

**MODEL 44  
BROADBAND RF  
WATT METER**

**OPERATION MANUAL**



**TELEWAVE, INC.**





## MODEL 44 BROAD BAND RF WATT METER

### DESCRIPTION AND OPERATION

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Model 44 Broad Band RF Watt Meter

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## 1. GENERAL

1.01 This manual provides the physical and functional description and operating theory necessary for effective use of the Telewave, Inc., Model 44 Broad Band Radio Frequency (RF) Watt Meter. Figure 1-1 illustrates the Model 44 RF Watt Meter. Its features include:

- Does not require inserts,
- Does not require bandswitching,
- Displays five power ranges,
- Measures 1 to 500 Watts,
- Provides 5 Watts full scale,
- Frequency range is 20 to 1000 MHz,
- Measures incident and reflected power,
- Optionally available with type N or UHF connectors,
- Lightweight, rugged and easy to carry.

1.02 The instrument integrates two broad-band directional couplers for measuring incident and reflected power, detectors, ranging, calibration and display. This wide band and dynamic range instrument does not require inserts or band switching.

1.03 A 20  $\mu$ A taut band meter movement is used to display the measured power providing the measurement accuracy necessary to tune low power portable transmitters.

1.04 The user is provided with a convenient, easy to read, voltage standing wave ratio (VSWR) chart on the rear of the instrument for determining VSWR from the measured incident and reflected power levels.

1.05 A die-cast metal case houses the instrument for rugged field use. The Model 44 is ideally suited for mobile, marine and aircraft applications as well as base stations.

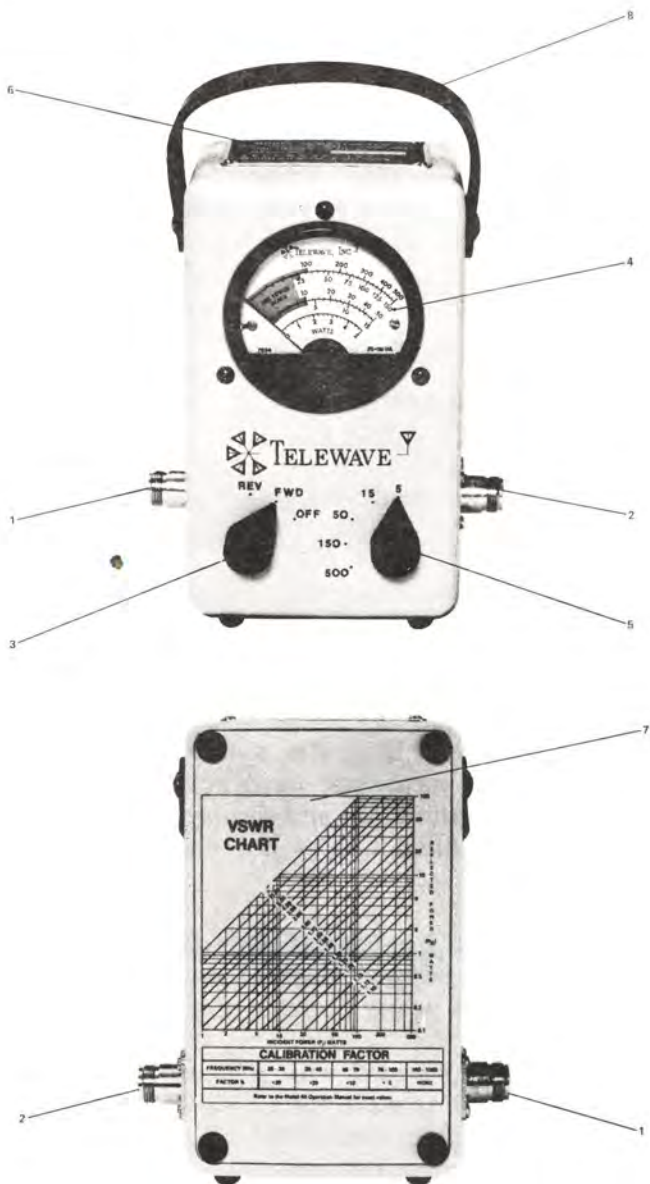


Figure 2-1 – Model 44 Broad Band RF Watt Meter – Controls and Indicators

## 2. PHYSICAL DESCRIPTION

2.01 The physical details of the Model 44 Broad Band RF Watt Meter are illustrated in Figure 2-1 and the functions of these elements are tabulated for the user in Table 2-1.

2.02 The instrument is designed for rugged field use and is housed in a die-cast metal case with a leather carrying strap. Measurement circuits in the watt meter draw a few microwatts from the user's rf source to power the instrument making it unnecessary to supply ac power or batteries. A carrying case (Model TC44) is furnished optionally.

Table 2-1 – Model 44 Broad Band RF Watt Meter –  
Controls and Indicators

| Key | Element          | Function   |
|-----|------------------|--|
| 1   | Input Connector  | Provides a connection to the RF source, e.g., RF power amplifier or transmitter. Mates with a type N connector.  |
| 2   | Output Connector | Provides a connection to the RF load, e.g., antenna or dummy load. Mates with a type N connector.  |
| 3   | Mode Switch      | (1) OFF – Provides protection to meter during instrument transit.<br><br>(2) FWD – (Forward) – Displays the incident power.<br><br>(3) REV – (Reverse) – Displays the reflected power. |
| 4   | Power Range      | Displays five RF power ranges.   |

Table 2-1 – Model 44 Broad Band RF Watt Meter –  
Controls and Indicators (Continued)

| Key | Element              | Function  |
|-----|----------------------|---|
| 5   | RF Range Switch      | Provides range sensitivity for the display.   |
| 6   | Identification Label | Provides the user with the model and serial number of the instrument.                                       |
| 7   | VSWR Chart           | Provides the user with information for determining the VSWR from the measured incident and reflected power. |
| 8   | Carrying Strap       | Provided for transporting the instrument.   |



### 3. FUNCTIONAL DESCRIPTION

3.01 The Model 44 RF Watt Meter is made up of two major sections. Refer to the schematic diagram in Figure 3-1 for this description.

- (a) A Dual RF Directional Coupler with directivity of greater than 25 dB.
- (b) A voltmeter circuit. Five ranges are provided.

3.02 The 50 Ohm coaxial Dual Directional Coupler, A1, samples a small amount of the power delivered to the rf load, the incident power. A small amount of the power reflected from the rf load is also sampled. The coupler also incorporates two rf detectors which deliver dc output voltages proportional to the sampled rf power.

3.03 The Mode Switch, S1, determines which of these voltages is displayed on the voltmeter, M1. The RF Power Range Switch, S2, selects the appropriate range and calibration resistors for the power to be measured. Each range is provided with an adjustable potentiometer for range calibration.

3.04 Meter, M1, is provided with five scales which correspond to the RF Power Range Switch positions. The lower third of the meter scale is shaded red, alerting the user to switch to a lower power range for full instrument accuracy. An OFF position is provided on the Mode Switch, S1, which shunts out the meter movement. This provides dampening for the sensitive meter when the instrument is being transported.

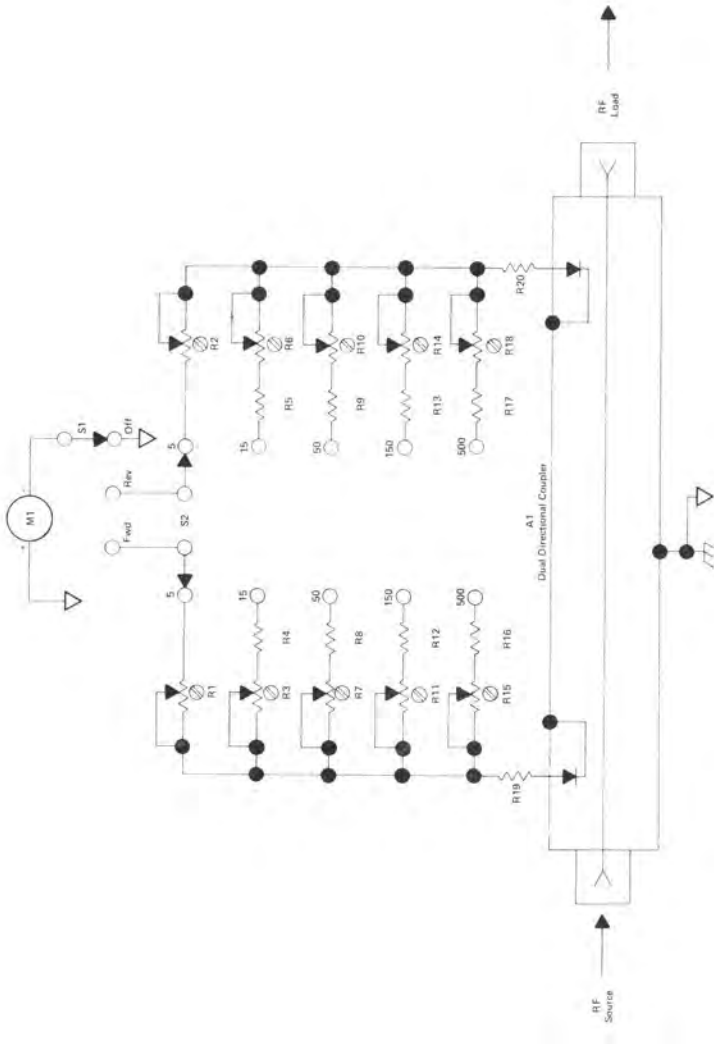


Figure 3-1 — Model 44 Broad Band RF Watt Meter Schematic

#### 4. SPECIFICATIONS

4.01 Table 4-1 will provide the user with tabulated specifications for the Telewave Model 44 Broad Band RF Watt Meter. These are provided to assist the user in formulating the applications, acceptance criteria and for periodic recalibration of this instrument. Minor deviations from these specifications which do not affect the performance of the Model 44 Watt Meter are excluded from the warranty.

Table 4-1 – Model 44 Broad Band RF Watt Meter Specifications

| Parameter                  | Characteristic   |
|----------------------------|--|
| Frequency<br>Range         | 20 to 1000 MHz.  |
| Accuracy,<br>20 to 100 MHz | ±6 per cent with Figure 7-1 curve.   |
| 100 to 512 MHz             | ±5 per cent.   |
| 512 to 1000 MHz            | ±6 per cent.   |
| Power<br>Ranges            | 5, 15, 50, 150 and 500 Watts.  |
| Primary Line<br>Impedance  | 50 Ohms nominal.   |
| VSWR                       | 1.1 maximum.   |
| RF Connectors<br>Standard  | Type N.  |
| Optional                   | Type UHF. These connectors reduce the frequency accuracy in the 512 to 1000 MHz range. |
| Dimensions                 |  |
| Height                     | 16.83 cm (6-5/8 in.)   |
| Width                      | 10.16 cm (4 in.)   |
| Depth                      | 8.26 cm (3-1/4 in.)  |
| Weight                     | 1.36 kg (3 lbs.)   |

## 5. OPERATION

## Unpacking

5.01 After the Model 44 RF Watt Meter arrives, examine the shipping container for visible loss or damage. Carefully unpack the watt meter and examine the exterior for damage.

## IMPORTANT

*The Model 44 RF Watt Meter is carefully tested, inspected and packed before leaving the Telewave factory. Claims for loss or damage sustained in transit should be made upon the carrier, NOT TO Telewave Inc., as follows:*

- (1) Visible Loss or Damage – Any evidence must be noted on the freight bill or express delivery sheet. The form required to file such a claim will be supplied by the carrier.*
- (2) Concealed Loss or Damage – This damage does not become evident until after the watt meter is unpacked. When the damage is discovered, make a written request for inspection by the carrier's agent within fifteen days of the delivery date. File a claim with the carrier.*

## RF Connections

5.02 The following procedure will assist the user in preparation for making an rf power measurement. Refer to Figure 2-1.

| Step | Procedure                                       |
|------|---|
| 1    | Remove the rf power from the transmission line. |

| Step | Procedure  |
|------|--|
| 2    | Set the RF Range Switch to the 500 Watt position.      |
| 3    | Connect the RF Source to the Model 44 input connector. |
| 4    | Connect the RF Load to the Model 44 output connector.  |

#### Incident Power Measurement

5.03 The following procedure will assist the user in making an incident or forward power measurement. Refer to Figure 2-1.

| Step | Procedure  |
|------|--|
| 1    | Set the Mode Switch to the FWD position.   |
| 2    | Apply rf power to the transmission line.   |
| 3    | Move the RF Range Switch to a lower range if necessary to obtain a reading in the upper two-thirds of the scale.   |
| 4    | Note the meter reading. Apply a Correction Factor if the frequency is from 25 MHz to 100 MHz. Refer to Figure 7-1. |

#### Reflected Power Measurement

5.04 The following procedure will assist the user in making a reflected or reverse power measurement.

| Step | Procedure                                |
|------|--|
| 1    | Set the Mode Switch to the REV position. |
| 2    | Same procedure as Step 2 of 5.03.        |
| 3    | Same procedure as Step 3 of 5.03.        |

### VSWR Calculation

5.05 The following procedure will assist the user in determining the Voltage Standing Wave Ratio.

| Step | Procedure   |
|------|---|
| 1    | Perform the procedures outlined in 5.03 and 5.04. Record the true incident and reflected power.   |
| 2    | Refer to the VSWR Chart on the rear of the instrument or Figure 7-2. Apply the reading, Step 1 above, to the chart.   |
| 3    | The VSWR is read from the nearest sloping line. For higher accuracy, calculate the VSWR by this formula:  |
|      | $\text{VSWR} = \frac{1 + \sqrt{\frac{P_{\text{REV}} \text{ (Watts)}}{P_{\text{FWD}} \text{ (Watts)}}}}{1 - \sqrt{\frac{P_{\text{REV}} \text{ (Watts)}}{P_{\text{FWD}} \text{ (Watts)}}}}$ |

### True Power at Load Calculation

- 5.06 The following procedure will assist the user in determining the actual power delivered to the load.

| Step | Procedure  |
|------|--|
| 1    | Perform the procedures outlined in 5.03 and 5.04. Record the true incident and reflected power.      |
| 2    | Subtract the reflected power from the incident power. This difference is the true power at the load. |

### Directivity Error

- 5.07 Directivity error results from the effect of imperfect directivity in the Dual Directional Coupler. Directivity is the ability of the coupler to sense power flowing in one direction and be insensitive to any power which may be flowing in the reverse direction. The directivity error is included within the specified instrument accuracy of  $\pm 5\%$ .

### Insertion Error

- 5.08 When the rf load and rf source are well matched, any error contributed by inserting the Model 44 RF Watt Meter is negligible. At VSWR's of over 1.5 and at frequencies above 100 MHz, the transmission line length becomes critical. Since the impedance on either side of  $1/2$  wavelength is identical, a length of coaxial cable can be added to the Model 44 to equal  $1/2$  wavelength, thus eliminating any error due to the width of the watt meter.

- 5.09 The chart shown in Figure 7-3 shows the length of RG-8/U cable and connectors vs. frequency which must be added when the user prepares a cable. The following should be considered when cutting the cable.

- (a) If type UHF-259 connectors are used, the cable length is measured from tip to tip of the center pin of the plugs.
- (b) If type N connectors are used, the cable length is measured from end to end of the outer conductor of connectors.

## 6. MAINTENANCE

6.01 The Model 44 RF Watt Meter is designed with high-reliability components and operates on low dc power levels. It can be expected to operate at peak performance for long intervals. A periodic calibration check conducted by an rf standards laboratory is recommended at least once a year.

### Warranty Service

6.02 It is intended that the Model 44 be maintained on a unit-replacement basis during the warranty. Faulty units should be returned to:

Manager, Customer Service  
TELEWAVE, INC.  
2166 Old Middlefield Way  
Mountain View, California 94040  
(415) 968-4400

6.03 When material is returned to Telewave, the following information will expedite repair and return if it is included:

- (a) The Model 44 serial number. Refer to Figure 2-1 and Table 2-1 for ID plate location. Include the date of purchase and the Purchase Order Number if known.
- (b) A brief statement of the problem.



- (c) The name and telephone number of the individual most familiar with the problem.

### Calibration

6.04 Adjustments to calibration should be performed by a rf calibration laboratory. Calibration should be made at a frequency of 250 MHz when possible. If it is necessary to perform the calibration at a frequency below 100 MHz, consult Figure 7-1 for the correction factor.

6.05 The calibration potentiometers are located on a pc assembly inside the instrument. Refer to Figure 2-1.

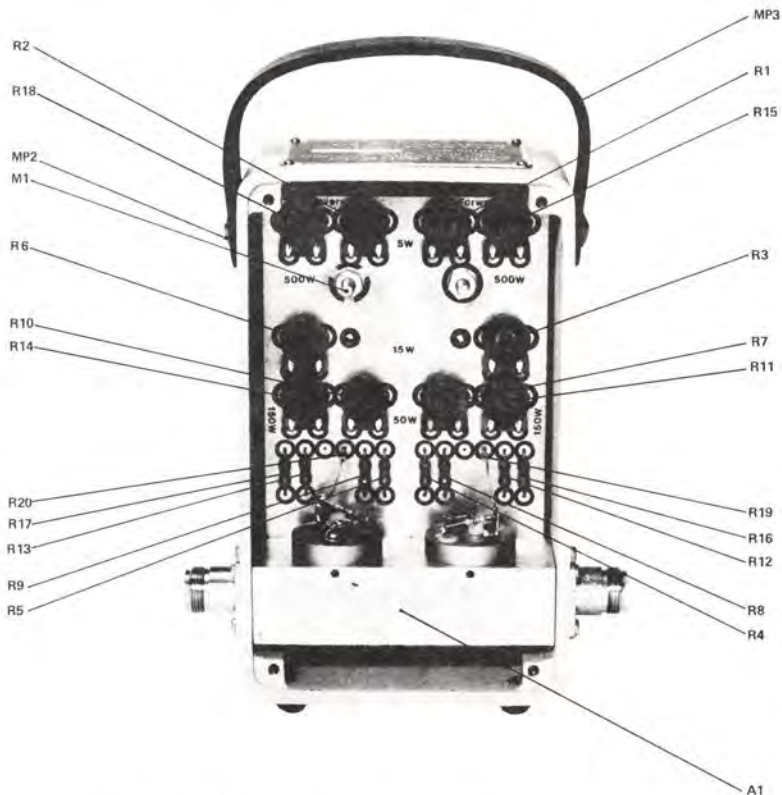


Figure 6-1 – Calibration Potentiometers and Parts Location

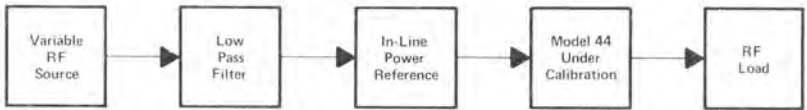


Figure 6-2 – Calibration Equipment Set-up

Remove the four bumper screws from the rear panel. Remove the rear panel. Figure 6-1 illustrates the calibration potentiometer locations.

- (a) Forward
- R 1 — 5 Watt range,
  - R 3 — 15 Watt range,
  - R 7 — 50 Watt range,
  - R11 — 150 Watt range,
  - R15 — 500 Watt range.
- (b) Reverse
- R 2 — 5 Watt range,
  - R 6 — 15 Watt range,
  - R10 — 50 Watt range,
  - R14 — 150 Watt range,
  - R19 — 500 Watt range.

6.06 Refer to Figure 6-2, the Calibration Equipment Requirements. Perform the calibration as follows:

| Step | Procedure   |
|------|---|
| 1    | Set the rf source to 250 MHz.                         |
| 2    | Set the watt meter Mode Switch to FWD position.       |
| 3    | Set the watt meter RF Range Switch to 5 Watts.        |
| 4    | Set the rf source to 5 Watts out.                     |
| 5    | Adjust R1 until the watt meter reads 5 Watts.         |
| 6    | Reverse the watt meter rf connections in the rf line. |

| Step | Procedure  |
|------|--|
| 7    | Set the watt meter Mode Switch to REV position.                    |
| 8    | Adjust R2 until the watt meter reads 5 Watts.                      |
| 9    | Reverse the watt meter rf connections in the rf line.              |
| 10   | Set the watt meter Mode Switch to the FWD position.                |
| 11   | Repeat Steps 1 through 10 for the 15, 50, 150 and 500 Watt ranges. |
| 12   | Reinstall the rear panel and bumper screws.                        |

## Replaceable Parts

6.07 Table 6-1 tabulates the replaceable parts which the user might expect to replace during the instrument lifetime.

Table 6-1 – Model 44 RF Watt Meter – Replaceable Parts List

| REF  | DESCRIPTION                | MFG       | MFG P/N        |
|------|----------------------------|-----------|----------------|
| A 1  | DIRECTIONAL COUPLER DUAL   | TELEWAVE  | 14044          |
| M 1  | METER 20 UA                | TRIPLETT  | 17034          |
| MP 1 | KNOR                       | RAYTHEON  | 1MS-9152B-1R2B |
| MP 2 | SCREW TRUSS HEAD 10-32     | ICD/RALLY | DESCRIPTION    |
| MP 3 | STRAP LEATHER              | TELEWAVE  | 1HH44          |
| MP 4 | SCREW BUMPER 6-32          | TELEWAVE  | 1TB44          |
| R 1  | VAR CC 0.25W 10% 2.5K OHM  | CTS       | 1U201R252B     |
| R 2  | VAR CC 0.25W 10% 2.5K OHM  | CTS       | 1U201R252B     |
| R 3  | VAR CC 0.25W 10% 10K OHM   | CTS       | 1U201R103B     |
| R 4  | FXD CC 0.25W 5% 1.0K OHM   | 1AB       | 1RC07          |
| R 5  | FXD CC 0.25W 5% 1.0K OHM   | 1AB       | 1RC07          |
| R 6  | VAR CC 0.25W 10% 10K OHM   | CTS       | 1U201R103B     |
| R 7  | VAR CC 0.25W 10% 10K OHM   | CTS       | 1U201R103B     |
| R 8  | FXD CC 0.25W 5% 16K OHM    | 1AB       | 1RC07          |
| R 9  | FXD CC 0.25W 5% 16K OHM    | 1AB       | 1RC07          |
| R 10 | VAR CC 0.25W 10% 10K OHM   | CTS       | 1U201R103B     |
| R 11 | VAR CC 0.25W 10% 25K OHM   | CTS       | 1U201R253B     |
| R 12 | FXD CC 0.25W 5% 33K OHM    | 1AB       | 1RC07          |
| R 13 | FXD CC 0.25W 5% 33K OHM    | 1AB       | 1RC07          |
| R 14 | VAR CC 0.25W 10% 25K OHM   | CTS       | 1U201R253B     |
| R 15 | VAR CC 0.25W 10% 25K OHM   | CTS       | 1U201R253B     |
| R 16 | FXD CC 0.25W 5% 82K OHM    | 1AB       | 1RC07          |
| R 17 | FXD CC 0.25W 5% 82K OHM    | 1AB       | 1RC07          |
| R 18 | VAR CC 0.25W 10% 25K OHM   | CTS       | 1U201R253B     |
| R 19 | FXD CC 0.25W 5% 50 OHM     | 1AB       | 1RC07          |
| R 20 | FXD CC 0.25W 5% 50 OHM     | 1AB       | 1RC07          |
| S 1  | SWITCH ROTARY 2 POLE 5 POS | CENTRALAB | 1FA6003        |
| S 2  | SWITCH ROTARY 2 POLE 5 POS | CENTRALAB | 1FA6003        |

## 7. REFERENCE

7.01 Part 7 contains additional information on the Model 44 RF Watt Meter which the user may need to refer to periodically.

7.02 Figure 7-1 will furnish the user with a watt meter correction factor for power measurements below 100 MHz. For example:

Frequency = 95 MHz,  
 Indicated Power = 275 Watts,  
 Correction Factor for 95 MHz = +4%,  
 Actual Power = (275 W) + (9.00 W) = 284 Watts.

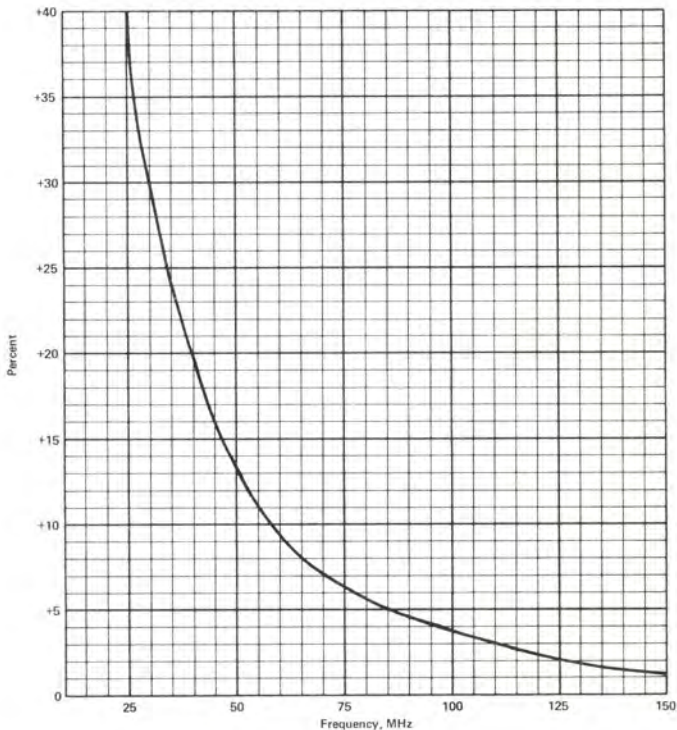
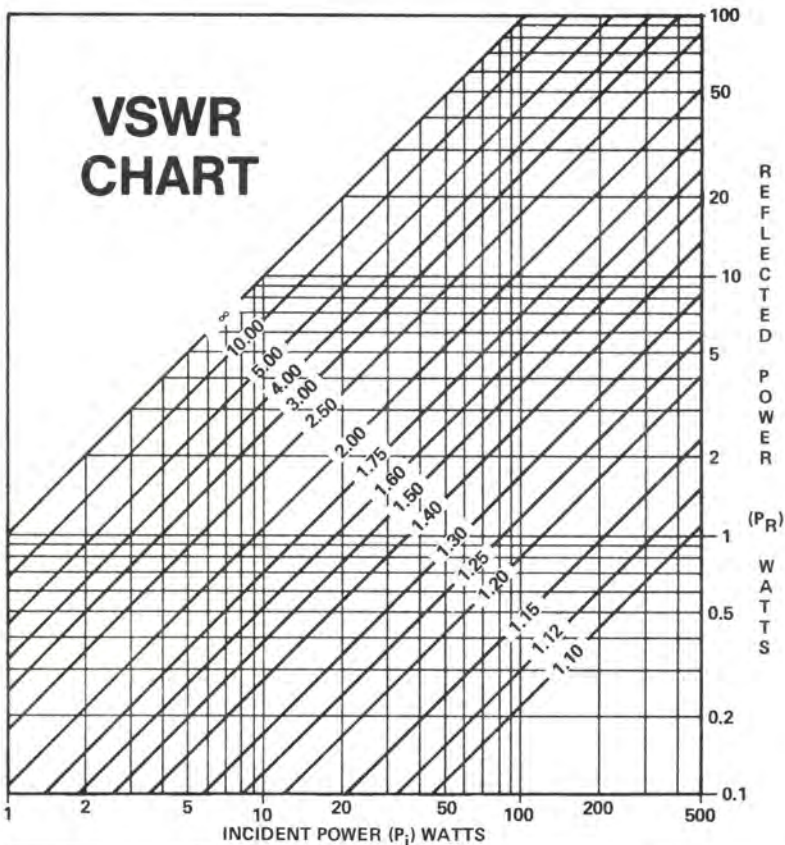


Figure 7-1 – Model 44 RF Watt Meter Calibration Chart  
 For Frequencies Below 150 MHz

7.03 Figure 7-2 will furnish the user with a nomograph for determining VSWR from the measured incident and reflected power.



### CALIBRATION FACTOR

| FREQUENCY MHz | 25 - 35 | 35 - 45 | 45 - 70 | 70 - 100 | 100 - 1000 |
|---------------|---------|---------|---------|----------|------------|
| FACTOR %      | +30     | +20     | +10     | + 5      | NONE       |

Refer to Figure 7-1 for exact values.

Figure 7-2 – VSWR Chart

7.04 Figure 7-3 will furnish the user with a chart for fabricating 1/2 wavelength coaxial line used in conjunction with the Model 44 Watt Meter to minimize measurement errors in rf systems with high VSWR.

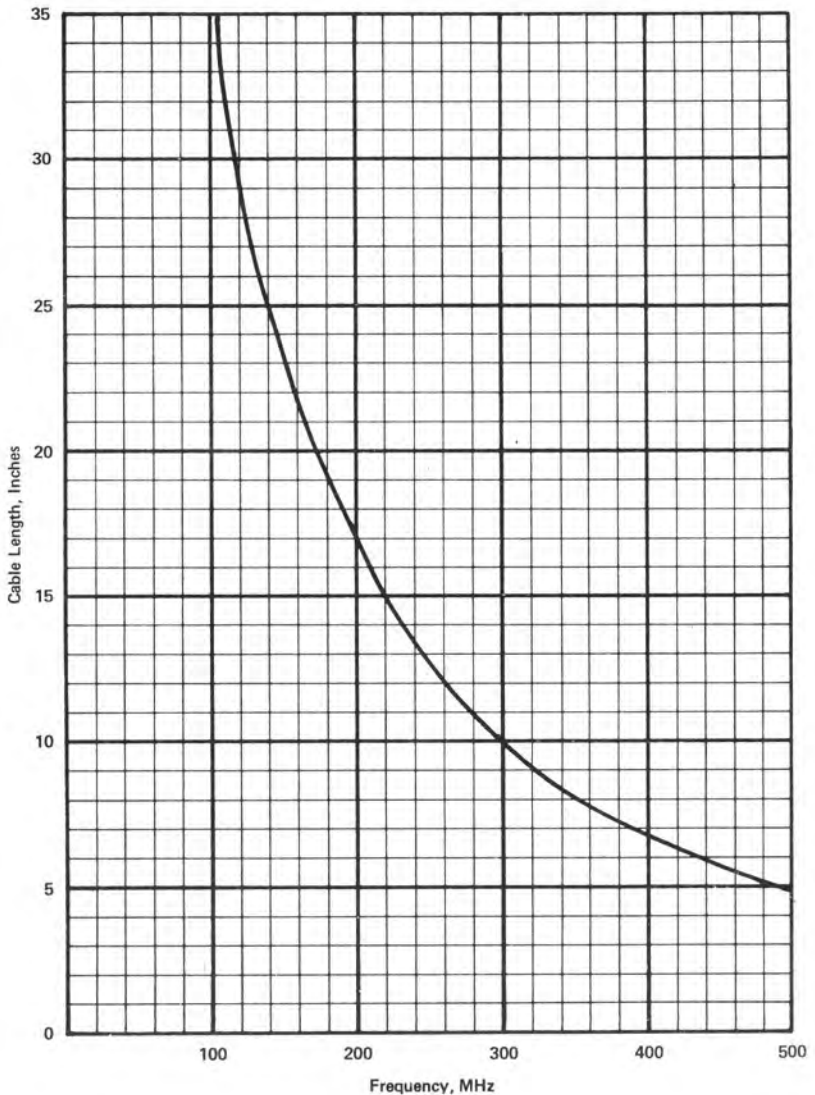


Figure 7-3 – One-Half Wavelength Coaxial Line



# WARRANTY

Products sold by Telewave, Inc. and covered by this Warranty are warranted to be free from defects in material and workmanship at the time of and for a period of one (1) year after delivery to the Buyer, Seller's entire warranty obligation is limited to making adjustments by repair, replacement or refunding the purchase price of any product which is returned to the Seller as provided below within one (1) year from the date of shipment by the Seller.

Adjustment will not be allowed for products which have been subjected to abuse, improper application or installation, alteration, accident or negligence in use, storage, transportation or handling. Alteration or removal of the serial number or identification markings voids the Warranty.

Seller shall have the right of final determination as to the existence and cause of a defect, whether adjustment will be allowed, and, if allowed, whether adjustment will be by repair, replacement or refund. Where adjustment is not allowed, a charge of 5 percent of the original purchase price will be made to the Buyer to cover the Seller's cost of inspection and handling.

Shipping and packaging instructions must be obtained from the Seller before products are returned for adjustment. The Buyer will pay for packing, transportation and transit insurance costs for returned products. The Seller reserves the right to discontinue models at any time or change specifications, design or price without notice and without incurring any obligation. Products will be returned to the Buyer, transportation collect.

Subject to the provisions of its "Patent Indemnity" clause, the Seller also warrants that it has the right to sell its products, that the Buyer shall have and enjoy quiet possession thereof as against any lawful claims existing at the time of the sale by the Seller, and that said products are free from any charge or encumbrance in favor of third persons existing at the time of sale by the Seller.

The foregoing constitutes the Seller's entire warranty, express, implied or statutory with respect to its products and states the full extent of its liability for breach of Warranty and for damages, whether direct, special or consequential resulting from any such breach. No change whatsoever thereto shall be binding upon the Seller unless in writing and signed by a duly authorized representative of the Seller.

*Manual Writer and Editor*     *Robert C. Shelton*  
*Atherton, California*

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