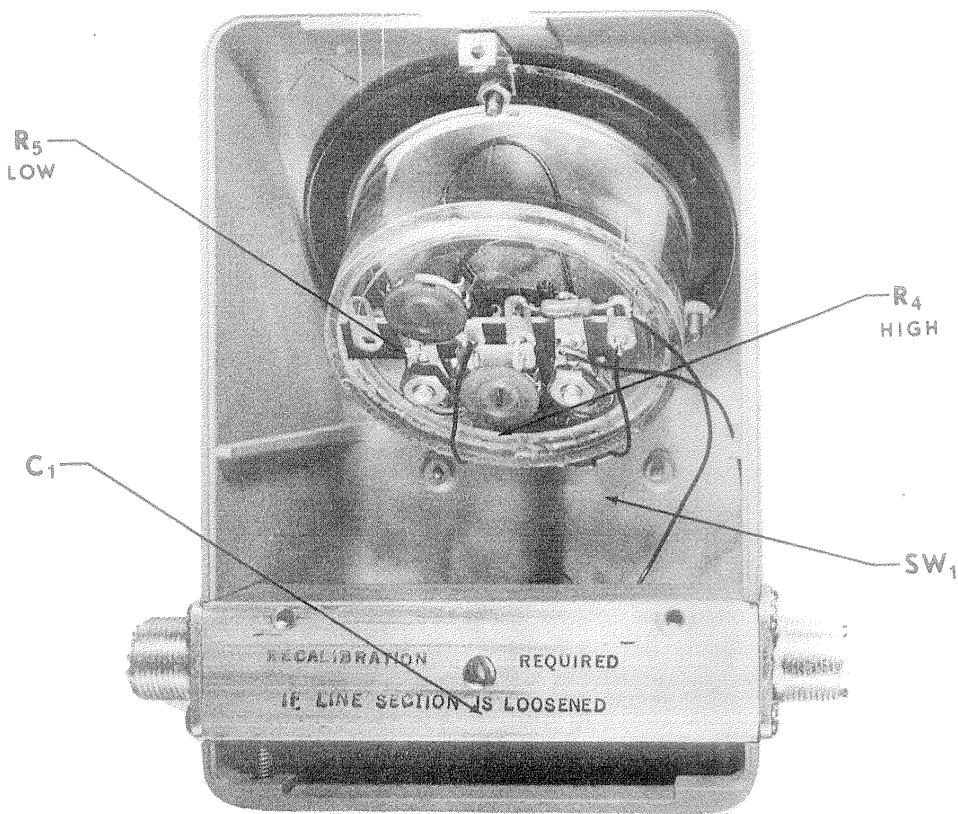


Fig. 2

8. Although not strictly necessary, a check can be made at the lowest and highest frequency to be used. In the case of Models 4350 and 4351, this is 1.8 MHz and 30 MHz, or 50 MHz and 150 MHz for Model 4352.
9. Should the above procedures fail to yield the desired accuracy, it is recommended that the user write to the factory service manager, giving details of incorrect operation.

HAM-MATE RF WATTMETER

TROUBLE SHOOTING

Symptom	Possible Causes	Remedy
No meter indication	Directional knob turned in wrong direction	Orient control knob properly
	No RF power	Check transmitter and cables.
	Defective sensing element	Factory repair, see section 4
	Defective meter	
Low scale position reads "High"	Defective final stage of transmitter	Check transmitter
	Open wiring	Check lead wires, element and ground to meter.
Intermittent or inconsistent meter readings	Open wires to switch	Check wires, SW1 switch lugs to terminal strip.
	Faulty switch	Check switch circuit closing.
Abnormal reflected power	Faulty transmission line or antenna. Also, transmitter may have developed troubles	Check cable and antenna. Check transmitter.
	Damaged antenna, shorted or open transmission line	Check antenna and/or coax line.

In the event the above checks do not reveal the reason for the malfunction, the Wattmeter should be returned to the factory for service.

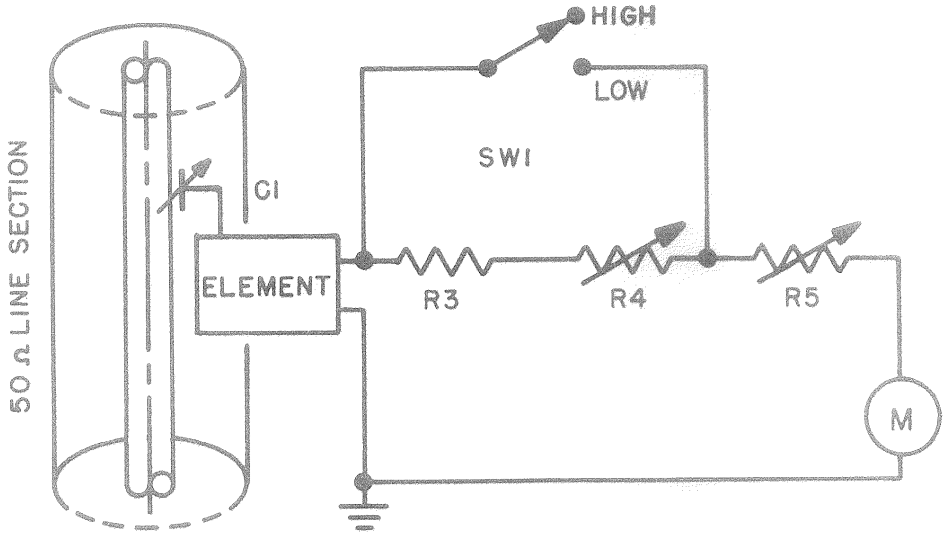
SECTION 5

REPLACEMENT PARTS LIST

PART NAME	Model: 4350	4351	4352
	Part no.:		
Connector Female UHF	5-800-1	5-800-1	5-800-1
Meter, 50 μ a 2745 ohms	2000-046	2000-047	2000-051

SECTION 6

SCHEMATIC

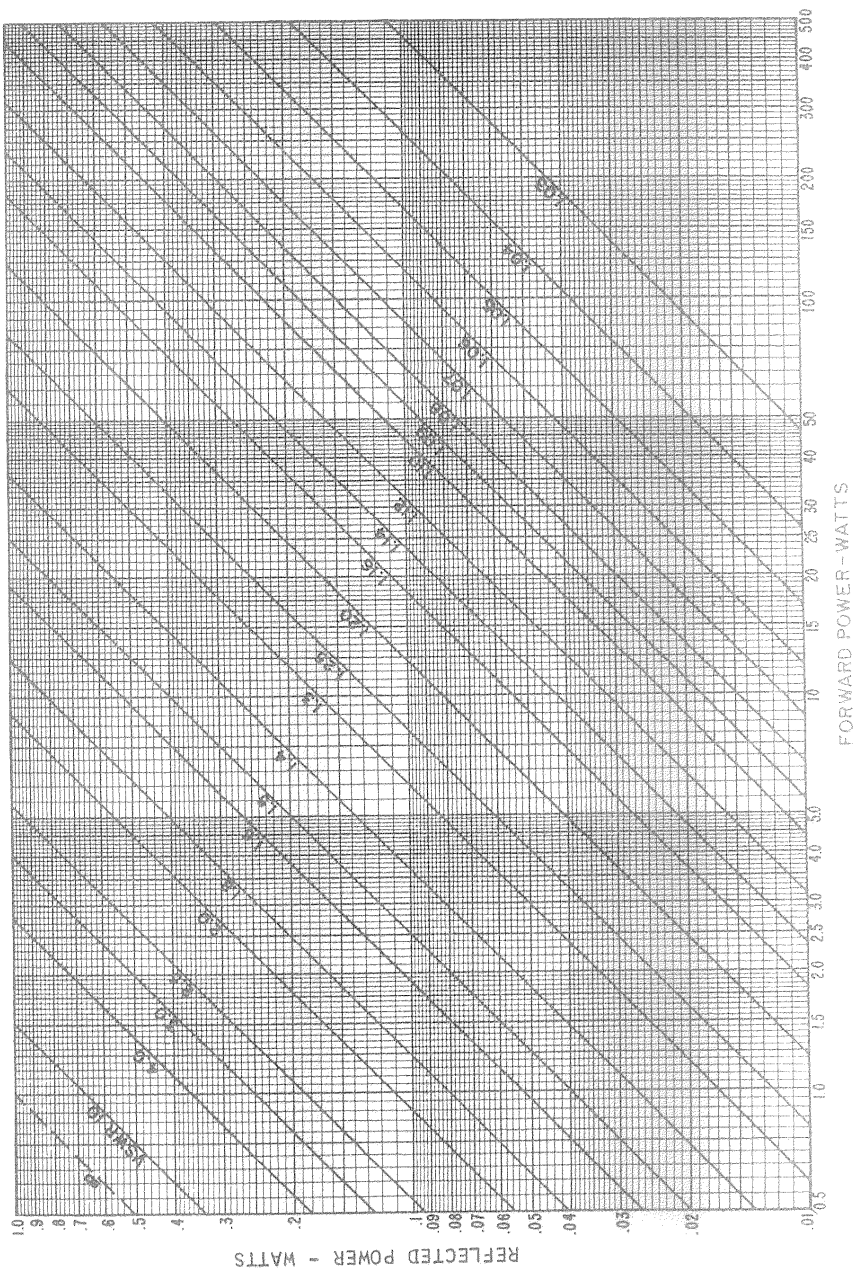


- C1 - Capacitor, balancing
- R3 - Resistor, calibrate
- R4 - Resistor, trimmer - High range
- R5 - Resistor, trimmer - Low range
- M - Meter, 50 μ a
- SW1 - Switch, Low - High range

Fig. 3

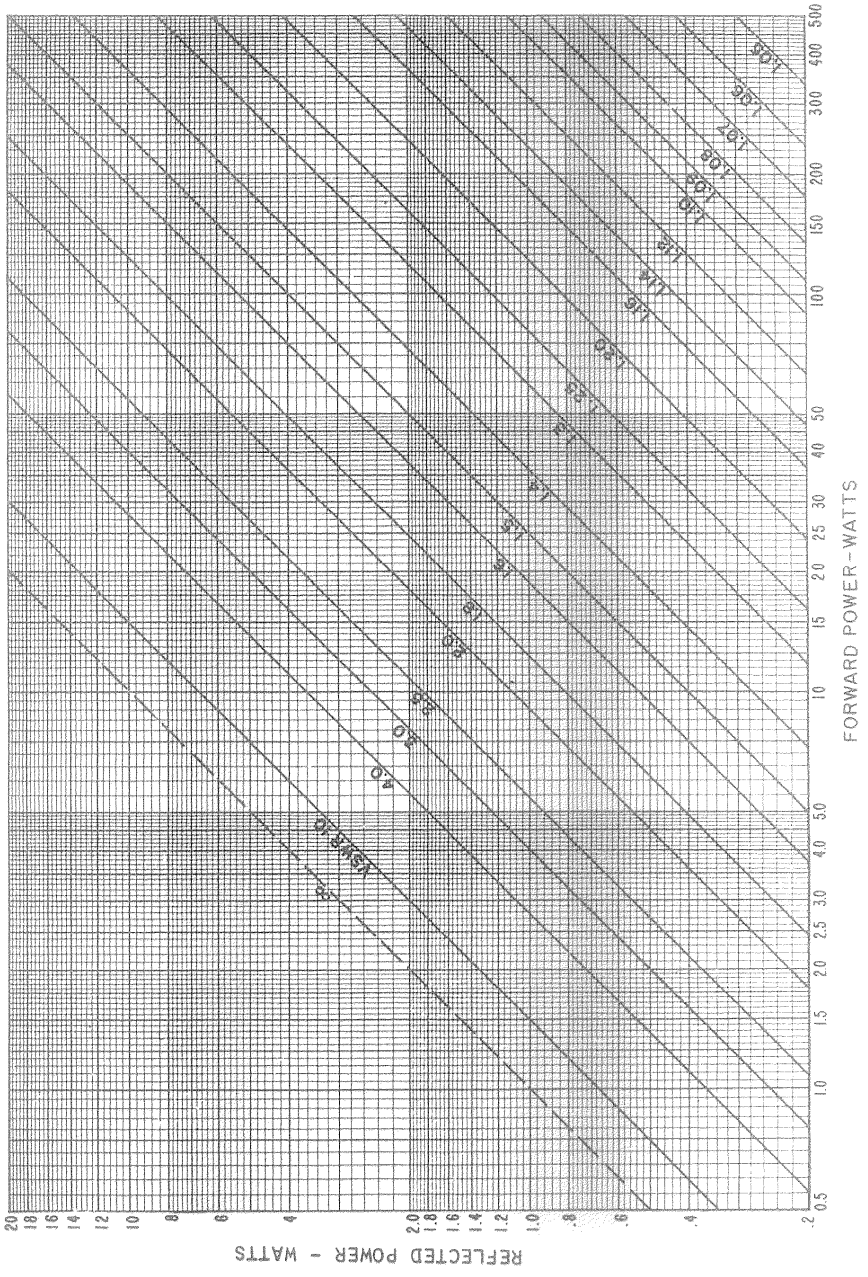
APPENDIX

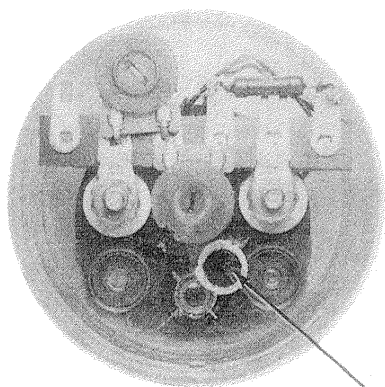
LOWER RATIOS
POWER VALUES vs. VSWR



APPENDIX

HIGHER RATIOS POWER VALUES vs. VSWR





"ZERO" ADJUST SCREW —

"Zero" Adjust screw for the meter pointer is on the back of the meter. Reach by removing 3 screws holding the back cover.

NOTES