Assembly and Operation of the

HEATHKIT

VHF WATTMETER

MODEL HM-2102

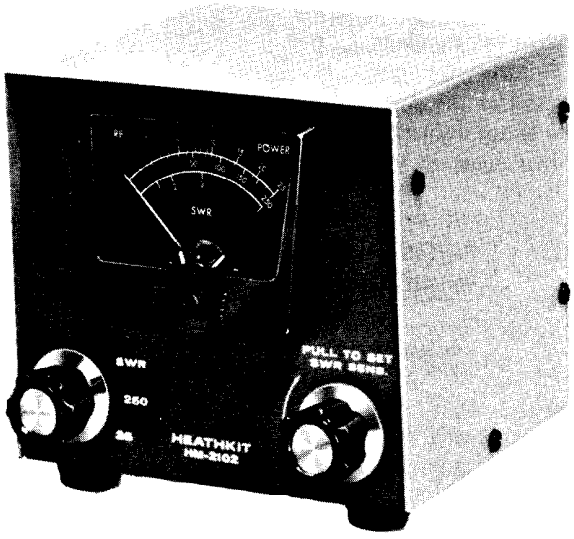


TABLE OF CONTENTS

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model HM-2102 VHF Wattmeter is a reliable instrument for measuring the forward and reflected RF power of a radio transmitting system in the 50 to 160 MHz VHF range.

When the Function switch is set to the 25 watt or the 250 watt position, the maximum forward power indicated on the meter helps you to tune your transmitter for maximum efficiency. When the switch is set at the SWR setting, the Wattmeter measures the reflected power and indicates on the SWR scale the mismatch between the transmission line and the load (antenna). This information is also valuable for antenna adjustments or to determine the frequency range of the antenna. The circuitry includes an internal calibration facility for 2-meter and 6-meter bands.

This Wattmeter may be permanently installed in your transmission line and needs no other power source. The unit gives negligible insertion loss, however, it is designed only for a transmission line of a 50 Ω nominal characteristic impedance. The small cabinet is designed for use at your operating position, but for convenience the detector portion may be removed and mounted nearby.

Read the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering and step-by-step assembly procedures.

PARTS LIST

Check each part against the following list. The key numbers correspond to the numbers in the Parts Pictorial (fold-out from Page 3). To order replacement parts: Use the Parts Order Form furnished with this kit. If one is not available, refer to "Replacement Parts" inside the rear cover of the Manual.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS				
1/2-Watt				
A1	1-157	2	470 Ω (yellow-violet-brown)	.15
A1	1-44	1	2200 Ω (red-red-red)	.15
A1	1-105	1	10 kΩ (brown-black-orange)	.15
A1	1-50	1	68 kΩ (blue-gray-orange)	.15
Other				
A2	1-43-1	1	51 Ω, 1-watt (green-brown-black)	.20
A3	2-50	1	10 kΩ precision	1.00
A4	10-325	1	50 kΩ control	1.00
A5	19-153	1	200 kΩ control with switch (appearance may vary)	2.75

CAPACITORS

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
A6	20-130	1	12 pF mica	.25
A6	20-148	2	100 pF mica	.30
A7	21-181	1	7.7 pF disc	.40
A7	21-3	1	10 pF disc	.15
A7	21-6	2	27 pF disc	.15
A7	21-140	4	.001 μF disc	.15
A7	21-27	2	.005 μF disc	.15
A8	28-3	1	.56 pF phenolic (green-blue-gray)	.15
A9	21-41	1	14 pF disc (brown-yellow-black)	.20
A10	31-57	1	2.7-20 pF trimmer	1.05

INDUCTORS-DIODE-SWITCH

B1	40-1628	1	Toroid coil	1.30
B2	56-20	3	1N295 diode (red-white-green)	.40
B3	63-47	1	3-position switch	1.40
B4	475-10	5	Ferrite bead	.15

HARDWARE

NOTE: C1 through C14 are shown actual size.

#4 Hardware

C1	250-213	8	4-40 x 5/16" screw	.05
C2	252-2	8	4-40 nut	.05
C3	254-9	8	#4 lockwasher	.05

#6 Hardware

C4	250-170	8	#6 x 1/4" sheet metal screw	.05
C4	250-369	8	#6 x 1/4" black screw	.05
C5	250-89	4	6-32 x 3/8" screw	.05
C6	250-162	5	6-32 x 1/2" screw	.05
C7	252-3	11	6-32 nut	.05
C8	253-89	1	#6 D washer	.05
C9	254-1	12	#6 lockwasher	.05
C10	259-1	1	#6 solder lug	.05

Other Hardware

C11	250-43	2	#8 setscrew	.05
C12	252-7	2	Control nut	.05
C13	253-10	2	Control flat washer	.05
C14	254-35	1	Control lockwasher	.20
C15	255-30	1	Control spacer	.15
C16	255-2	1	Small spacer	.05
C17	257-12	1	Eyelet	.05
C18	436-5	2	Coaxial connector	.85

METAL PARTS

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
D1	90-503-1	1	Cabinet top	1.80
D2	90-504-2	1	Cabinet chassis	1.65
D3	214-116	1	Remote chassis cover	2.10
D4	214-172-1	1	Remote chassis	4.65
D5	204-135	1	Short bracket	.15
D6	204-363	1	Long bracket	.30
D7	205-778	1	Alignment tool blade	.15

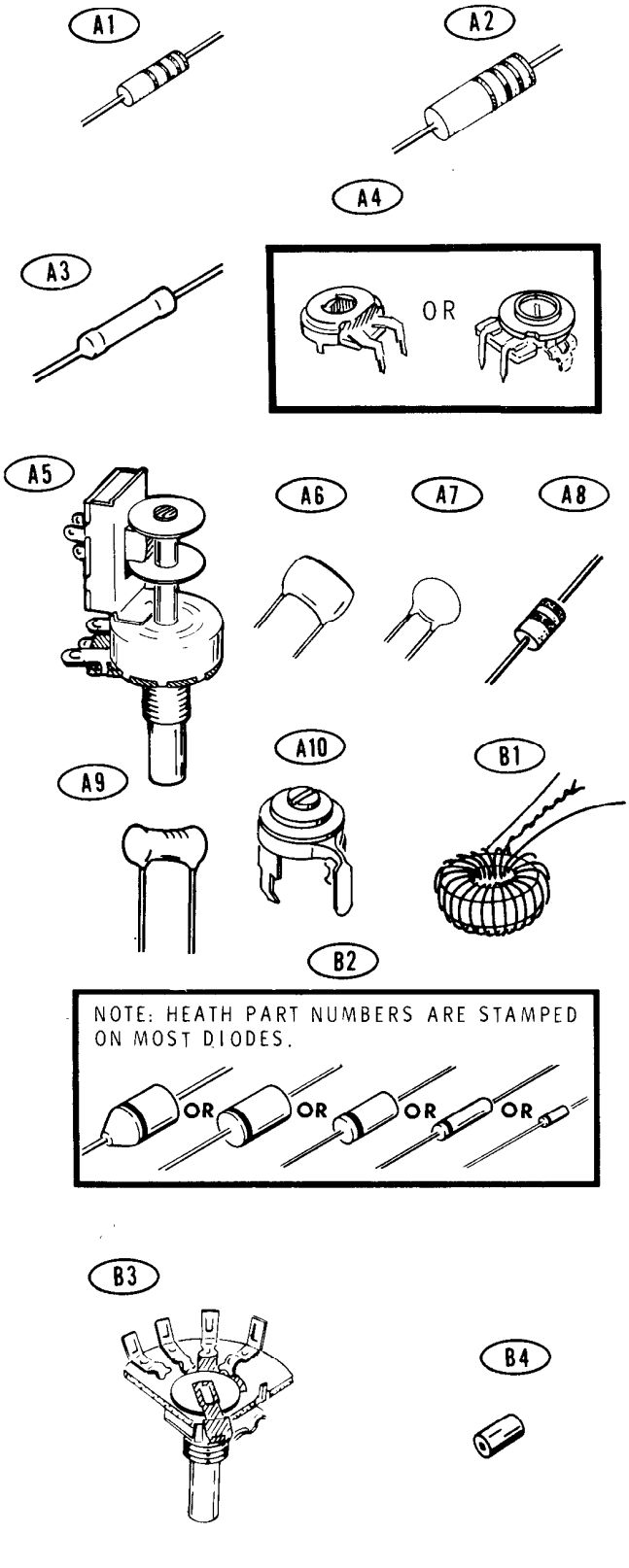
MISCELLANEOUS

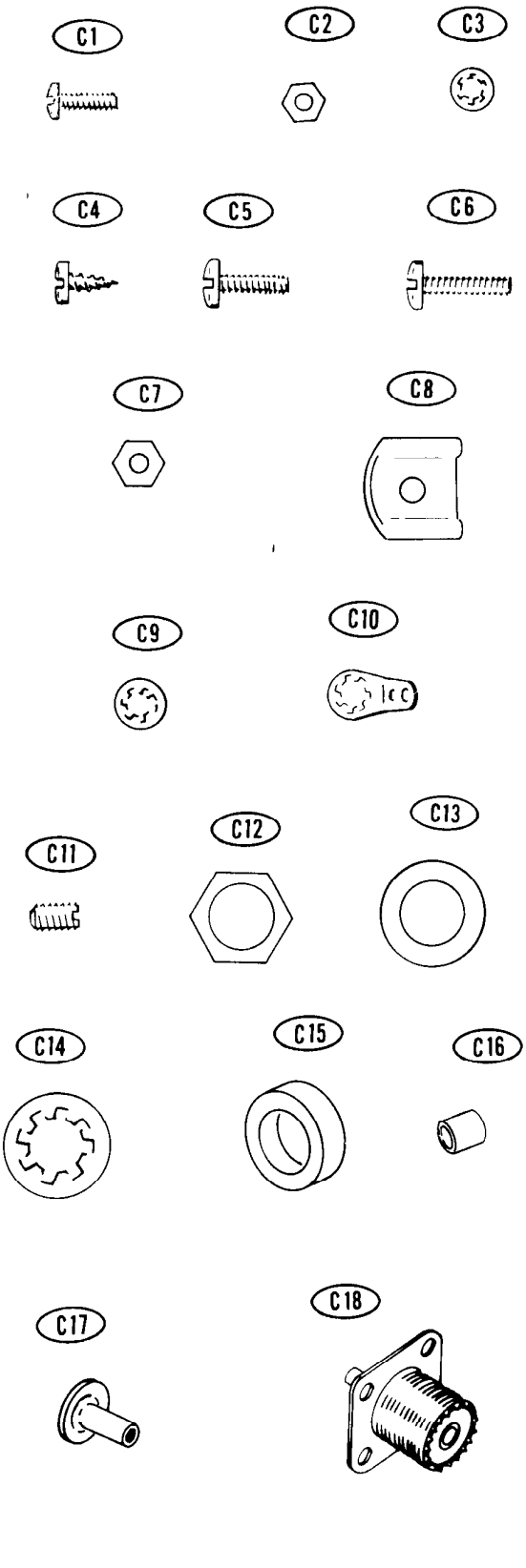
E1	75-30	1	Strain relief	.15
	85-1443-2	1	Circuit board	2.05
E2	207-5	1	Cable clamp	.15
E3	261-9	4	Rubber foot	.05
E4	407-179	1	Meter	21.65
E5	432-120	1	Female connector	.15
E6	432-121	2	Connector pin	.15
E7	462-191	2	Knob	1.25
	340-3	1	Bare wire	.05/ft
	346-21	1	Teflon* sleeve	.35/ft
	347-39	1	Cable	.15/ft
	490-5	1	Nut starter	.15
	391-34	1	Blue and white label	
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
		1	Assembly Manual (See front cover for part number.)	2.00

Solder (Additional 3' rolls of solder, #331-6, can be ordered for 25 cents each.)

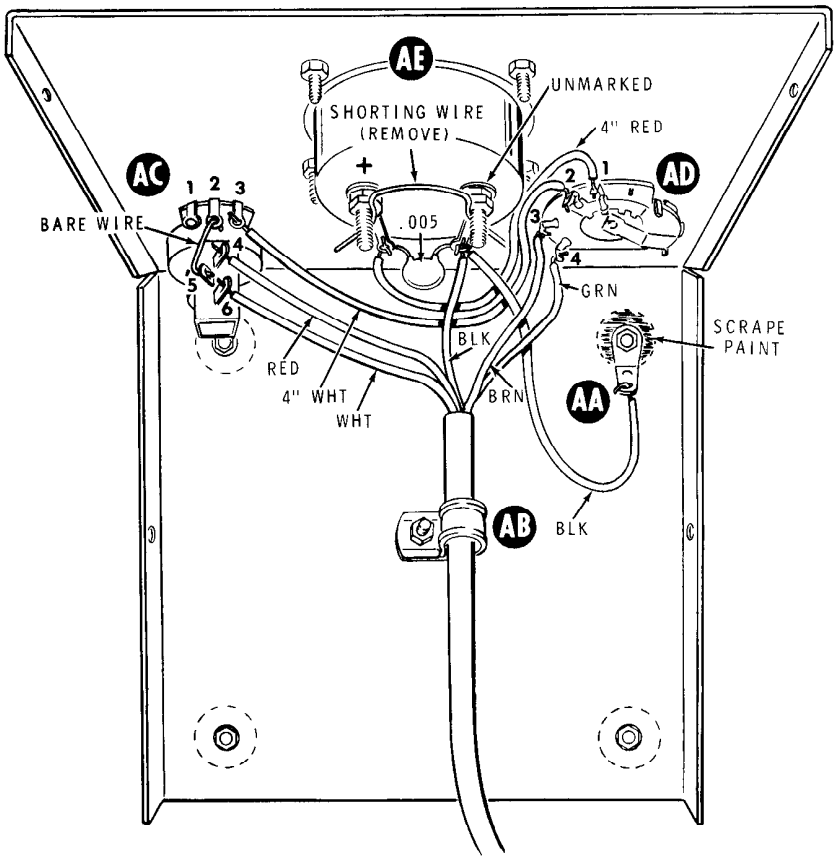
*Dupont Registered Trademark

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.


A1
A2
A3
A4
OR
A5
A6
A7
A8
A9
A10
B1
B2
NOTE: HEATH PART NUMBERS ARE STAMPED ON MOST DIODES.
OR
OR
OR
OR
B3
B4

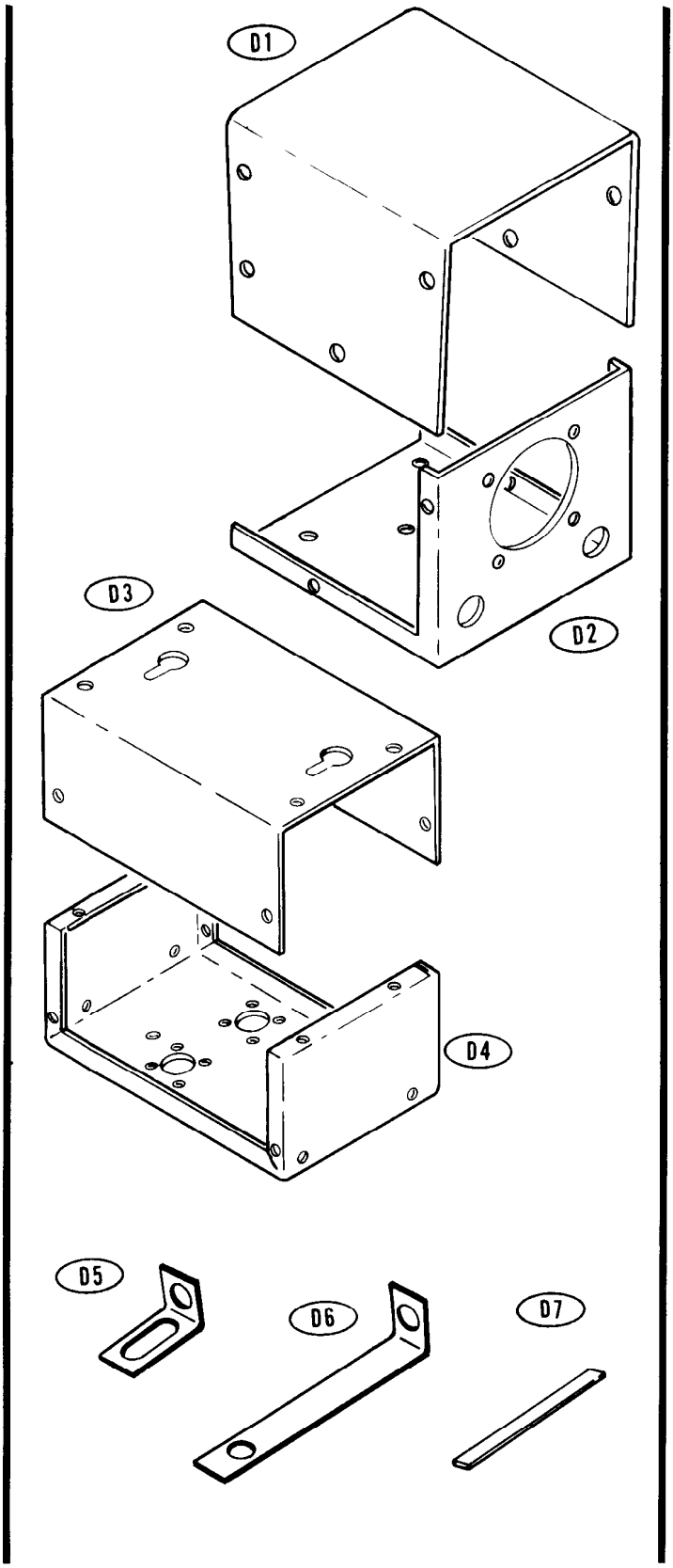

C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18

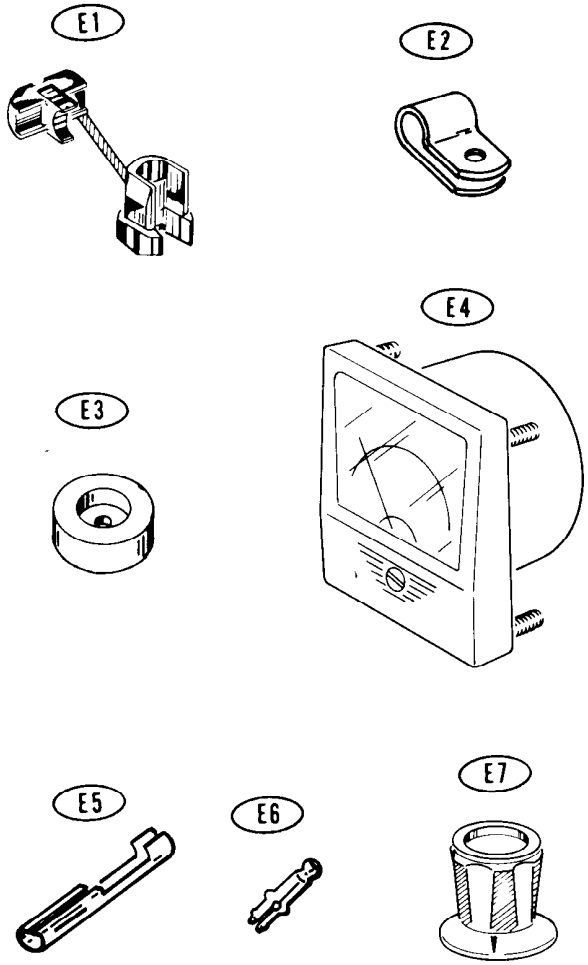

D
D5


AE
SHORTING WIRE
(REMOVE)
UNMARKED
4" RED
AC
1 2 3
AD
BARE WIRE
.005
GRN
SCRAPE
PAINT
BLK
RED
4" WHT
WHT
BRN
AA
AB
BLK

PICTORIAL 4

S PICTORIAL





STEP-BY-STEP ASSEMBLY

Before you start the "Circuit Board Assembly," be sure to read the "Circuit Board Parts Mounting" and "Soldering" sections of the "Kit Builders Guide."

CIRCUIT BOARD ASSEMBLY

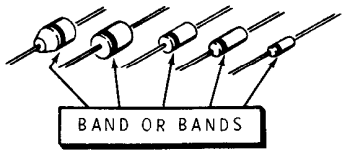
Components will be installed on the circuit board by following the steps on Pages 4 and 5. Position all parts as shown in the Pictorials. Follow the instructions carefully and read the entire step before performing the operation.

All resistors will be called out by resistance values (in Ω or kΩ); the color code will also be given for all except the precision resistor. Capacitors will be called out by capacitance value (in pF or μF) and type (mica or disc).

Locate the circuit board and position it lettered side up as shown in Pictorial 1. Then complete each step on Pictorials 1 and 2.

START

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



( ) 1N295 diode (red-white-green) at D1 (#56-20).

( ) 1N295 diode (red-white-green) at D2 (#56-20).

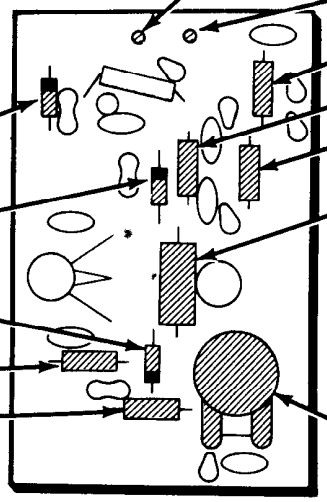
( ) 1N295 diode (red-white-green) at D3 (#56-20).

( ) 2200 Ω (red-red-red).

( ) 470 Ω (yellow-violet-brown).

SAFETY WARNING: Avoid eye injury when you clip off excess leads. We suggest that you wear glasses, or at least clip the leads so the ends will not fly toward your eyes.

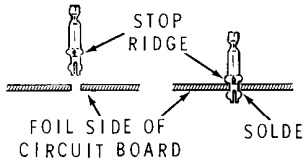
( ) Solder all leads to the foil and cut off the excess lead lengths.



PICTORIAL 1

CONTINUE

( ) Install a connector pin in the circuit board as shown.



( ) Connector pin.

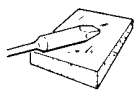
( ) 68 kΩ (blue-gray-orange).

( ) 470 Ω (yellow-violet-brown).

( ) 10 kΩ (brown-black-orange).

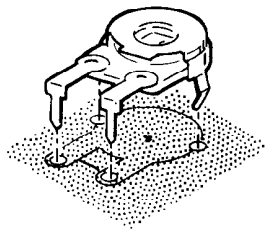
( ) 51 Ω, 1-watt (green-brown-black). Position clear of circle.

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN... WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.



( ) Solder all leads and connector pins to the foil and cut off the excess lead lengths.

( ) Install the 50 kΩ control as shown. Solder the four lugs to the foil.



START

NOTE: Before you install ceramic capacitors, remove any insulation from the leads as shown.

( ) .001 μF disc.

( ) .001 μF disc.

( ) .001 μF disc.

( ) .005 μF disc.

NOTE: In the following step, install the 12 pF capacitor for a 2-meter built-in calibrator. Otherwise, use the 14 pF capacitor. See Power Meter Calibration on Page 14.

( ) 12 pF mica or 14 pF disc at C2.

( ) 100 pF mica.

( ) 27 pF disc.

( ) 27 pF disc.

( ) 100 pF mica.

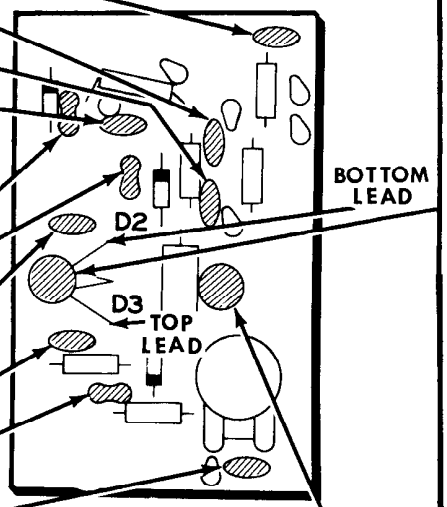
( ) .001 μF disc.

( ) Solder the leeds to the foil and cut off the excess lead lengths. NOTE: Save one of the excess lead lengths for use in later steps.

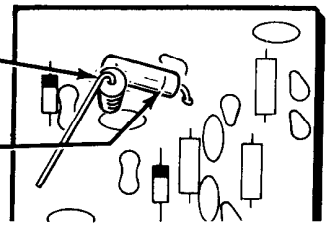
( ) Refer to Detail 2A and install the .56 pF phenolic (green-blue-gray). Position this capacitor vertically against the circuit board as shown. The free end will be connected later.

( ) 10 kΩ precision. Position it as shown.

( ) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 2



Detail 2A

CONTINUE

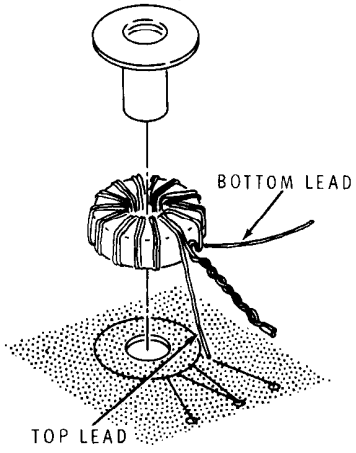
( ) Install the toroid coil as follows:

1. Position the three toroid coil leads as shown, and push the leads through the circuit board. NOTE: Be sure the twisted pair of leads goes into the center hole. The lead coming from the top of the coil must go to the hole nearest D3, and the lead from the bottom must go to the hole nearest D2.

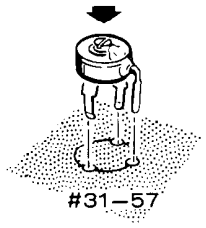
2. Carefully push an eyelet through the center of the toroid coil. Do not force the eyelet. Then push the eyelet through the circuit board and solder it to the foil.

NOTE: If an ohmmeter is available, check between the eyelet and one of the coil leads to be sure they are insulated.

3. Solder the tinned ends of the three leads to the foil and remove any excess lead lengths.

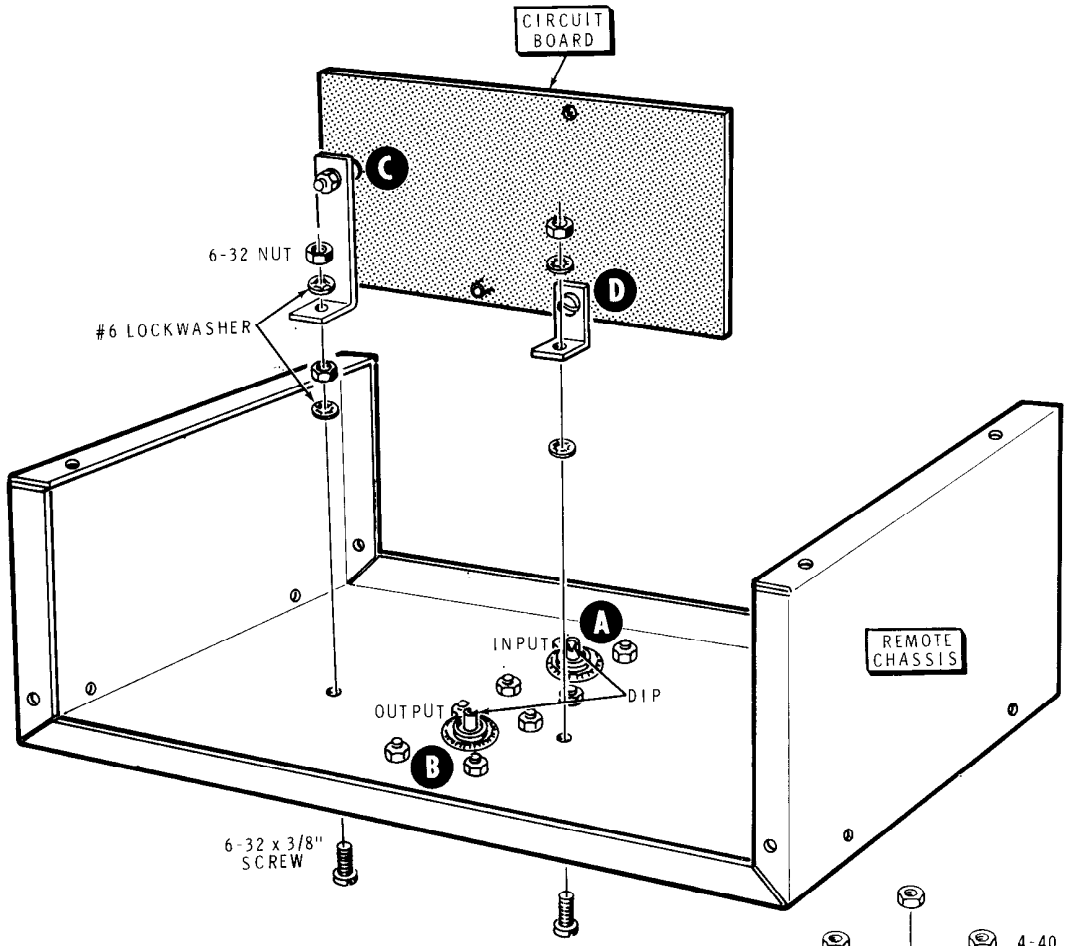


( ) Install the 2.7-20 pF trimmer as shown. Solder the three lugs to the foil.



Temporarily set the circuit board aside.

FINISH



PICTORIAL 3

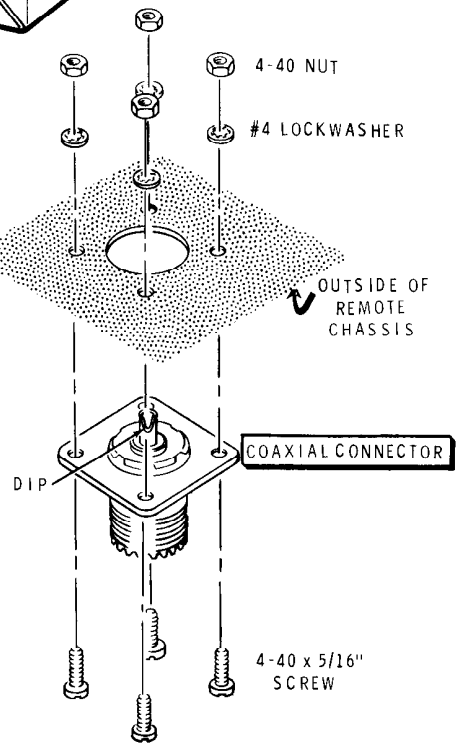
REMOTE CHASSIS ASSEMBLY

Refer to Pictorial 3 for the following steps.

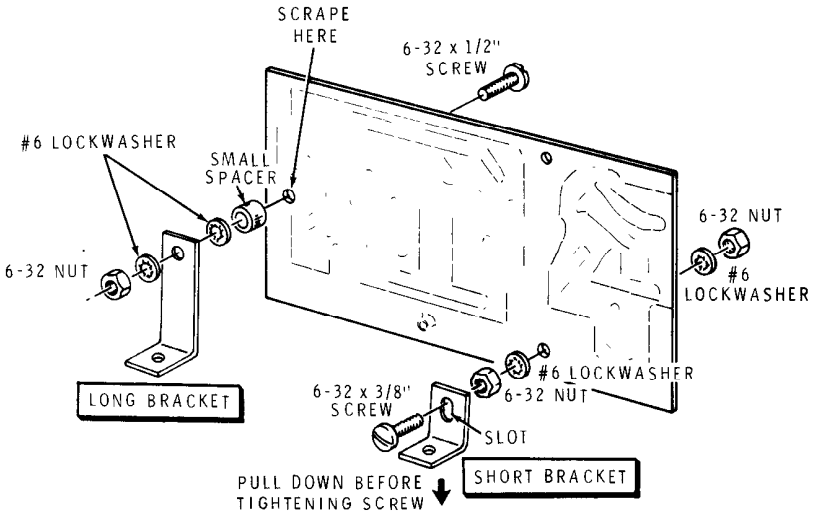
NOTE: The Heath Company has provided a plastic nut starter with this kit. Use this nut starter to hold and start 4-40 and 6-32 nuts on screws.

( ) Mount a coaxial connector on the outside of the remote chassis at A. Use four 4-40 x 5/16" screws, four #4 lockwashers, and four 4-40 nuts as shown in Detail 3A. Position the center pin dip toward the other mounting hole.

( ) In a similar manner, mount a coaxial connector at B.



Detail 3A



Detail 3B

( ) In the next step, you will mount the long bracket to the circuit board. Therefore, scrape away the colored protective coating from the foil where the small spacer will contact it.

( ) Mount a long bracket on the circuit board at C as shown in Detail 3B. Use a 6-32 x 1/2" screw, two #6 lockwashers, a small spacer, and a 6-32 nut.

( ) Mount a short bracket on the circuit board at D with a 6-32 x 3/8" screw, two #6 lockwashers, and two 6-32 nuts. Position the slotted hole as shown. Pull the bracket down as far as it will go, as shown, before tightening the screws.

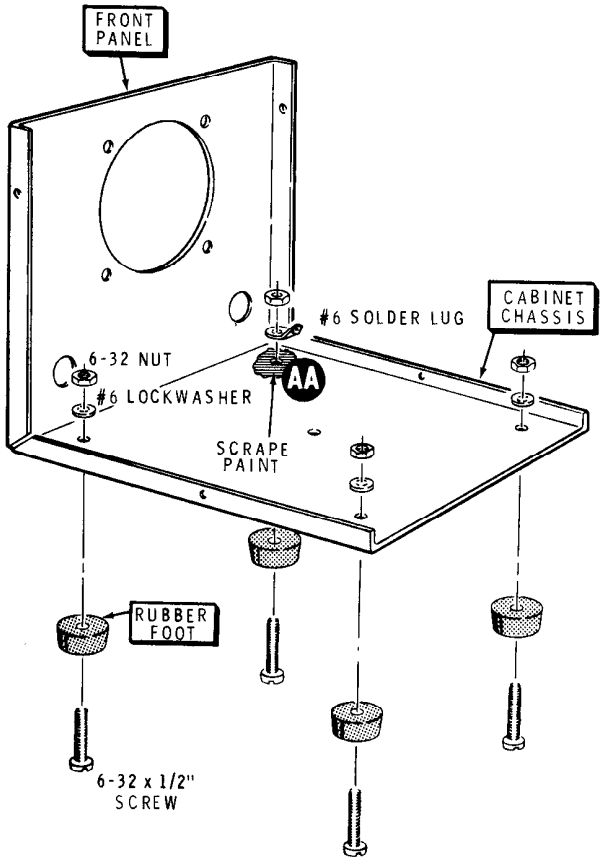
( ) Mount the circuit board in the center of the remote chassis as shown in Pictorial 3. Use a 6-32 x 3/8" screw, two #6 lockwashers, and two 6-32 nuts on bracket C. Then mount bracket D with a 6-32 x 3/8" screw, two #6 lockwashers and a 6-32 nut.

CABINET ASSEMBLY AND WIRING

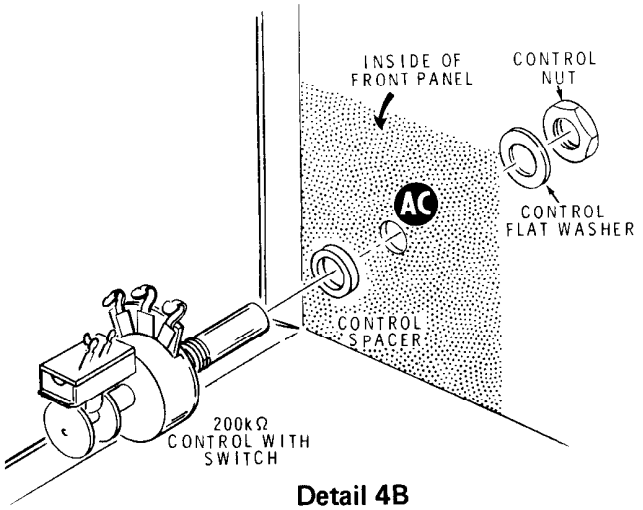
Refer to Pictorial 4 (fold-out from Page 4) for the following steps.

( ) Refer to Detail 4A and scrape the paint from around hole AA on the cabinet chassis to provide a good ground for the solder lug.

( ) Install four rubber feet on the cabinet chassis with four 6-32 x 1/2" screws, three #6 lockwashers, and four 6-32 nuts. Use a #6 solder lug at AA in place of a #6 lockwasher. Position the solder lug as shown in Pictorial 4.

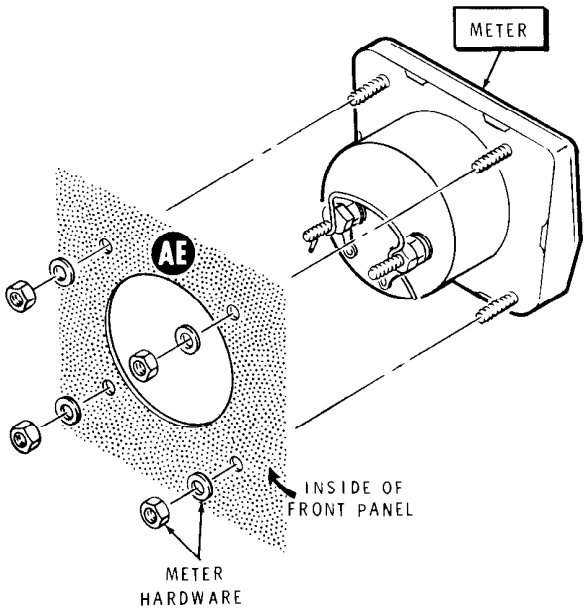


Detail 4A



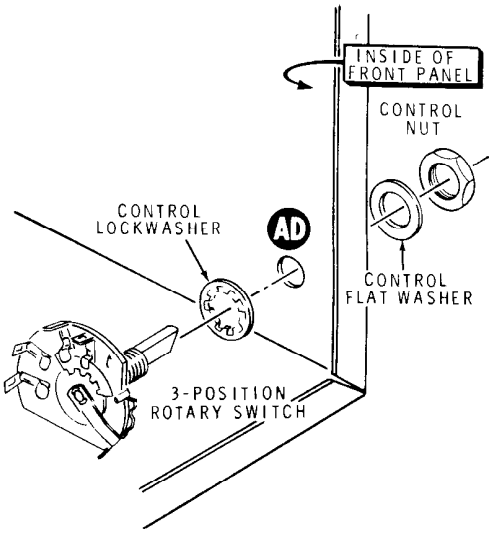
Detail 4B

( ) Install the 200 kΩ control with switch at AC on the front panel with a control spacer, a control flat washer, and a control nut, as shown in Detail 4B.



Detail 4C

( ) Remove the meter from its carton and locate the meter hardware in the same carton. Mount the meter at AE; use the meter hardware as shown in Detail 4C. NOTE: Do not overtighten the meter nuts, as the meter case can be broken. Make sure the meter top is parallel with the top of the panel. The shorting wire will be removed later.



Detail 4D

( ) Refer to Detail 4D and install the 3-position switch at AD with a control lockwasher, a control flat washer, and a control nut. Position the switch as shown in Pictorial 4.

( ) Connect a .005 μF disc capacitor between the positive (+) lug (NS) and the negative (unmarked) lug (NS) of meter AE.

NOTE: Where a wire passes through a connection and then goes to another point, as in the next step, it will count as two wires in the solder instructions (S-2), one entering and one leaving the connection.

( ) Locate the bare lead saved from the circuit board assembly and connect it from lug 5 (S-1) to lug 2 (S-1) of switch AC.

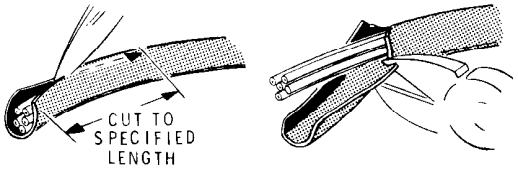
( ) Cut 4" from one end of the cable. Carefully cut about 1/2" of the outer insulation from the wires in the 4" length. With a pair of long-nose pliers pull the wires out of the outer insulation. Save a 1" piece of the outer insulation to use later.

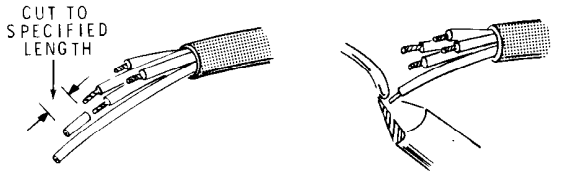
( ) Prepare the 4" red, white and black wires by removing 1/4" of insulation from both ends of each wire. Then twist the wire ends tightly and apply a small amount of solder to each end to hold the small strands together.

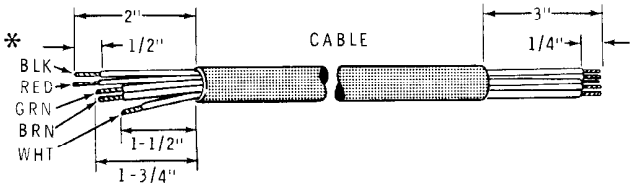
( ) Connect the red wire between the positive meter lug (S-2) and lug 1 of switch AD (S-1).

( ) Connect the white wire between lug 3 of switch AC (S-1) and lug 2 of switch AD (S-1).

( ) Connect the black wire between the negative meter lug (NS) and solder lug AA (S-1).







* NOTE: REMOVE 1/2" OF INSULATION FROM EACH WIRE ON THIS END.

Detail 4E

( ) Refer to Detail 4E and prepare both ends of the long cable as shown. Twist the bare wire ends tightly and apply a small amount of solder to each end to hold the small strands together.

Connect the 3" prepared end of this cable to the cabinet components in the following steps.

( ) Connect the black wire to the negative (unmarked) meter lug (S-3).

( ) Connect the brown wire to lug 3 of switch AD (S-1).

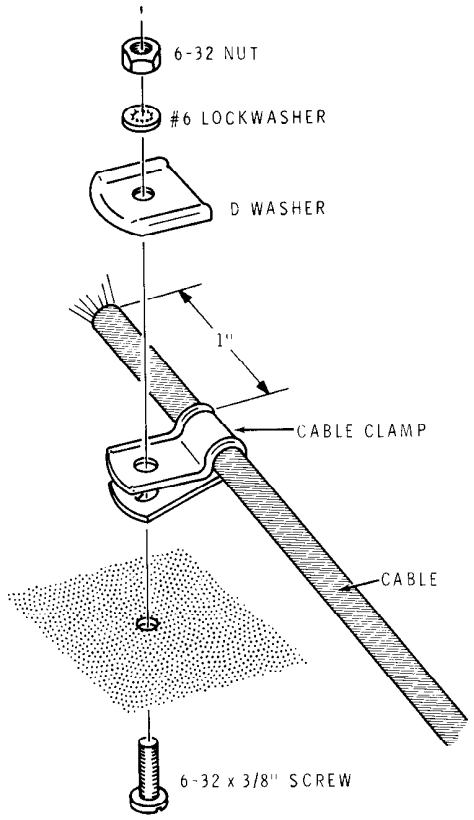
( ) Connect the green wire to lug 4 of switch AD (S-1).

( ) Connect the red wire to lug 4 of switch AC (S-1).

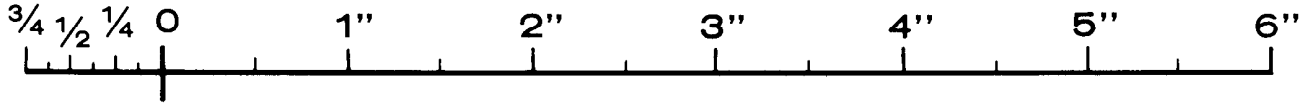
( ) Connect the white wire to lug 6 of switch AC (S-1).

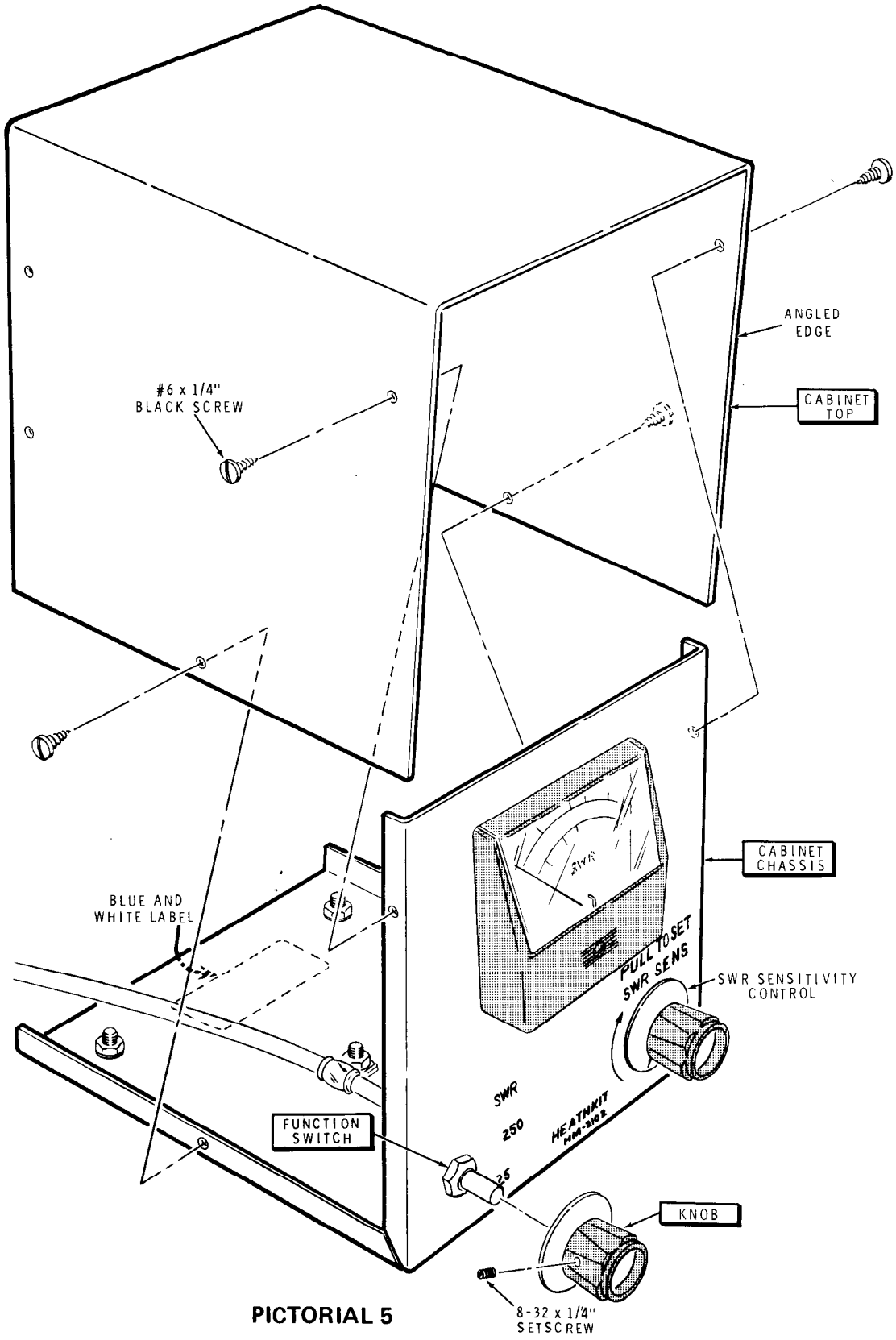
( ) Place a cable clamp on the cable so that 1" of the outer insulation extends beyond the clamp as shown in Detail 4F. Secure the clamp to the chassis at AB with a 6-32 x 3/8" screw, a D washer, a #6 lockwasher, and a 6-32 nut.

( ) Remove and discard the shorting wire from the meter terminals.



Detail 4F




ANGLED EDGE
#6 x 1/4" BLACK SCREW
CABINET TOP
CABINET CHASSIS
BLUE AND WHITE LABEL
PULL TO SET SWR SENS
SWR SENSITIVITY CONTROL
SWR
250
HEATHKIT
FUNCTION SWITCH
KNOB
8-32 x 1/4" SETSCREW

PICTORIAL 5

Refer to Pictorial 5 for the following steps.

( ) Loosely secure the cabinet top to the chassis with four #6 x 1/4" black screws as shown, with the angled edge to the front.

( ) Start an 8-32 x 1/4" setscrew into each of the knobs.

( ) Turn the Function (SWR-250-25) switch shaft to its center position.

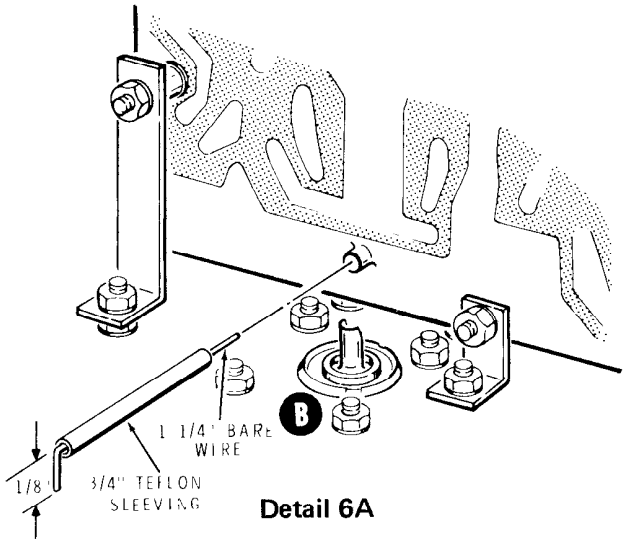
( ) Install a knob on the Function switch shaft. Position the knob so the pointer is directly toward the "250" on the front panel. Tighten the setscrew securely.

( ) Turn the SWR Sens control shaft fully counterclockwise. Place the other knob on the control shaft and position it so the pointer is at the 7 o'clock position (at the lower end of the rotation arrow); then, tighten the setscrew securely.

NOTE: The blue and white label shows the model number and production series number of your kit. Refer to these numbers in any communications with the Heath Company about this kit; this assures you that you will receive the most complete and up-to-date information in return.

( ) Remove the paper backing from the blue and white label; then, press the label firmly onto the bottom of the cabinet as shown on Pictorial 5.

Refer to Pictorial 6 for the following steps.

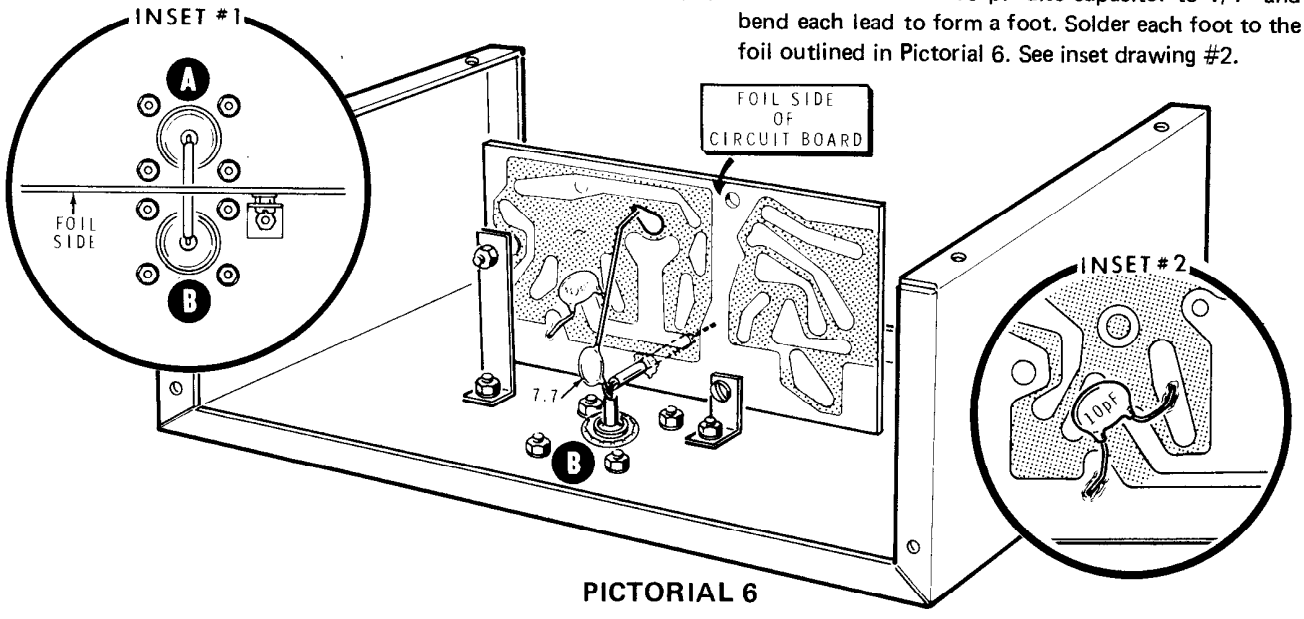


Detail 6A

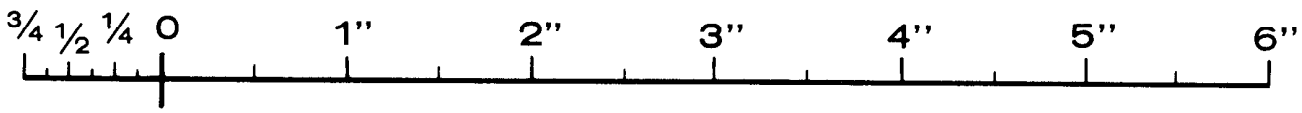
( ) Locate the remote chassis and place a 3/4" Teflon sleeve on a 1-1/4" bare wire. Connect this wire from the center pin of connector B (NS), through the eyelet in the circuit board, and into the center pin dip of connector A (NS). See inset drawing #1 and Detail 6A.

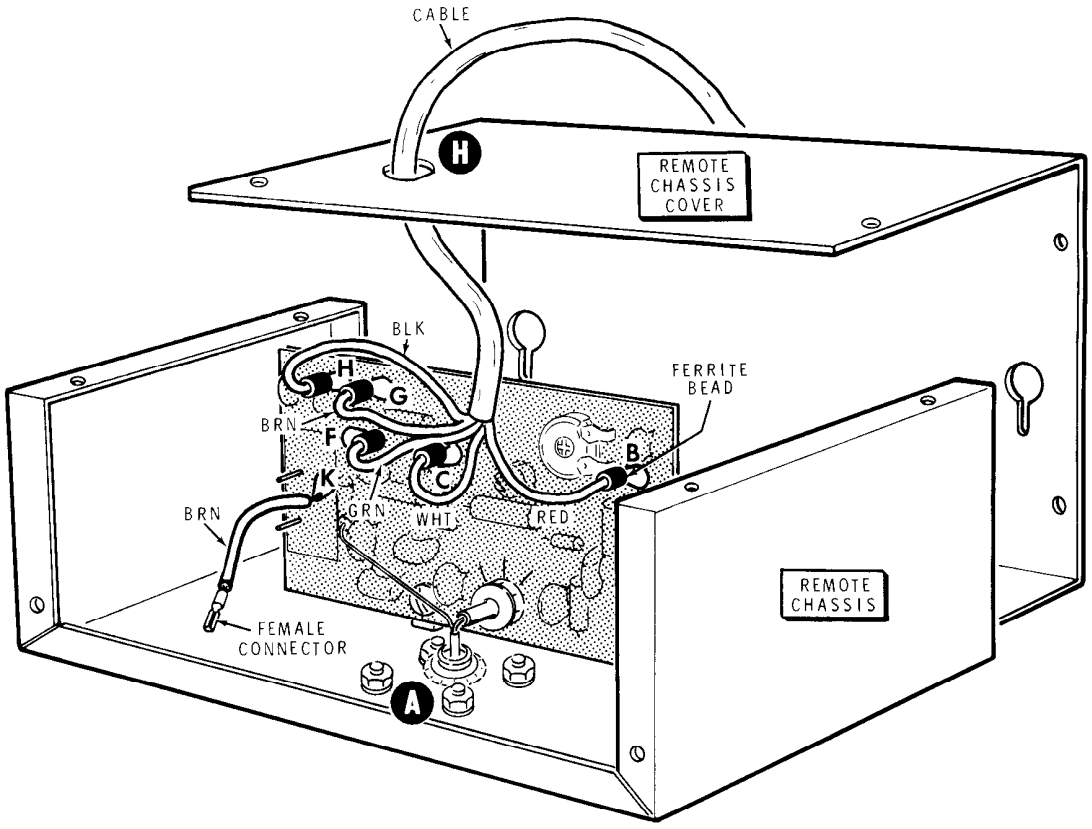
( ) Cut one lead of a 7.7 capacitor to 1/4". Insert this lead into the center pin of connector B (S-2). Connect the other lead of this capacitor to the hole in the foil outlined in Pictorial 6 (S-1). Cut off the excess lead on the component side.

( ) Cut both leads of a 10 pF disc capacitor to 1/4" and bend each lead to form a foot. Solder each foot to the foil outlined in Pictorial 6. See inset drawing #2.

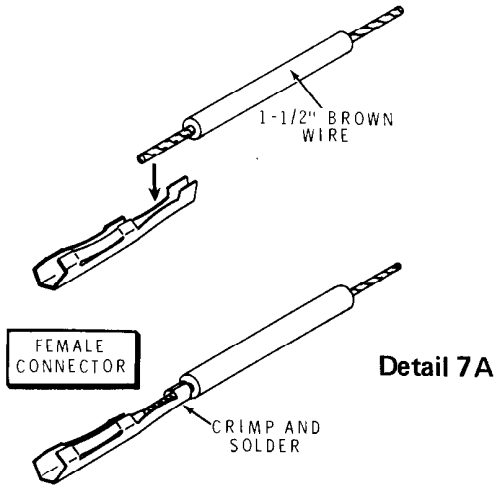


PICTORIAL 6





PICTORIAL 7



Detail 7A

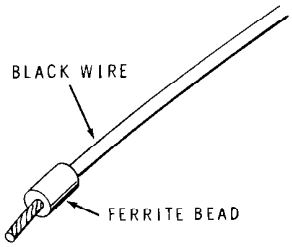
Refer to Pictorial 7 for the following steps.

( ) Insert the free end of the .56 pF capacitor into the center pin of connector A and solder both wires.

( ) Remove 1/4" insulation from each end of a 1-1/2" length of brown wire and solder a female connector on one end as shown in Detail 7A.

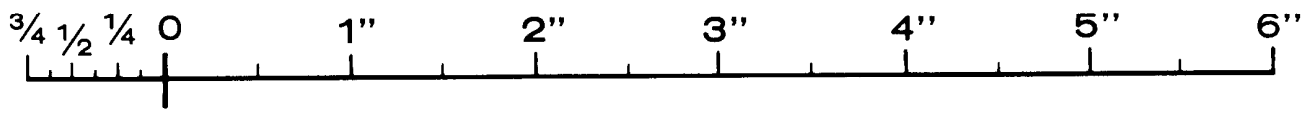
( ) Insert the other end through hole K on the circuit board and solder it to the foil.

( ) From the outside of the remote chassis cover insert the free cable end through the round hole as shown in Pictorial 7.



Detail 7B

( ) Refer to Detail 7B and place a ferrite bead over the bare end of the black wire. Then, push the end of the black wire through hole H until the ferrite bead is down against the component side of the circuit board. Solder the wire to the foil.



( ) Install the brown wire and bead combination at G (S-1).

( ) Install the green wire and bead combination at F (S-1).

( ) Install the white wire and bead combination at C (S-1).

( ) Install the red wire and bead combination at B (S-1).

( ) Cut off the excess lead lengths on the foil side of the circuit board.

( ) Carefully inspect the foil side of the circuit board and be sure that all the connections are soldered and that there are no solder bridges between foils. NOTE: Some of the circuit board holes and one capacitor will not be used.

This completes the "Step-by-Step Assembly." Proceed to the "Adjustment and Calibration" section.

ADJUSTMENT AND CALIBRATION

To perform the following steps, the Wattmeter must be connected in the transmission line between the transmitter and the load. An internal calibration circuit is provided for the calibration steps.

NOTE: If you have an accurate VHF Wattmeter, you can calibrate to it with similar results. The Wattmeter must also be connected in series with your HM-2102 VHF Wattmeter.

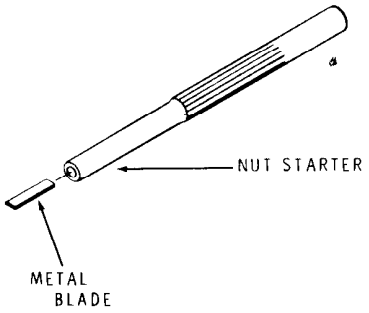


Figure 1

PREPARATION

( ) Prepare an alignment tool in the following manner: Insert the 1/8" x 3/4" alignment tool blade into the small end of the nut starter as shown in Figure 1. Leave 1/4" of the blade exposed.

( ) Check to see that the meter needle is directly over the zero on the scale. If it is not, adjust the screw on the meter case slightly to position the needle over the zero.

( ) Connect a 50 Ω noninductive load, such as the Heathkit Cantenna to the remote chassis OUTPUT jack.

( ) Connect the transmitter output to the INPUT jack.

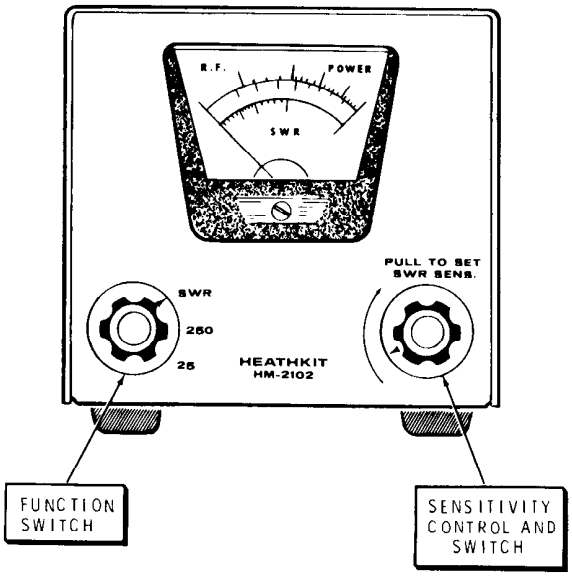


Figure 2

( ) Set the FUNCTION switch to 25 (see Figure 2).

( ) Push the SWR SENS control knob in and turn the control fully counterclockwise.

( ) Connect the CALIBRATION JUMPER on the remote chassis circuit board to the CAL pin. (See Figure 3 fold-out from this page.)

( ) Turn on the transmitter and set it to the CW mode in the 6 or 2-meter band. Then tune the transmitter and watch the RF Power Meter needle move up-scale. If the meter needle does not move up-scale, refer to the "In Case of Difficulty" section of this Manual.

SWR BALANCE ADJUSTMENT

( ) Set the FUNCTION switch to SWR.

( ) Apply transmitter power and adjust the SWR SENS control for a midscale reading.

( ) Refer to Figure 3 and adjust SWR NULL trimmer C4 on the circuit board for the best null or greatest dip of the meter needle. This reading should be at or near zero. NOTE: Use only the alignment tool (nut starter) for this adjustment.

( ) Readjust the SWR SENS control for a maximum reading.

( ) Repeat the two preceding steps. Make these final adjustments carefully and precisely. The accuracy of the instrument depends on a well balanced bridge circuit.

( ) Pull the SWR SENS knob to its out position. Then set SWR SENS control for a full-scale reading.

( ) Push the switch in and note the meter reading. If the meter reads higher than 1.5, refer to the "In Case of Difficulty" section of the Manual.

POWER METER CALIBRATION

The internal calibration circuit may be used for calibration with 5-watt to 15-watt transmitters on the 2-meter (6-meter, if C2 is 14 pF) band.

An external wattmeter may be used with transmitters at frequencies of 50 to 160 MHz and power up to 200 watts. (The internal calibration circuit is not used in this case.)

Either procedure will give accurate results over the full range specified for your Wattmeter. However, the accuracy of the external wattmeter will determine how accurate your Wattmeter will be.

Use only one of the two following procedures.

Internal Calibration

1. ( ) Turn the FUNCTION switch to 25.

2. ( ) Connect the CALIBRATE Jumper on the circuit board to the CAL pin.

3. ( ) Tune the transmitter on the 2- (or 6-) meter band.

4. ( ) Note the meter reading.

5. ( ) Connect the CALIBRATE jumper to the NORM pin and adjust POWER CALIBRATE control R6 with the alignment tool so the meter reads the same as noted in step 4.

6. ( ) Repeat steps 2, 4, and 5 until the meter readings for both CAL and NORM connections are the same.

7. ( ) Connect the CALIBRATE jumper to the NORM pin.

This completes the "Internal Calibration" of your VHF Wattmeter.

External Calibration

( ) Connect the external wattmeter.

( ) Turn the FUNCTION switch to 25.

( ) Tune the transmitter on the 2-meter (or 6-meter) band.

( ) Note the external wattmeter reading.

( ) Connect the calibrate jumper to the NORM pin and adjust POWER CALIBRATE control R6 so both meters read the same.

This completes the "External Calibration" of your VHF Wattmeter.

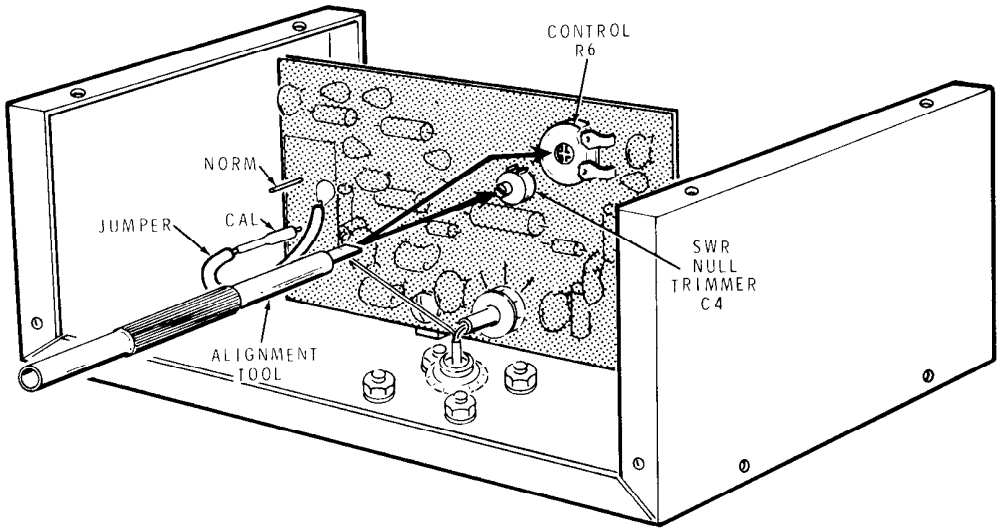
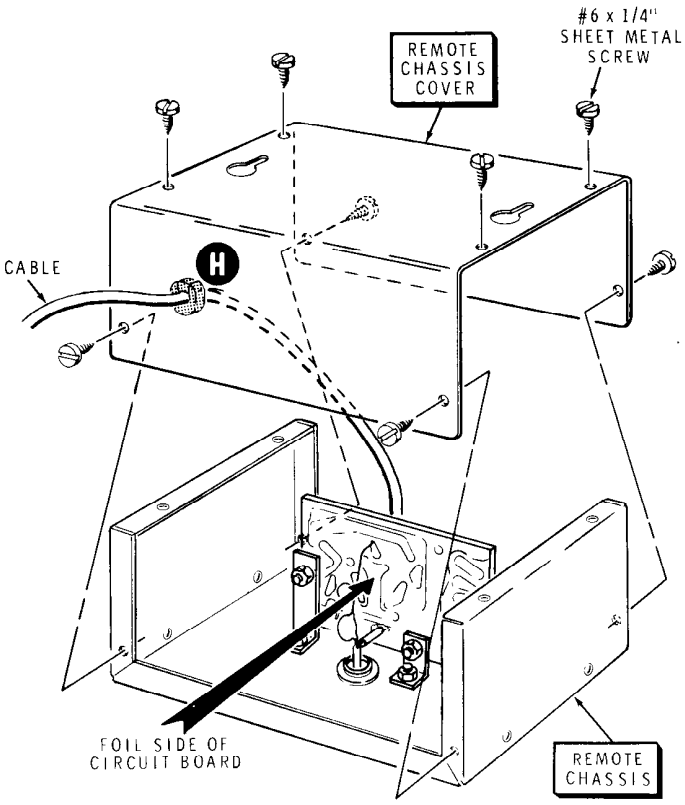

CONTROL
R6
NORM
JUMPER
CAL
SWR
NULL
TRIMMER
C4
ALIGNMENT
TOOL

Figure 3

FINAL ASSEMBLY

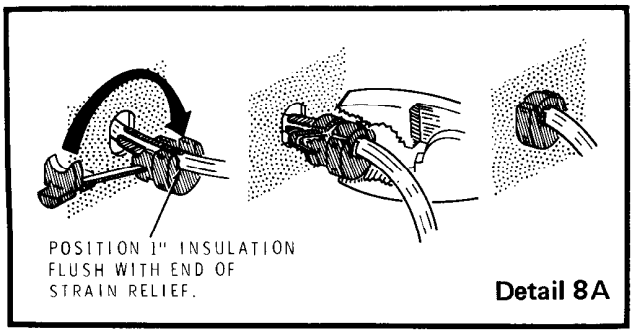


PICTORIAL 8

Refer to Pictorial 8 for the following steps.

( ) Disconnect the transmission line and place the remote chassis face down on your work surface. Place the cover on the remote chassis with the cable routed against the chassis to emerge from the side of the cover facing you as shown.

( ) Secure the cover to the chassis with eight #6 x 1/4" sheet metal screws. Do not use the black screws.



Detail 8A

( ) Refer to Detail 8A and install the cable strain relief on the cable in hole H as follows: Locate the 1" length of outer insulation saved from the previous step and slit it. Gently pull the cable from the remote chassis and place the length of insulation and the strain relief on the cable 1" from the hole. Then, with pliers, insert the strain relief in the hole.

Refer to Pictorial 9 for the following steps.

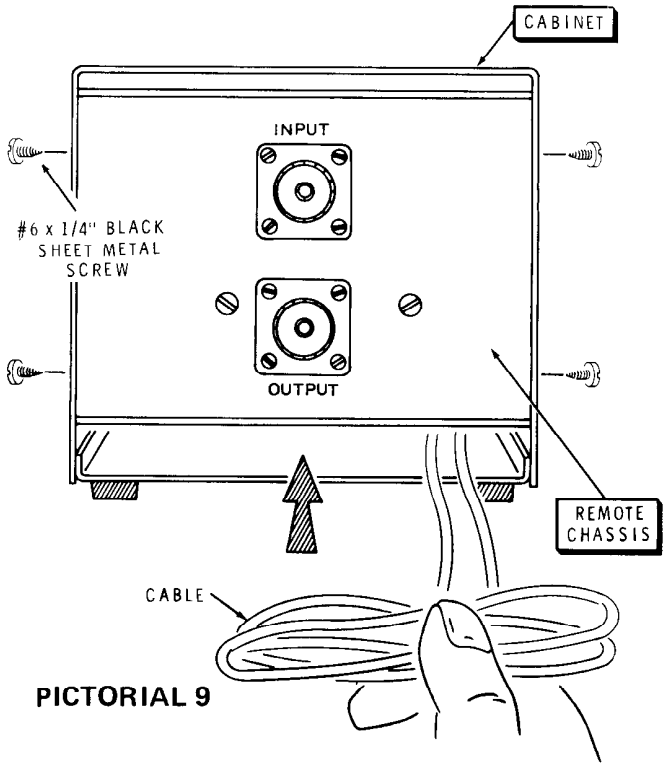
NOTE: In the following steps, you will install the remote chassis in the cabinet. If you wish to place the remote chassis in some location away from the cabinet, so the remote unit will be near the transmission lines, do not complete the following steps. In this case, place the four black screws in a small envelope and tape them to the bottom of the cabinet. Tighten the four cabinet screws and proceed to the "Operation" section of the manual.

( ) Position the remote chassis inside the top rear opening of the cabinet. Then secure the remote chassis to the cabinet with four #6 x 1/4" black screws.

( ) Tighten the other four black cabinet screws.

( ) Coil the cable neatly and slide it into the opening beneath the remote unit.

This completes the "Final Assembly" of your VHF Wattmeter. Proceed to the "Operation" section of the manual.



PICTORIAL 9

OPERATION

The Wattmeter (SWR Bridge) may be left in the transmission line at all times for continuous monitoring purposes.

SWR METER

NOTE: The Wattmeter SWR bridge can only be used with 50-ohm nominal transmission lines. It will not work on transmission lines that are used as tuned feeders, since tuned feeders normally have a high SWR.

1. Turn the FUNCTION switch to SWR.

2. Pull the SWR SENS switch out and turn it fully counterclockwise.

3. Apply power to the transmitter and tune it for maximum RF output reading. Disregard the Power Meter readings at this time.

4. Turn the SWR SENS control clockwise for a midscale meter reading. A minor "touch-up" tuning of the transmitter may show an increase on the Meter. This indicates a closer match between the transmitter and the transmission line.

5. Turn the SWR SENS control clockwise to give a full-scale meter reading.

6. Push the SWR SENS control knob in and read the SWR directly on the lower meter scale.

Normal Operating Characteristics

The peaks on controlled carrier modulation will "kick" the meter needle upward. SSB and DSB signals will give a bouncing indication when transmitting; so no SWR measurement can be made with these signals. Therefore, use a single-tone or CW carrier with sideband transmitters when taking readings. When operating SSB, any indication with no modulation indicates spurious or parasitic emission, or poor carrier suppression.

Physical Placement and Losses

The detector unit may be removed from the cabinet and placed at a location more convenient for connection to your transmission line. The interconnecting cord that is furnished may be replaced by a longer one, if this is desired. You may even position the detector unit at the antenna, although there is always the possibility of RF pickup on the extended interconnecting cable from the transmission line. If this should occur, the use of properly grounded, shielded interconnecting cable may be required. NOTE: The remote cabinet is not weatherproofed. Any outdoor application should be temporary.

The SWR meter readings may vary if the Meter is placed at different locations in the transmission line, or if the length of the transmission line is changed. For this reason, assume that the highest SWR reading is most correct.

Misleading readings may be obtained with long transmission lines since the losses in the cable tend to "smooth out" the standing waves, giving a much better indication at the transmitter than actually exists at the antenna. Therefore, if you are using a transmission line long enough to have appreciable losses, locate the Wattmeter near the antenna, especially when adjusting beams or tuning traps. You can better understand the extent of this effect when you realize that a line with a 3 dB loss will show an SWR of 3:1 when it is terminated in a dead short. A line with a loss of over 10 dB will show an SWR of practically 1:1, on this or any other SWR meter, regardless of what load or termination is connected at the far end.

The power losses in these cases are occurring in the cable, but the SWR meter reading will not indicate that anything is wrong. When in doubt, make measurements at the antenna and at the transmitter, so future changes in the readings will be meaningful. The values of cable losses at various frequencies can be obtained from Figure 4. These losses become worse as time and moisture affect the cable.

With a high SWR, the transmission line losses may become so great that the radiated power is appreciably reduced; with high-power transmitters, the cable ratings may be exceeded. Figure 5 shows the effect of increasing cable losses caused by various values of SWR. When these losses occur, the RF power is turned into heat in the cable instead of being radiated from the antenna.

To obtain total losses in a given length of coaxial cable, determine the dB loss per foot of the cable from Figure 4. This is done by finding your operating frequency on the bottom line of the chart, and moving up to find the type of cable used. By looking at this same level on the left-hand side of the chart, you can read the dB loss per 100 feet of the cable at that frequency.

Now determine the additional loss caused by the SWR from Figure 5 as follows: Use the amount of loss determined from Figure 4 and find this value on the bottom line of Figure 5. Now move up the graph until you come to the SWR of your antenna system. Move over to the left-hand side of the graph and determine the amount of loss caused by the SWR. To obtain the total loss of your system, add the value from Figure 4 to the value from Figure 5. Multiply the total loss by the cable length in feet. Then divide by 100.

Loading

The load presented to the transmitter output circuit may create conditions that make it touchy or impossible to load the transmitter. With a low SWR, the load that the transmitter sees is practically pure resistive. However, at a high SWR, the apparent load may change from a very low to a very high resistance, accompanied by either capacitive or inductive reactance. These resistance and reactance values change when the transmission line length or frequency is changed.

Remember when you are using 50 Ω nominal unbalanced feed lines that the SWR cannot be changed by changing the transmission line length. However, the loading to the transmitter may be changed considerably; thus making it appear that "pruning" the cable length offers improvement, when it actually does not affect the SWR.

The SWR can only be changed by changing the load or termination at the cable. If the transmission line length is changed, for example, with 50 Ω cable and an SWR of 3:1, the apparent load to the transmitter may vary from 16-2/3 Ω to 150 Ω resistive in series with reactance varying from 66-2/3 Ω capacitive, to zero, to 66-2/3 Ω inductive. If the transmitter output tuning adjustments will not accommodate this impedance range, the transmitter will be difficult to load until the load is properly matched to the line. When the load is matched, the SWR will be low, approaching 1:1. This condition provides the greatest accuracy for Power Meter measurements.

POWER METER

The operation of the Power Meter is simple. A load must be connected to the output jack of the Meter. Merely place the FUNCTION switch in either the 25- or 250-watt position; then read the corresponding scale on the meter scale to obtain the power output of the transmitter.

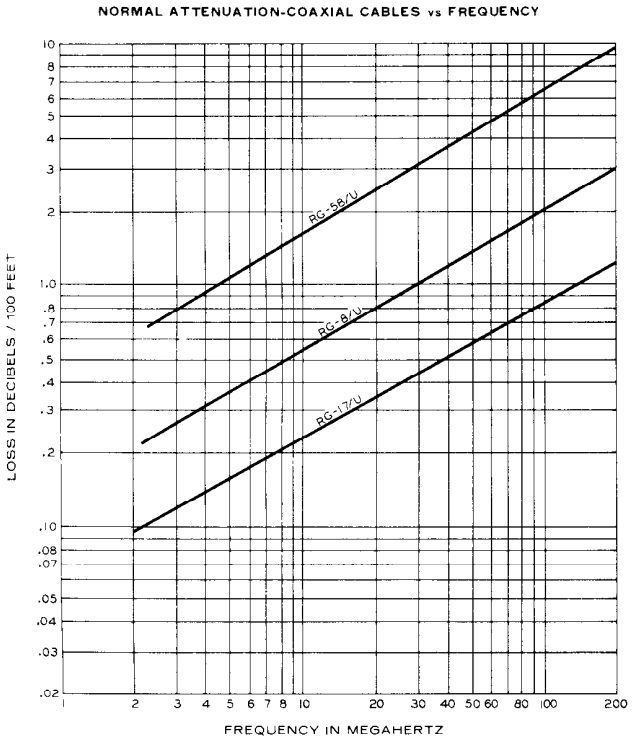


Figure 4

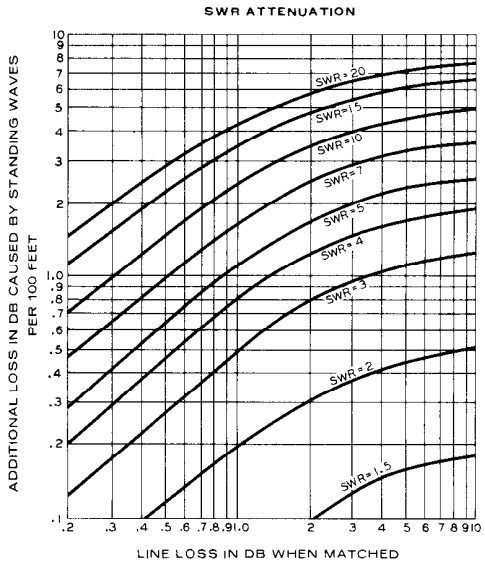


Figure 5

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits that are returned for repair, do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the "Soldering" section of the "Kit Builders Guide."

3. Check the values of parts. Be sure that the proper part has been wired into the circuit, as shown in the Pictorial diagrams and as called out in the wiring instructions.

4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

5. A review of the Circuit Description and the Schematic Diagram may prove helpful in locating a trouble.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE
Meter reads down-scale on SWR or wattmeter.	1. Meter leads reversed. 2. Diode D1 or D2 reversed.
Lower meter reading for SWR Set (switch out) than for SWR.	1. Input and output plugs reversed. 2. Pickup coil L1 leads reversed. 3. Switch S3 incorrectly wired.
Calibrator portion of meter not functioning correctly.	1. Input and output plugs reversed. 2. Diode D1 reversed. 3. Capacitor C1, C2, or C9. 4. Resistor R1.
SWR reading while transmitter is off.	1. Nearby transmitter in operation.
SWR null not correct.	1. Improper load on wattmeter. 2. Pickup coil L1 leads reversed. 3. C3 improperly connected.
No meter reading.	1. Shorting wire not removed.

SPECIFICATIONS

Frequency Range	50 MHz to 160 MHz.
Wattmeter Accuracy	±10% of full-scale reading.*
Power Capability	To 250 watts.
SWR Sensitivity	Less than 10 watts.
Transmission Line Impedance	50 ohms nominal.
SWR Bridge	Continuous to 250 watts.
Connectors	UHF type SO-239.
Dimensions	5-1/4" wide, 5-1/16" high, and 6-1/2" deep, assembled as one unit.
Net Weight	2-1/2 lbs.

*Using a 50 Ω noninductive load.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

Refer to the Schematic while reading this "Circuit Description."

SWR BRIDGE CIRCUIT

Toroid coil L1 is a current pickup element for forward and reflected power. A bus wire is routed from the Input jack through toroid coil L1, and then to the Output jack. A transmitted signal routed along this wire induces a current in coil L1. The voltage formed in coil L1 is rectified by diode D3 and decoupled by capacitor C7 and resistor R4. Reverse power readings are determined, in the same manner, by the circuit consisting of diode D2, capacitor C8, and resistor R5.

Forward and reverse voltages are connected to the meter through switch S2, Sensitivity control R9, and Function switch S3.

Resistor R2 is a ground-return path for diodes D2 and D3. Capacitors C3, C4, C5, and C6 form a voltage divider circuit to balance the capacitive effects of the bifilar (doubled) windings in coil L1, which provides correct SWR readings.

POWER METER CIRCUIT

Current is induced in toroid coil L1 in the same manner as for the SWR bridge circuit. Resistor R3 forms a load across coil L1 to reduce the Q of the coil circuit. This prevents the transmitted frequency from affecting the wattmeter.

The wattmeter is calibrated by measuring the voltage at control R6, which varies the current going to the meter. Resistors R7 and R8 are voltage dividers for the two power ranges: 25 watts and 250 watts.

Capacitors C1 and C2, diode D1, and voltage divider resistor R1 through the calibrate jumper complete a voltmeter circuit for the wattmeter calibration.

Ferrite beads L2 through L6 prevent RF from traveling through the cable into the readout circuits.

CIRCUIT BOARD X-RAY VIEW

NOTE: To identify a part shown in this View, so you can order a replacement, proceed in either of the following ways:

1. A. Refer to the place where the part is installed in the Step-by-Step instructions and note the "Description" of the part (for example: 2200 Ω, .005 μF,).

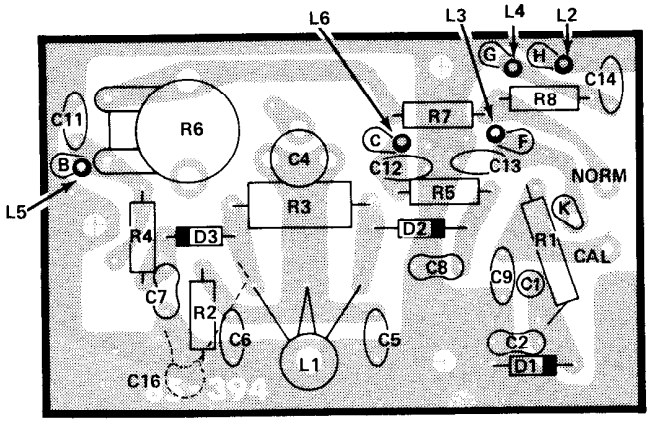
   B. Look up this Description in the "Parts List."

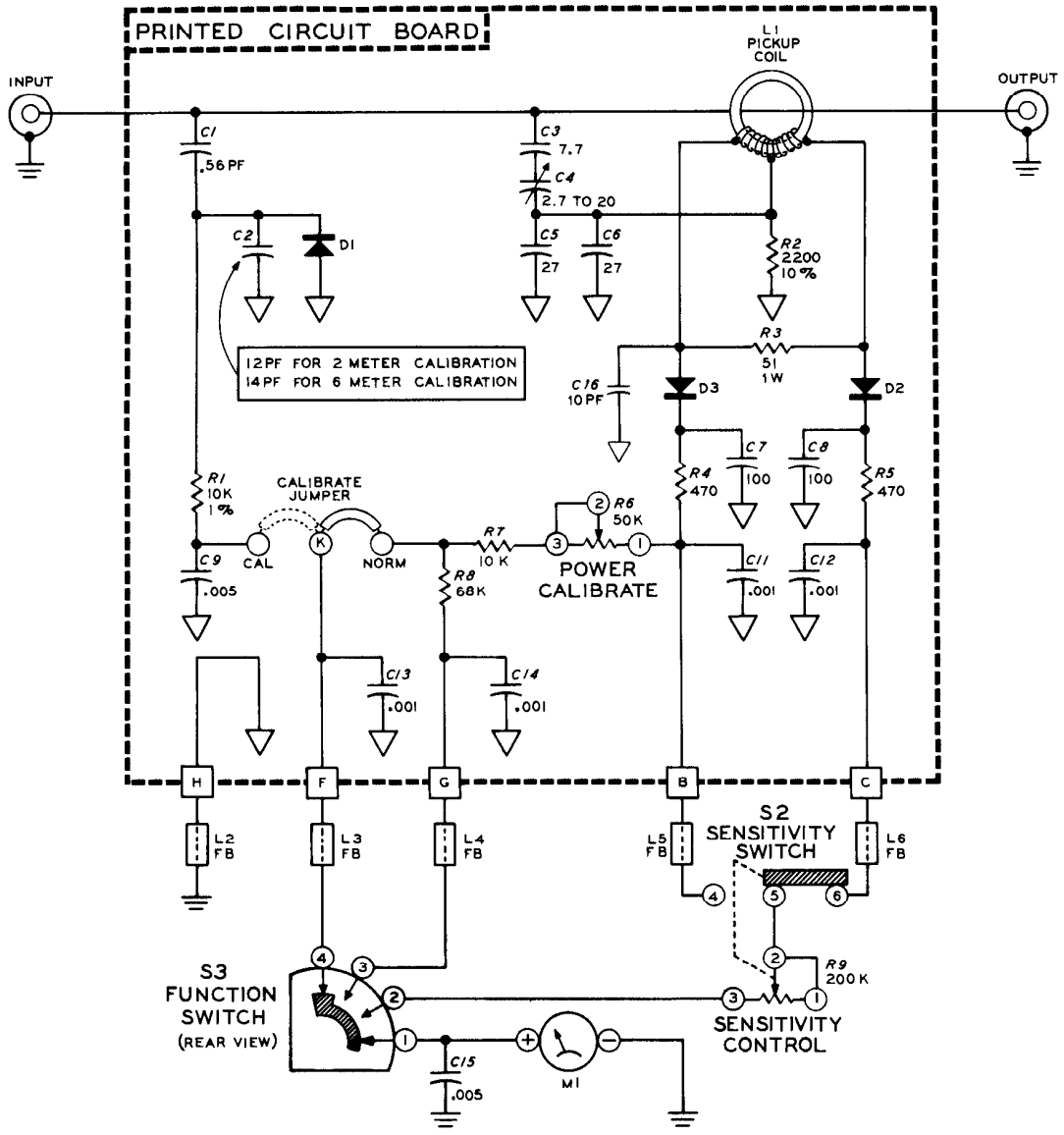
2. A. Note the identification number of the part (R-number, C-number, etc.).

   B. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part will also appear near the part.

   C. Look up this Description in the "Parts List."

(Viewed from foil side)



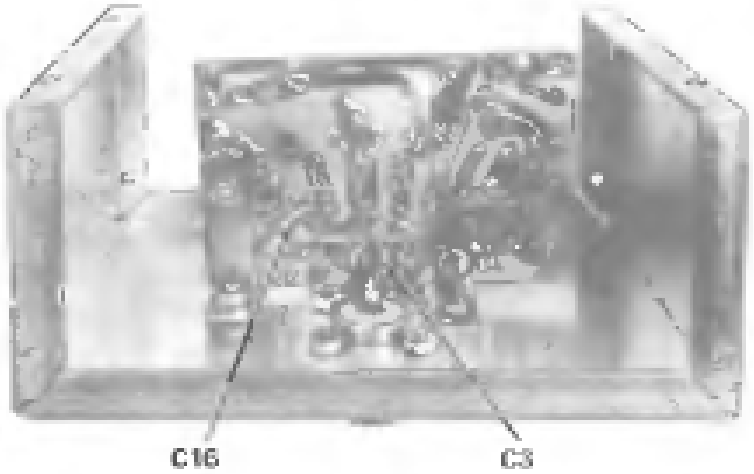


SCHEMATIC OF THE HEATHKIT®
VHF WATTMETER
MODEL HM-2102

NOTES:

1. ALL RESISTORS ARE 1/2 WATT 5% UNLESS OTHERWISE NOTED. RESISTOR VALUES ARE IN OHMS (K=1000).
2. ALL CAPACITORS LESS THAN 1 ARE IN µF; GREATER THAN 1 ARE IN pF.
3. FUNCTION SWITCH SHOWN IN 25 POSITION.
4. SENSITIVITY SWITCH SHOWN PUSHED IN.
5. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD COMMON.
6. ⏚ THIS SYMBOL INDICATES CHASSIS GROUND.
7. □ THIS SYMBOL INDICATES AN EXTERNAL CONNECTION TO THE CIRCUIT BOARD.
8. FB ⊣▭⊢ THIS SYMBOL INDICATES A FERRITE BEAD.

REMOTE CHASSIS PHOTOGRAPH



CABINET PHOTOGRAPH