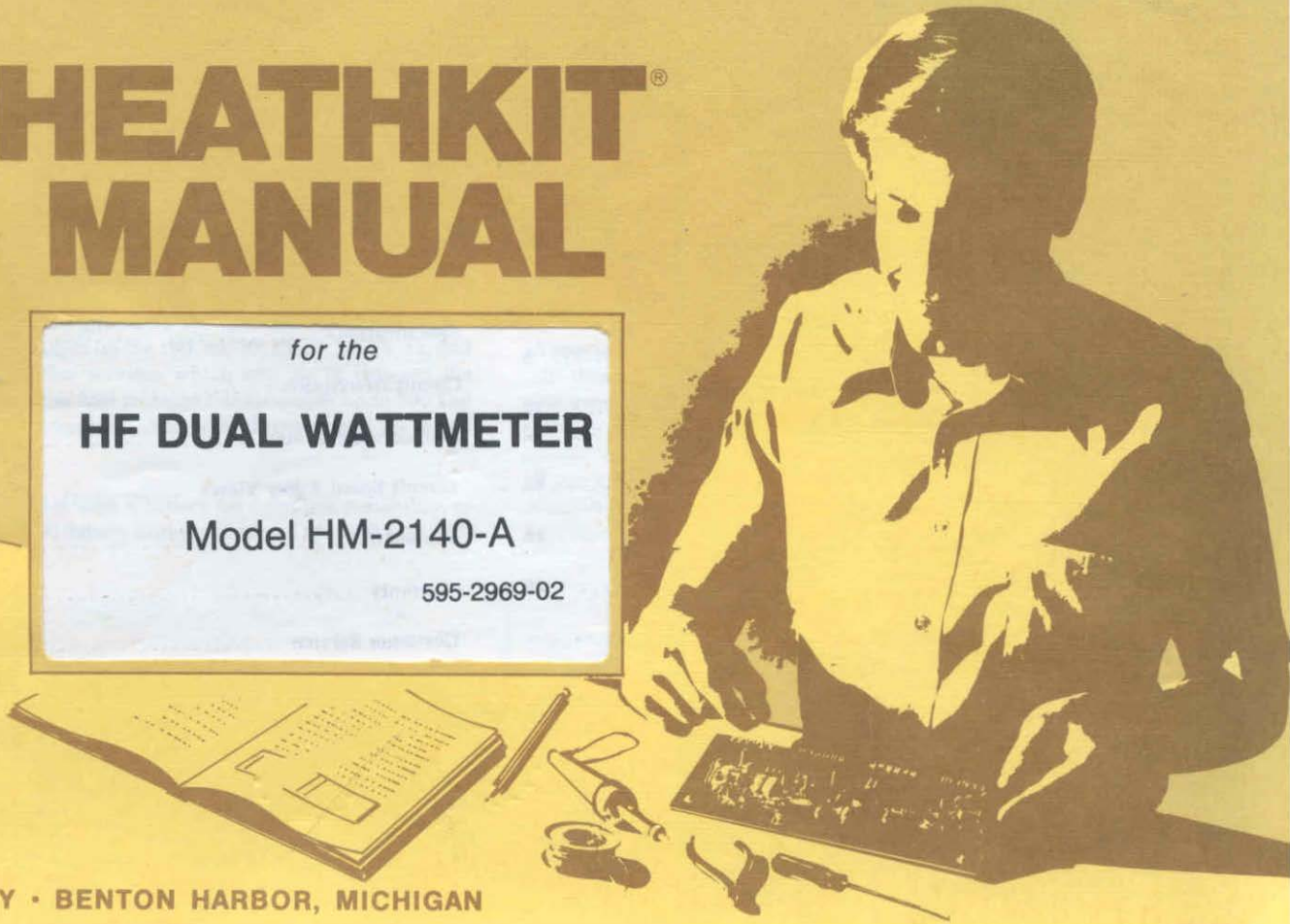
HEATHKIT® MANUAL

for the

HF DUAL WATTMETER

Model HM-2140-A

595-2969-02



HEATH COMPANY · BENTON HARBOR, MICHIGAN

YOUR HEATHKIT 90-DAY LIMITED WARRANTY

Consumer Protection Plan for Heathkit Consumer Products

Welcome to the Heath family. We believe you will enjoy assembling your kit and will be pleased with its performance. Please read this Consumer Protection Plan carefully. It is a "LIMITED WARRANTY" as defined in the U.S. Consumer Product Warranty and Federal Trade Commission Improvement Act. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Heath's Responsibility

PARTS — Replacements for factory defective parts will be supplied free for 90 days from date of purchase. Replacement parts are warranted for the remaining portion of the original warranty period. You can obtain warranty parts direct from Heath Company by writing or telephoning us at (616) 982-3571. And we will pay shipping charges to get those parts to you . . . anywhere in the world.

SERVICE LABOR — For a period of 90 days from the date of purchase, any malfunction caused by defective parts or error in design will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heathkit Electronic Center (units of Veritechnology Electronics Corporation), or any of our authorized overseas distributors.

TECHNICAL CONSULTATION — You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

NOT COVERED — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished component will void this warranty in its entirety. This warranty does not include reimbursement for inconvenience, loss of use, customer assembly, set-up time, or unauthorized service.

This warranty covers only Heath products and is not extended to other equipment or components that a customer uses in conjunction with our products.

SUCH REPAIR AND REPLACEMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF HEATH FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORSEEABLE.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Owner's Responsibility

EFFECTIVE WARRANTY DATE — Warranty begins on the date of first consumer purchase. You must supply a copy of your proof of purchase when you request warranty service or parts.

ASSEMBLY — Before seeking warranty service, you should complete the assembly by carefully following the manual instructions. Heathkit service agencies cannot complete assembly and adjustments that are customer's responsibility.

ACCESSORY EQUIPMENT — Performance malfunctions involving other non-Heath accessory equipment, (antennas, audio components, computer peripherals and software, etc.) are not covered by this warranty and are the owner's responsibility.

SHIPPING UNITS — Follow the packing instructions published in the assembly manuals. Damage due to inadequate packing cannot be repaired under warranty.

If you are not satisfied with our service (warranty or otherwise) or our products, write directly to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

HEATH COMPANY PHONE DIRECTORY

The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information	(616) 982-3411
Credit	(616) 982-3561
Replacement Parts	(616) 982-3571

Technical Assistance Phone Numbers
8:00 A.M. to 4:30 P.M., EST, Weekdays Only

Audio	(616) 982-3310
Amateur Radio	(616) 982-3296
Test Equipment, Weather Instruments and Home Clocks	(616) 982-3315
Television	(616) 982-3307
Aircraft, Marine, Security, Scanners, Automotive, Appliances and General Products	(616) 982-3496
Computers — Hardware	(616) 982-3309
Computers — Software:	
Operating Systems, Languages, Utilities	(616) 982-3860
Application Programs	(616) 982-3884



Prices and specifications subject to change without notice.

Heathkit® Manual

for the

HF DUAL WATTMETER

Model HM-2140-A

595-2969-02

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

Copyright © 1983
Heath Company
All Rights Reserved
Printed in the United States of America

TABLE OF CONTENTS

Introduction 3

Assembly Notes 4

Parts List 5

Step-by-Step Assembly 12
Circuit Board Assembly 12

Tests and Adjustments 25

Final Assembly 28

Operation And Installation 29

In Case of Difficulty 32
Troubleshooting Chart 33

Specifications 34

Circuit Description 36

Semiconductor Chart 39

Circuit Board X-Ray Views ..... (Ill. Booklet, Page 13)

Schematic ..... Fold-in

Warranty ..... Inside front cover

Customer Service ..... Inside rear cover

INTRODUCTION

The HF Dual Wattmeter Model HM-2140-A measures forward and reflected power in transmission lines for frequencies between 1.8 and 30 MHz.

This Wattmeter was designed primarily for the Amateur Radio bands within the high-frequency ranges on the 160, 80, 40, 30, 20, 17, 15, 12, and 10 meter bands, and for other services which may lie in between the amateur bands. The Wattmeter will measure transmissions up to 200 and 2000 watts peak-envelope-power in the forward direction and up to 500 watts reflected.

You can power the Wattmeter with a battery for complete portability, or with the optional Heathkit AC Battery Eliminator Model PS-2350 where AC power is available. No additional plug-in modules are required to cover the power or frequency ranges. The Wattmeter is housed in a small, attractive, readily portable cabinet.

A special switching circuit permits you to observe the battery condition at any time. The remote sensor can be mounted into the cabinet or up to four feet away from the metering cabinet and nearer to the transmitter's output cables.

If you use only the 9-volt battery to power the Wattmeter, you must purchase it separately. See Page 11 for additional details.

ASSEMBLY NOTES

IMPORTANT: Before you begin to assemble this kit, be sure to read the information in the "Kit Builder's Guide."

1. When you perform the steps in the circuit board Pictorials, position each part as shown. Follow the instructions carefully and read the entire step before you perform each operation.

2. Due to the small foil area around some of the circuit board holes and the small area between the foils, use the utmost care to prevent solder bridges between adjacent foils. Use only a minimum amount of solder and small tip soldering iron of not over 40 watts. Allow the iron to reach operating temperature; then apply it only long enough to make a good solder connection. If you think a solder bridge may exist, but you are not sure, compare the foil on the circuit board with the "Circuit Board X-Ray View" in the "Illustration Booklet."

3. To eliminate a solder bridge; hold the circuit board above the soldering iron and reheat the solder. As the solder melts; it will flow down the iron.

4. If your work surface is smooth, place the circuit board on a cloth to prevent it from sliding around when you solder component leads to the foil.

5. Resistors will be called out by their resistance value in Ω (ohms) or in kΩ (1000 ohms).

6. Capacitors will be called out by their capacitance value in pF (picofarads) or μF (microfarads) and type.

7. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

   — In the Parts List,

   — At the beginning of each step where a component is installed,

   — In some illustrations,

   — In the Schematic,

   — In the section at the rear of the Manual.

Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.

SAFETY WARNING: Avoid eye injury when you clip off excess lead lengths. Hold the leads so they cannot fly toward your eyes.

PARTS LIST

Unpack the kit and check each part against the following list. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until all parts are accounted for.

The key numbers correspond to the numbers on the "Parts Pictorial" in the separate "Illustration Booklet" beginning on Page 1.

Each circuit part in this kit has its own "Circuit Component Number" (R1, C2, D101, etc). This is a specific number for only that one part. The purpose of these numbers is to help you identify the same part in each section of the Manual.

These numbers will appear:

- In the Parts List.
- At the beginning of each step where a component is installed.
- In some illustrations.
- In the sections at the rear of the Manual.

To order a replacement part: Always include the PART NUMBER. Use the Parts Order Form furnished with the kit. If one is not available, see "Replacement Parts" inside the rear cover of the Manual. Your Warranty is located inside the front cover. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.

RESISTORS

NOTE: The following resistors are rated at 1/4-watt, and have a tolerance of 5% unless otherwise noted.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.

Resistors (cont'd.)

A1	6-561-12	4	560 Ω (green-blue-brown)	R2, R4, R8, R9
A1	6-102-12	2	1000 Ω (brown-black-red)	R18, R22

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Resistors (cont'd.)				
A1	6-103-12	2	10 kΩ (brown-black-orange)	R7, R11
A1	6-153-12	2	15 kΩ (brown-green-orange)	R19, R21
A1	6-473-12	2	47 kΩ (yellow-violet-orange)	R12, R16
A1	6-563-12	1	56 kΩ (green-blue-orange)	R6
A1	6-334-12	2	330 kΩ (orange-orange-yellow)	R15, R17
Precision Resistors, 1% Tolerance				
A2	6-1652-12	1	16.5 kΩ (brown-blue-green-red)	R24
A2	6-4022-12	1	40.2 kΩ (yellow-black-red-red)	R23
CAPACITORS				
B1	21-140	6	.001 μF ceramic	C1, C2, C3, C4, C7, C8
B1	21-176	7	.01 μF ceramic	C9, C11, C12, C13, C14, C15, C16

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Capacitors (cont'd.)				
B2	25-885	2	100 μF electrolytic	C5, C6
B3	27-128	1	.022 μF Mylar*	C17
B3	27-138	1	.033 μF Mylar*	C18
DIODES-INTEGRATED CIRCUIT (IC)				
CI	56-56	2	1N4149 diode	D1, D2

NOTE: Integrated circuits may be marked for identification in any of the following four ways:

1. Part number.
2. Type number. (This refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

C2	442-602	1	LM324N IC	U1

*Du Pont Registered Trademark

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

CABINET PARTS

D1	90-1223-2	1	Cabinet top
D2	90-1224-2	1	Cabinet bottom
D3	203-1919-3	1	Front panel
D4	205-1898-1	2	Side trim
D5	261-28	4	Foot

HARDWARE

NOTE: Hardware packets may be marked to show the size of the hardware they contain (HDW #6, for example). You may have to open more than one packet to locate all the hardware. The hardware is shown actual size in the Parts Pictorial.

#6 Hardware

E1	250-1325	4	6-32 ×1/4" screw
E2	250-365	2	#6 × 1/4" hex head screw
E3	250-1157	4	1/4" circuit board spacer

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

#6 Hardware (cont'd)

E4	250-1420	4	6-32 × 3/8" flat head screw
E5	250-1280	1	6-32 × 3/8" screw
E6	250-347	2	#6 × 1" sheet-metal screws
E7	252-3	9	6-32 nut
E8	253-21	4	#6 flat washer
E9	253-89	1	#6 D-washer
E10	254-1	9	#6 lockwasher

Other Hardware

F1	250-49	2	3-48 × 1/4" screw
F2	252-1	2	3-48 nut
F3	252-7	1	Control nut
F4	253-10	1	Control flat washer
F5	254-4	1	Control lockwasher
F6	254-7	2	#3 lockwasher

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
GENERAL				
G1	10-390	4	20 kΩ control	R3, R5, R13, R14
G2	19-739	1	250 kΩ control with switch	R1/SW5
G3	64-62	1	2-section switch	SW3, SW4
G4	64-870	1	2-section switch	SW1, SW2
	85-2039-1	1	Switch circuit board	
G5	407-741	1	Forward power meter	M2
G5	407-742	1	Reflected power meter	M1
MISCELLANEOUS				
H1	205-778	1	Alignment tool blade	
H2	207-5	1	Cable clamp	
H3	208-42	1	Battery holder	
H4	432-798	1	Battery clip	
H5	436-49	1	Power jack	J1
H6	455-633	1	Knob bushing	
H7	462-1154	1	Knob	
H8	490-5	1	Nut starter	
			Solder	
Printed Material				
		1	Blue and white label	
	390-1524	1	"Operation" label	
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
		1	Assembly Manual (See title page for part number.)	

Remote Sensor Assembly (#100- 1749)

The Remote Sensor Assembly is a sealed unit which contains the following parts. This Assembly has been factory tested and aligned. CAUTION: Do not break the seal on the Remote Sensor Assembly; to do so may void the warranty.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS, 1/4-WATT, 5%				
	6-472-12	1	4700 Ω (yellow-violet-red)	X104
	6-470-12	2	47 Ω (yellow-violet-brown)	R101, R102
	6-332-12	1	3300 Ω (orange-orange-red)	R103
	6-223-12	1	22 kΩ (red-red-orange)	X102
	6-222-12	1	2200 Ω (red-red-red)	X101
	6-104-12	1	100 kΩ (brown-black-yellow)	X103
CONTROLS				
	10-312	1	10 kΩ	R104
	10-390	1	20 kΩ	R107
	10-941	2	100 kΩ	R105, R106

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
CAPACITORS				
	20-103	2	150 pF mica	C101, C102
	20-172	2	.001 μF (1000 pF) mica	C103, C104
	27-141	2	.0027 μF Mylar	C106, C107
	31-8	1	1-8 pF trimmer	C105
HARDWARE				
	250-1325	2	6-32 × 1/4″ phillips head screw	
	250-475	6	#6 × 3/8″ hex head screw	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Hardware (cont'd)				
	253-14	1	#8 fiber flat washer	
	254-1	12	#6 lockwasher	
	257-12	1	#6 brass eyelet	
	259-6	2	#6 solder lug	
	256-5	8	Long rivet	
	256-8	2	Short rivet	
MISCELLANEOUS				
	40-1970	1	Toroid coil	L101
	56-20	2	1N295 (red-white-green) or 1N295S or 1N60H diode	D101, D102

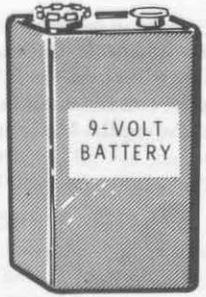
KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Miscellaneous (cont'd.)				
	75-30	1	Strain relief	
	85-2038-1	1	Printed circuit board	
	204-9	2	Angle bracket	
	214-215	1	Cover	
	214-216	1	Chassis	
	340-3	2″	Large bare wire	
	340-8	2″	Small bare wire	
	346-21	1″	Sleeving	
	347-39	60″	5-wire cable	
	390-1505	1	Label seal	
	436-5	2	Coaxial jack	J101, J102



BATTERY

You should purchase the following battery at this time for use in your kit:

One 9-volt transistor battery, NEDA # 1604.



Representative manufacturers and their type numbers are:

Eveready #216 or # 1222
Mallory #M1604
Mallory #TR-146X (long life)
Burgess #2V6
RCA #VS323
Hellesens #410
Varta #438

The separate "Illustration Booklet" contains numbered illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. The step-by-step assembly instructions will direct you to the proper illustration in the Booklet. After you have completed the assembly of your kit, place the Illustration Booklet with the Manual and save them for future reference.

STEP-BY-STEP ASSEMBLY

CIRCUIT BOARD ASSEMBLY

( ) Locate the remote sensor and cable. Cut the cable 12" from the free wire ends. Pull each of the wires from the 12" length of the cable; then discard the 12" white wire and the outer insulation. The remaining four wires will be used during the Meter assembly.

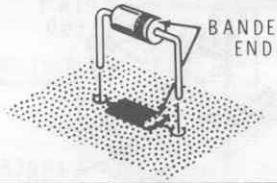
NOTE: To prepare a wire, cut it to the length indicated and remove 1/4" of insulation from each wire end. Tightly twist the bare wire ends and add a small amount of solder to hold the fine strands together.

( ) Locate the circuit board and position it lettered side up as shown in Pictorial 1-1 on the next page. Then install the parts as directed in the steps.



START

NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board. A DIODE WILL NOT WORK IF IT IS INSTALLED BACKWARDS. See Detail 1-1A.



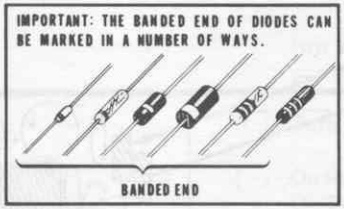
( ) D1: 1N4149 diode #56-56).

( ) D2: 1N4149 diode (#56-56).

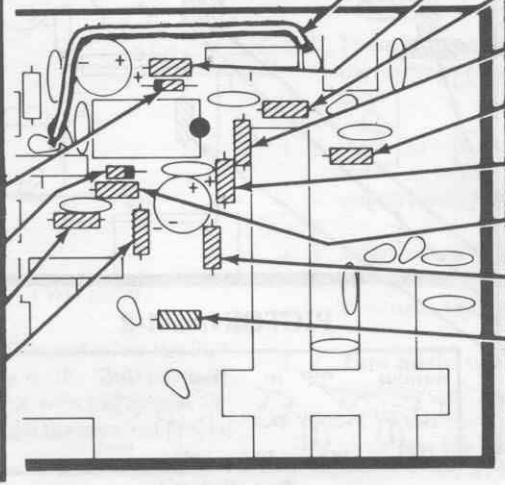
( ) R4: 560 Ω (green-blue-brown).

( ) R9: 560 Ω (green-blue-brown).

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



Detail 1-1A



PICTORIAL 1-1

CONTINUE

( ) Prepare a 2-3/4" black wire. Connect this wire between the two "H" holes as shown.

( ) R7: 10 kΩ (brown-black-orange).

( ) R2: 560 Ω (green-blue-brown).

( ) R8: 560 Ω (green-blue-brown).

( ) R22: 1000 Ω (brown-black-red).

( ) R21: 15 kΩ (brown-green-orange).

( ) R11: 10 kΩ (brown-black-orange).

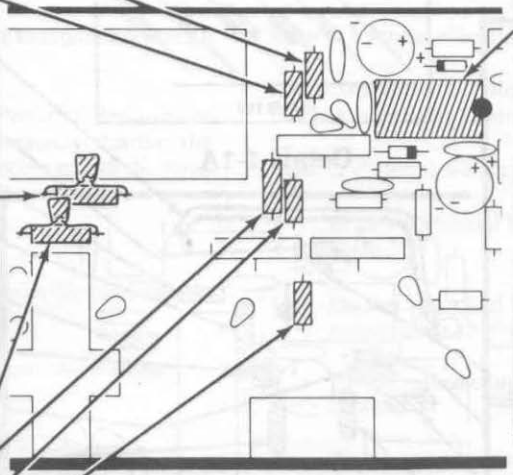
( ) R17: 330 kΩ (orange-orange-yellow).

( ) R6: 56 kΩ (green-blue-orange).

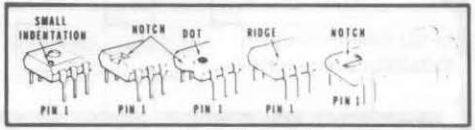
( ) Solder the leads to the foil and cut off the excess lead lengths.

START

- ( ) R19: 15 kΩ (brown-green-orange).
- ( ) R18: 1000 Ω (brown-black-red).
- ( ) Wrap the leads of a .033 µF Mylar capacitor around the leads of a 16.5 kΩ (brown-blue-green-red) precision resistor. Solder the leads and cut off the excess capacitor lead lengths. See Detail 1-2B.
- ( ) R24/C18: Resistor/capacitor combination.
- ( ) Similarly, wrap the leads of a .022 µF Mylar capacitor around the leads of a 40.2 kΩ (yellow-black-red-red) precision resistor. Solder the leads and cut off the excess lead lengths.
- ( ) R23/C17: Resistor/capacitor combination.
- ( ) R15: 330 kΩ (orange-orange-yellow).
- ( ) R16: 47 kΩ (yellow-violet-orange).
- ( ) R12: 47 kΩ (yellow-violet-orange).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



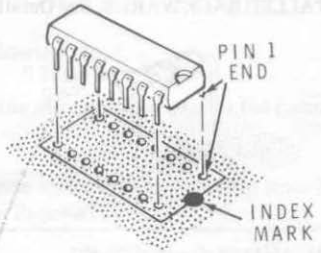
PICTORIAL 1-2



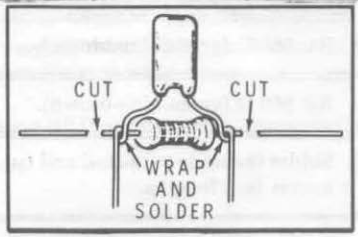
Detail 1-2A

CONTINUE

Refer to Detail 1-2A and locate pin 1 of the IC. Then install the IC so pin 1 is inserted into hole 1 on the circuit board. Make sure all of the IC pins go through the circuit board before you solder the pins to the foil.



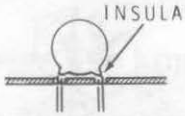
U1: LM324N integrated circuit.



Detail 1-2B

START

NOTE: When you install ceramic capacitors, do not push the insulated portions of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.



( ) C7: .001 μF ceramic.

( ) C9: .01 μF ceramic.

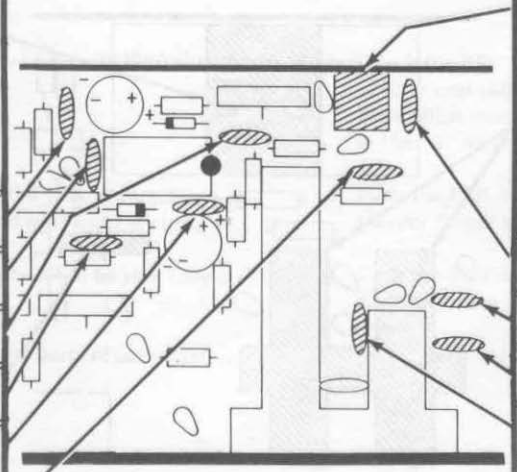
( ) C3: .001 μF ceramic.

( ) C4: .001 μF ceramic.

( ) C8: .001 μF ceramic.

( ) C11: .01 μF ceramic.

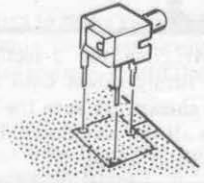
( ) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-3

CONTINUE

( ) J1: Mount the power jack (#436-49) firmly down onto the circuit board as shown. Then solder its lugs to the foil.



( ) C13: .01 μF ceramic.

( ) C16: .01 μF ceramic.

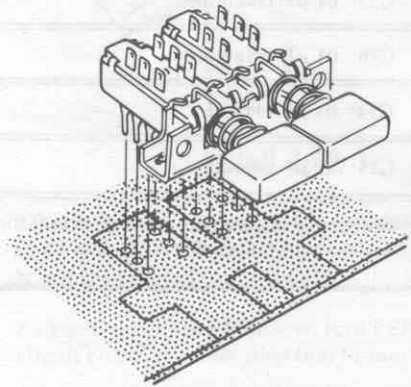
( ) C14: .01 μF ceramic.

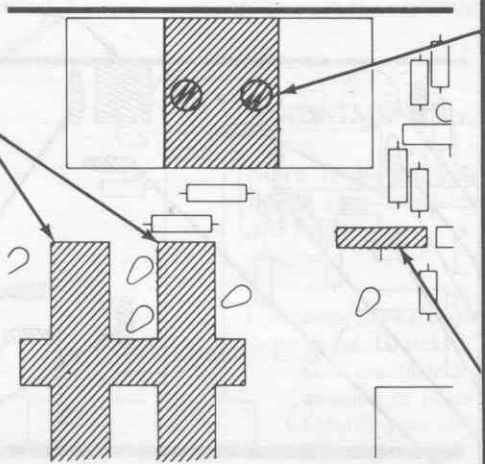
( ) C15: .01 μF ceramic.

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

START

( ) SW3/SW4: Push the 2-section switch (#64-62) firmly down onto the circuit board as shown. Be sure the switch assembly is all the way down; then solder its 12 lugs to the foil.

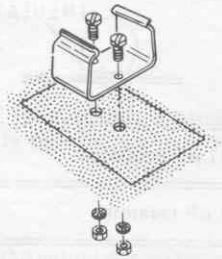




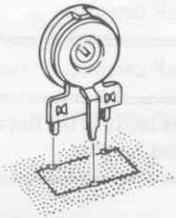
PICTORIAL 1-4

CONTINUE

( ) Mount the battery holder with two 3-48 × 1/4" screws, two #3 lockwashers, and two 3-48 nuts as shown. Use the plastic nut starter to hold and start 3-48 and 6-32 nuts.



( ) R13: 20 kΩ control (#10-390). Push the control firmly down onto the board; then solder the lugs to the foil.



START

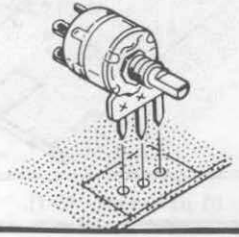
NOTE: As you install each component in this column, be sure it is fully seated onto the circuit board; then solder its lugs to the foil.

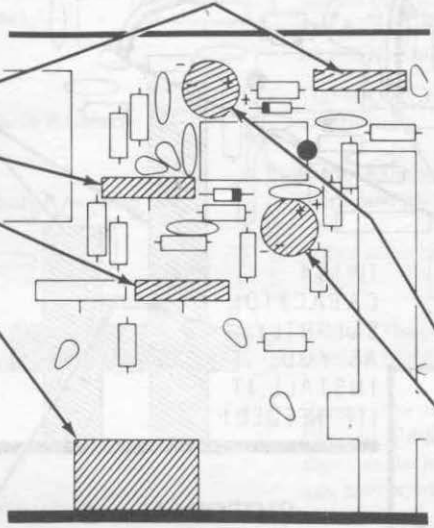
( ) R3: 20 kΩ control (#10-390).

( ) R5: 20 kΩ control (#10-390).

( ) R14: 20 kΩ control (#10-390).

( ) R1/SW5: 250 kΩ control with switch (#19-739). Mount the switch as shown. NOTE: Be sure the switch stands vertically from the board.

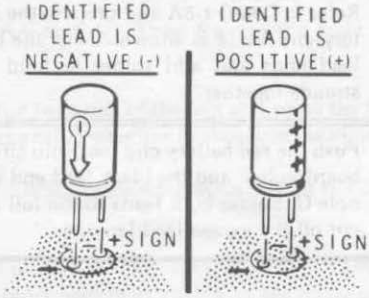




PICTORIAL 1-5

CONTINUE

NOTE: Before you install an electrolytic capacitor, note the position of the identified (+ or −) lead. Be sure you connect the positive (+) lead to the positive (+) marked point on the circuit board.



( ) C5: 100 μF electrolytic.

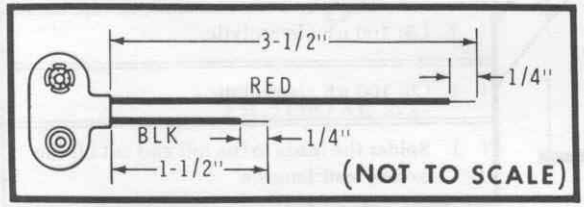
( ) C6: 100 μF electrolytic.

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

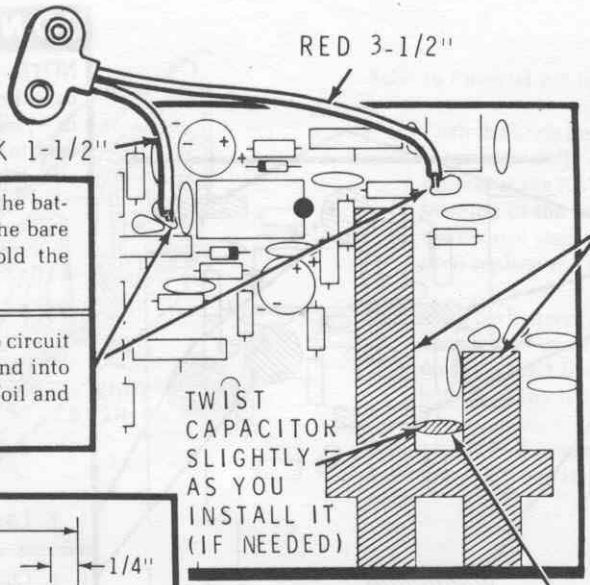
START

( ) Refer to Detail 1-6A and prepare the battery clip leads as shown. Twist the bare lead ends and add solder to hold the strands together.

( ) Push the **red** battery clip lead into circuit board hole F and the black lead end into hole G. Solder both leads to the foil and cut off the excess lead lengths.



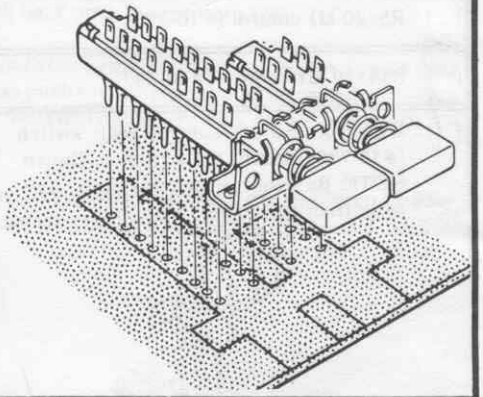
Detail 1-6A



PICTORIAL 1-6

CONTINUE

( ) SW1/SW2: Push the 2-section switch assembly (#64-870) firmly down onto the circuit board as shown. Be **sure** the assembly is fully seated; then solder its 24 pins to the foil.



( ) C12: .01 μF ceramic (S-1).

Refer to Pictorial 1-7 (Illustration Booklet, Page 4) for the following steps.

( ) Position the circuit board assembly on your work area as shown in the Pictorial.

( ) Prepare the following wires:

2" red	2-1/4" black
1-1/2" red	2-1/4" black
1-3/4" red	7" green
3-1/2" red	7-1/2" brown

NOTE: In the following steps, when you connect a wire to a circuit board hole, solder the wire to the foil and cut off any excess wire length.

( ) Connect a 2" red wire to circuit board hole B. The free end will be connected later.

NOTE: In the following steps, (NS) means not to solder because other wires will be added later. "S-" with a number, such as "S-2" means to solder the connection; the number following the "S" tells how many wires are at the connection. When a wire passes through one connection and goes to another, the "through" connection will be counted as two wires in the solder note, one entering and one leaving the connection.

( ) Connect a 1-1/2" red wire from circuit board hole C to switch SW5 lug 1 (S-1).

( ) Connect a 1-3/4" red wire from circuit board hole D to switch SW5 lug 4 (S-1).

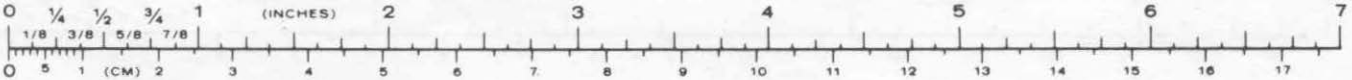
( ) Remove an additional 1/2" of insulation from one end of the 3-1/2" red wire. Pass this end of the wire through switch SW5 lug 2 (S-2) and connect the wire end to lug 3 (S-1). The free end of the wire will be connected later.

( ) Connect a 2-1/4" black wire to circuit board hole A. The free wire end will be connected later.

( ) Connect a 2-1/4" black wire to circuit board hole E. The free wire end will be connected later.

NOTE: The brown and green wires you will install in the next two steps are jumper wires. Be sure to route these wires exactly as shown in the Pictorial.

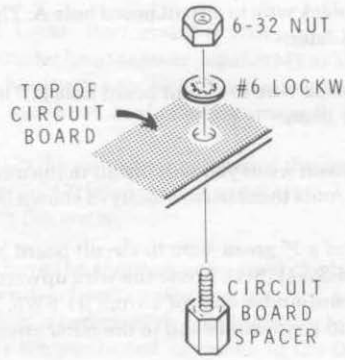
( ) Connect one end of a 7" green wire to circuit board hole J (between switches SW3 and SW4) (S-1). Route the wire upward, forward, and then across the board under control switch R1/SW5. Then route the wire to the rear and connect the end to the other circuit board hole J (S-1).



( ) In the same manner, connect the 7-1/2" brown wire from "K" on the left to "K" on the right. Route the wire as shown in the Pictorial.

Refer to Pictorial 1-8 for the following steps.

( ) Refer to Detail 1-8A and mount a circuit board spacer at AC as shown. Use a #6 lockwasher and a 6-32 nut.



Detail 1-8A

( ) In the same manner, mount circuit board spacers at AD, AE, and AF.

( ) Locate the remote sensor and its 4-foot cable. Remove 2" of the outer insulation; then prepare the ends of the five cable leads.

Connect the ends of the cable leads to the following circuit board holes. Solder each lead to the circuit board as you install it and cut off the excess lead ends.

( ) White lead to WHT.

( ) Green lead to GRN.

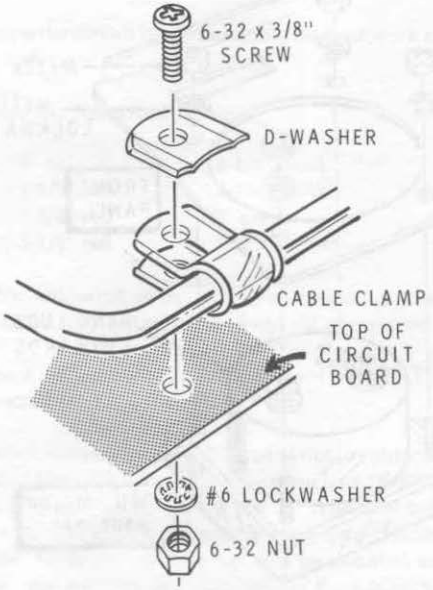
( ) Brown lead to BRN.

( ) Red lead to RED.

( ) Black lead to BLK.

Refer to the Pictorial and to Detail 1-8B for the following step.

( ) Place a cable clamp around the 5-wire cable as shown. Then push a 6-32 × 3/8" screw through the D-washer, through the cable clamp and then through the circuit board at AG. Position the clamp and D-washer as shown in the Pictorial and secure the mounting screw with a #6 lockwasher and a 6-32 nut.



Detail 1-8B

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections.

( ) Poor solder connections.

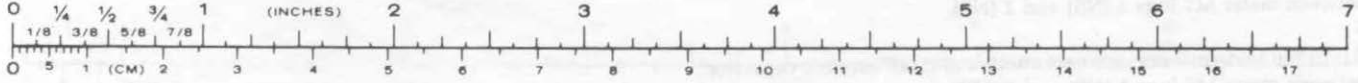
( ) Solder bridges between foil patterns (see "Circuit Board X-Ray Views" Illustration Booklet, Pages 13 and 14).

( ) Protruding leads which could touch together.

( ) Integrated circuit for proper **installation**.

( ) Electrolytic capacitors for the correct position of the positive (+) lead.

( ) Diodes for the correct position of the banded end.



CHASSIS ASSEMBLY

Refer to Pictorial 2-1 (Illustration Booklet, Page 6) for the following steps.

( ) Place a soft cloth on your work area. Then place the front panel on the cloth as shown in the Pictorial.

Refer to Detail 2-1A for the next three steps.

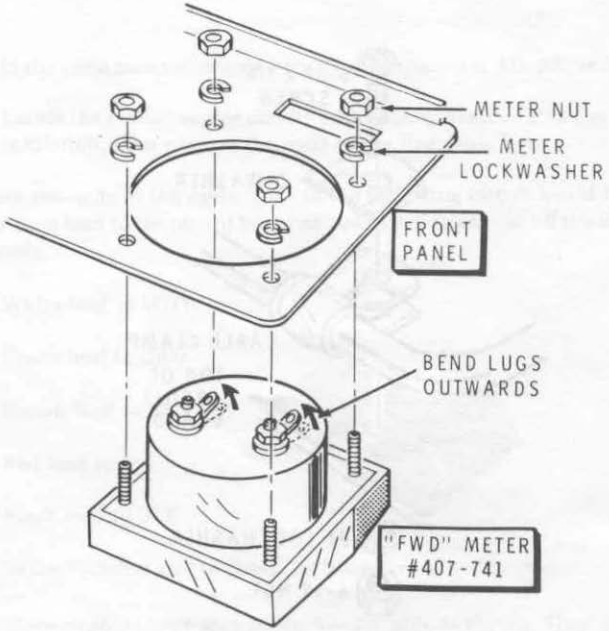
( ) 1. M2: Locate the forward (FWD) power meter (#407-741). Mount the meter into the front panel at M2 as shown in the Pictorial. Use the hardware supplied with the meter. NOTE: Do no overtighten the hardware, as this may damage the plastic meter housing.

( ) 2. M1: In the same manner, mount the reflected (REF) power meter (#407-742) into the front panel at M1. Use the hardware supplied with the meter.

( ) 3. Remove the shorting wires from the lugs of meters M1 and M2. Then bend each meter lug outward away from the meter case. NOTE: If necessary, loosen the meter lug nuts and turn the lugs so they are positioned as shown in the Detail.

( ) C2: Refer to Pictorial 2-1 and connect a .001 μF ceramic capacitor between meter M1 lugs 1 (NS) and 2 (NS).

( ) C1: In the same manner, connect another .001 μF ceramic capacitor between meter M2 lugs 1 (NS) and 2 (NS).



Detail 2-1A

( ) Place a control lockwasher on circuit board control with switch R1/SW5. Push the control shaft through the front panel as shown in the Pictorial and secure it with a control flat washer and a control nut. Tighten this hardware finger tight. NOTE: Be sure not to pinch any wires between the circuit board and the front panel.

Wire meters M1 and M2 as follows:

( ) Connect the black wire coming from circuit board hole A to meter M1 lug 2 (S-2).

( ) Connect the red wire coming from circuit board hole B to meter M1 lug 1 (S-2).

( ) Connect the black wire coming from circuit board hole E to meter M2 lug 2 (S-2).

( ) Connect the red wire coming from switch SW5 lug 2 to meter M2 lug 1 (S-2).

Refer to Pictorial 2-2 (Ill. Booklet, Page 7) for the following steps.

( ) Position the circuit board-front panel assembly into the cabinet bottom as shown. Loosely secure the front panel bottom edge to the cabinet bottom at AA and AB with two #6 × 1/4" hex head screws.

( ) Secure the circuit board spacers to the cabinet bottom at AC, AD, AE, and AF with four 6-32 × 1/4" screws. NOTE: If necessary, temporarily loosen the spacer-circuit board hardware.

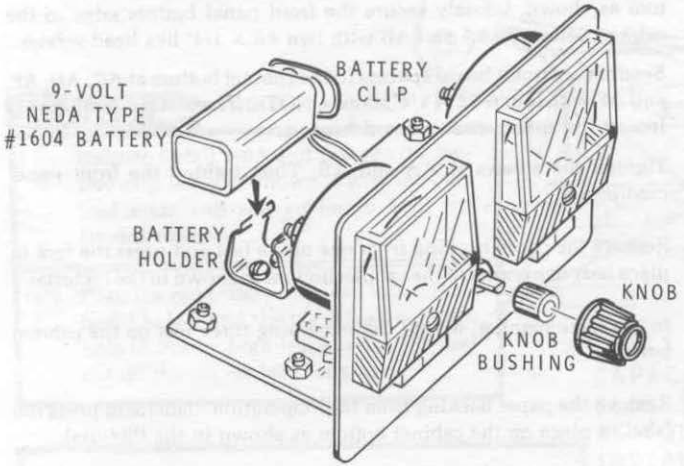
( ) Tighten the screws at AA and AB. Then tighten the front panel control nut.

( ) Remove the paper backing from one of the feet and press the foot in place near one corner of the cabinet bottom as shown in the Pictorial.

( ) In the same manner, mount the remaining three feet on the cabinet bottom.

( ) Remove the paper backing from the "Operation" label and press the label in place on the cabinet bottom as shown in the Pictorial.

( ) Remove the paper backing from the blue and white label and press the label in place on the cabinet bottom as shown. NOTE: Be sure to mention the Model and Series numbers on the blue and white label in any correspondence you have with the Heath Company about your kit.



PICTORIAL 2-3

Refer to Pictorial 2-3 for the following steps.

( ) Push the knob bushing onto the end of the front panel control. Turn the control fully counterclockwise until it clicks off. With the knob pointer at the 7 o'clock position, push the knob firmly onto the knob bushing in the manner shown. Remove the knob and bushing from the control shaft, tap the insert into the knob until it is fully seated, then replace the knob back onto the control shaft.

( ) Push the battery clip onto the terminals of a 9-volt NEDA Type #1604 battery as shown. Then push the battery down into the battery holder on the circuit board. NOTE: The battery will not fit flush with the bottom of the holder.

Except for "Final Assembly" on Page 28, this completes the "Step-by-Step Assembly" of your HF Dual Wattmeter. Proceed to "Tests and Adjustments."

TESTS AND ADJUSTMENTS

Refer to Pictorials 3-1 and 3-2 (Illustration Booklet, Page 8) for the following steps.

INITIAL TESTS AND ADJUSTMENTS

( ) Refer to Pictorial 3-1 and, on the front panel of your Wattmeter, turn the SENSITIVITY control fully counterclockwise until it clicks.

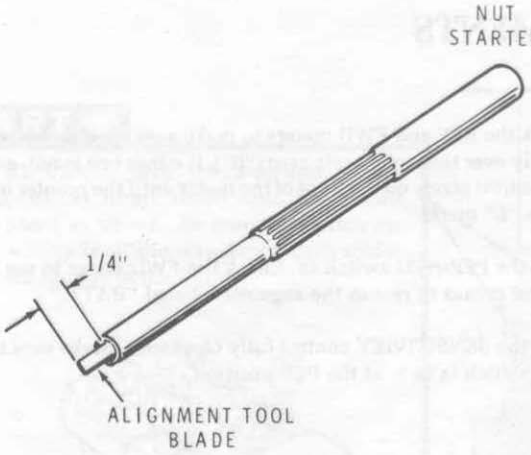
( ) Press the four pushbutton switches once or twice to be sure they are all in the "out" position.

( ) Set each of the circuit board controls to the mid-point of their rotation.

( ) Check the REF and FWD meters to make sure each meter pointer is exactly over the meter scale zero ("0"). If either one is not, adjust the zero-adjust screw on the front of the meter until the pointer is exactly at the "0" mark.

( ) Push the PEP-AVG switch in. Check the FWD meter to see that the pointer comes to rest in the segment labeled "BATT."

( ) Turn the SENSITIVITY control fully clockwise. Make sure the PEP-AVG switch is **in** – at the PEP position.



Detail 3-2A

( ) Refer to Detail 3-2A and push the thin alignment tool blade into the small end of the nut starter as shown. This is the tool you will use to adjust the circuit board controls in the following steps.

( ) As you observe the REF meter, turn REF NULL control R13 (on the circuit board) in either direction to exactly zero the pointer.

( ) As you observe the FWD meter, turn FWD NULL control R14 (on the circuit board) in either direction to exactly zero the pointer.

( ) Push the PEP-AVG switch to its AVG (out) position.

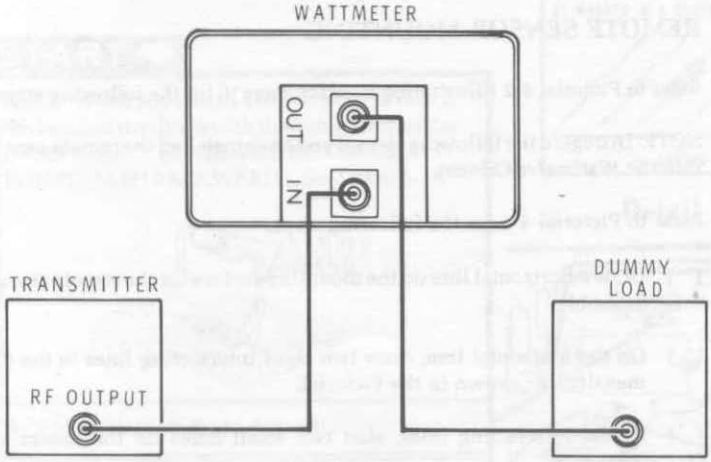
ADJUSTMENTS

NOTE: In the following steps that call for adjustments using transmitter power, your transmitter should ideally put out a CW level of at least 100-watts.

( ) Refer to Pictorial 3-3 and connect the output of your transmitter to the IN coaxial jack on the remote sensor and a 50-ohm dummy load to the OUT coaxial jack on the sensor as shown. NOTE: You may also use an antenna in place of the dummy load, but remember to properly identify your station because you will be radiating a signal.

( ) Tune the transmitter for a CW signal.

( ) Set the LOW-HIGH switch to the position that produces the highest-on-scale reading.



PICTORIAL 3-3

( ) Transmit a CW signal; note the reading on the FWD meter.

( ) Push the PEP-AVG switch to its PEP (in) position and allow the PEP reading a short time to settle. Note the reading on the FWD meter; it should be the same as the first reading. If it is not, refer to Pictorial 3-2 and adjust PEP FWD CAL control R5 until you get the same reading as in the previous step.

( ) Operate the PEP-AVG switch in and out as you perform the preceding two steps until the meter indication is the same for both switch positions.

( ) Turn off the transmitter.

( ) On the remote sensor assembly, connect the transmitter output to the OUT coaxial jack and the dummy load cable to the IN coaxial jack.

( ) Set the PEP-AVG switch to AVG (out).

( ) Tune the transmitter to produce a high-scale REF meter reading. Note the reading on the REF meter. Reduce the transmitter power if necessary.

( ) Push the PEP-AVG switch to the PEP (in) position. If the REF meter does not indicate the same reading as in the previous step, adjust circuit board PEP REF CAL control R3 until the reading is the same.

( ) Operate the PEP-AVG switch in and out as you perform the previous two steps until the meter indication is the same for both switch positions. Leave the switch in the AVG position.

( ) Turn off the transmitter and disconnect the cables from the remote sensor.

This completes the "Tests and Adjustments" of your HF Dual Wattmeter. Proceed to "Final Assembly."

FINAL ASSEMBLY

Refer to Pictorial 4-1 (Illustration Booklet, Page 9) for the following steps.

NOTE: Perform the next step only if you are **not** going to mount the remote sensor assembly away from the meter assembly.

( ) Position the remote sensor as shown in the Pictorial. Remove the three bottom housing screws from the sensor assembly. Position the remote sensor into the cabinet as shown and secure it with the three hex head sheet metal screws you just removed.

( ) Prepare the two side trim strips as follows:

1. Insert two 6-32 × 3/8" flat head screws through the countersunk hole side of each trim strip.
2. Slide a #6 flat washer and a #6 lockwasher onto each screw.
3. Just start a 6-32 nut onto the end of each screw.

( ) Position each trim strip down onto the top side edges of the cabinet bottom so the screw heads are out as shown in the Pictorial. Make sure the flat washers are inside the cabinet.

( ) Lower the cabinet top down behind the side trim strips. Make sure the front and rear edges of the two cabinet halves are aligned; then tighten the four side trim strip mounting screws.

( ) Coil the sensor cable and push it into the cabinet at the side of the sensor assembly.

REMOTE SENSOR MOUNTING

Refer to Pictorial 4-2 (Illustration Booklet, Page 9) for the following steps.

NOTE: Disregard the following steps if you have installed the remote sensor into the Wattmeter Cabinet.

Refer to Pictorial 4-2 for the following steps.

( ) Draw a horizontal line on the mounting surface for the remote sensor assembly.

( ) On the horizontal line, draw two short intersecting lines to the dimensions as shown in the Pictorial.

( ) At the intersecting lines, start two small holes for the mounting screws.

( ) Start each of the #6 × 1" sheet metal screws into the mounting surface and turn them down until they are about 1/16" from the wall or panel. Place the remote sensor onto the mounting screws.

This completes the assembly of your HF Dual Wattmeter. Proceed to "Operation and Installation."

OPERATION AND INSTALLATION

Refer to Pictorial 5-1 (Illustration Booklet, Page 10) for the following information.

The HF Dual Wattmeter was designed for amateur radio use, in the frequency spectrum between 1.8 and 30 MHz. The meter will help you:

- Tune your transmitter for its optimum output power.
- Adjust your antenna and antenna tuner for minimum standing wave ratios (VSWR).
- Provide you with an accurate power measurement when you use a good 50-ohm dummy load or a 1:1.1 (or less) VSWR antenna.

The wattmeter can be installed at any point in your transmission line and it will indicate the VSWR at that point. It is usually convenient to install the remote sensor assembly in the "ham shack" to measure the VSWR your transmitter will "see." Pictorial 5-1 (Illustration Booklet, Page 10) illustrates several examples of amateur stations which incorporate Wattmeters.

You can obtain the best results with readings that are greater than midrange of your Meter. Although you can use the Wattmeter with low-powered transmitters, you will get the best results when you use it with transmitters that produce 25 watts or more output since its accuracy is specified in percent of full scale.

CONTROL AND SWITCH FUNCTIONS

Refer to Pictorial 5-2 (Illustration Booklet, Page 11) for the following information.

LOW-HIGH switch — This pushbutton switch should be set to LOW (in) for all transmitters (or amplifiers) which produce an output of less than 200 watts (PEP) or 100 watts (AVG). Set the switch to HIGH (out) for output power from 200 to 2000 watts output (PEP) or 1000 watts (AVG).

PEP-AVG switch — Set this pushbutton switch to PEP (in) for single sideband operation. For all other transmitting modes, set the switch to AVG (out). IMPORTANT: When the Meter is not in use, set this switch to the AVG position; this disconnects the battery circuit.

SWR-REF switch – Set this pushbutton switch to REF (out) to read the amount of reflected power (in watts) directly from the REF meter. Set the switch to SWR (in) to take standing-wave readings from the REF meter. NOTE: This procedure will be described in "SWR Measurements" which follows.

SET-FDW switch — Set this pushbutton switch to FWD (out) as you perform tuning adjustments or at any time you wish to observe the forward output power (in watts) of the transmitted signal on the FWD meter. The SET (in) switch position allows you to adjust the SENSITIVITY control to the "SET" mark on the REF meter (see "SWR Measurements").

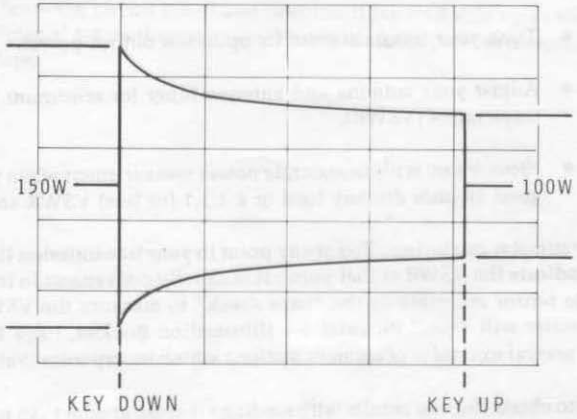
SENSITIVITY control (and Battery Switch) — When you wish to check the condition of the Wattmeter battery (if used - see "Wattmeter Power" in the following text), turn the SENSITIVITY control fully counterclockwise until it clicks, and set the PEP-AVG switch to PEP (in). Then make sure the FWD meter pointer comes to rest inside the "BATT" scale on the meter. If it does not, replace the battery before you use the Wattmeter. The control function is used when you "Set" the meter to read SWR (see "SWR Measurements").

REF meter — This is a direct readout meter that indicates either the power reflected back through the transmission line in watts or indicates the standing wave ratio on the transmission line. A "Set" index is used in conjunciton with SWR measurements.

FWD meter – This meter indicates the direct power output (in watts) of your equipment at the point in the transmission line where you have installed the Wattmeter. The meter has two power scales – high and low – and a third scale labeled "BATT" so you may observe the condition of the battery at any time.

Special Note

Many transceivers do not provide the same output power in the CW mode when the peak power and the average power readings are taken. A typical waveform is shown in Pictorial 5-3.



PICTORIAL 5-3

This drop is usually attributed to inherent conditions in some power supplies, especially those in self-contained transceivers, that is, with all power being internal to the unit. This is a normal condition; neither the transceiver nor the Wattmeter are malfunctioning.

SWR MEASUREMENTS

To make standing wave ratio measurements:

A. Push the SWR-REF pushbutton to SWR (in).

B. Push the SET-FWD pushbutton to SET (in).

C. Transmit a CW signal. Turn the SENSITIVITY control and position the REF meter pointer to the "SET" index.

D. Push the SET-FWD pushbutton to FWD (out).

E. Read the standing wave ratio (SWR) on the REF meter.

If you wish to calculate an exact VSWR, refer to the "SWR Calculator" shown in Pictorial 5-4 (Illustration Booklet, Page 12). Follow the instructions on the scale and read the SWR directly from the center scale.

WATTMETER POWER

You may use either of two power sources in the Wattmeter, or you may use both. We recommend an **alkaline** power cell, NEDA Type #1604 for battery power, and you may purchase the optional 9-volt Heathkit AC Battery Eliminator Model PS-2350 if you want to power the Wattmeter without a battery or if you wish to use both.

When you use the Wattmeter away from conventional AC power sources, you will need the battery for PEP operation. The battery is easy to install into the battery holder on the switch circuit board; merely loosen the four side-trim screws, lift the top cover from the Wattmeter, then plug in the battery and push the battery down into the battery holder. Replace the cabinet top cover and tighten the trim screws.

When you are close to a conventional source of 120-volt AC power, and if you have the Converter, merely plug it into a wall outlet and push the small plug into switch circuit board jack J1. NOTE: In the HF Dual Wattmeter, the Converter is used as a **Battery Eliminator**; it will **not** charge your battery, which is disconnected from the Wattmeter circuits when the Converter is connected to J1.

IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts. This first part, titled "General," describes what to do about any difficulties that might occur right after the unit as assembled. The second part, titled "Troubleshooting Chart," lists a number of possible difficulties that could arise. It also lists the possible causes of these difficulties.

GENERAL

The following paragraphs deal with the types of difficulties that may show up right after the kit is assembled, before you can put it into operation. These difficulties are most likely to be caused by assembly errors or faulty soldering. The following checks will help you locate any error of this type.

NOTE: Refer to the "X-Ray Views" (Illustration Booklet, Pages 13 and 14) for the physical location of parts.

1. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you consistently overlook.

2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore you can eliminate many troubles by reheating all connections to make sure that they are soldered as described in the "Soldering" section parts. Be sure the proper part has been wired into the circuit at each location as shown in the Pictorials and as called out in the wiring instructions.

3. Check the values of the parts. Be sure the proper part has been wired into the circuit at each location as shown in the Pictorials 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 or between the foils on the circuit board.

5. If, after careful checks, you still can not locate the trouble and a voltmeter is available, check voltage readings against those shown on the Schematic Diagram. NOTE: All voltage readings were taken with a high input impedance voltmeter. Voltages may vary as much as ±20%.

6. A review of the "Circuit Description" may also help you find the 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

The following chart lists conditions and possible causes of several specific malfunctions. If a particular part is mentioned (R23 for example) as a possible cause, check that part and other components connected to that part to see that they are installed and/or wired correctly. Also check for solder bridges and poor connections in the surrounding area. It is also possible, on rare occasions, for a part to be faulty and require replacement.

PROBLEM	POSSIBLE CAUSE
Meters inoperative, PEP-AVG switch in AVG position.	1. Shorting wire still on meters. 2. Sensitivity control wiring. 3. No RF through remote sensor. 4. Sensor cable connections on the circuit board.
Meters inoperative, PEP-AVG switch in PEP position.	1. Battery dead. 2. Integrated circuit U1. 3. Solder bridge on circuit board foil.
Battery check produces no meter movement.	1. Battery dead. 2. Resistor R6. 3. Battery switch SW5. 4. PEP-AVG switch set to AVG (out).
Unable to calibrate PEP circuit.	1. Solder bridge on circuit board foil. 2. Battery weak or dead. 3. Check PEP circuit components for correct installation.

SPECIFICATIONS

Frequency Range	1.8 to 30 MHz.
Functions	Forward and reflected power (AVG and PEP), and SWR.
Meter Ranges	
Forward (2 scales)	Low, 0-200 watts. High, 0-2000 watts.
Reverse (3 scales)	Low, 0-50 watts. High, 0-500 watts. SWR, 1:1 to 3:1.
Insertion SWR	Less than 1.05:1.

Accuracy (full scale)	
200 W and 2000 W (FWD), 500 W (REF)	±5% (AVG).
50 W (REF)	±7.5% (AVG).
Power	9-volts DC (Battery NEDA Type #1604, or optional Heathkit Converter).
Dimensions (overall)	7-1/2" wide × 4-1/8" high × 6-3/8" deep. (19.05 × 10.48 × 16.19 cm).
Net Weight	4 lbs. (1.82 kg).

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

CIRCUIT DESCRIPTION

Refer to the fold-in Schematic Diagram as you read the following circuit description.

REMOTE SENSOR

A bare wire connects input jack J101 to output jack J102 through toroid coil L101. L101 is a current pickup element for both the forward and reflected power which passes through the remote sensor. A transmitted signal passing through the sensor induces a voltage in the toroid coil which is directly proportional to the RF current. A voltage sampled directly from the transmission line is summed with the voltage at L101. The sum of the voltages is then rectified by diode D102 and is filtered by capacitor C104. The sensor is factory calibrated to within 5% accuracy by control R106 for the 0-2000-watt circuit and by control R107 for the 0-200-watt circuit.

The "out-of-phase" (reflected) current-induced voltage that was summed with the sampled voltage is rectified by diode D101 and filtered by capacitor C101. With a very good load, that is one with less than 1.05: 1 VSWR, the two voltages will be about equal and out of phase and no reflected voltage would appear in the reflected circuits. Reflected power is factory calibrated by control R104 for the 0-50-watt scale and by R105 for the 0-500-watt scale.

The calibrated voltages from the remote sensor are routed through a 5-wire cable to the input circuits of the switch circuit board.

IMPORTANT: The remote sensor is factory aligned, calibrated, and is sealed; unauthorized tampering with the remote sensor can void the Warranty on your Wattmeter.

SWITCHING CIRCUITS

NOTE: The forward and reflected circuits on the switch circuit board are virtually identical. In the following discussion, we will explain the operation of the forward circuits. Where differences exist between the basic operation of the two circuits, further details will be supplied.

The forward signal from the remote sensor is coupled to the switch circuit board and is routed through LOW-HIGH switch SW1. If the output of the transmitter is known to be less than 200 watts, switch SW1 should be set to the LOW (in) position. If the power is greater than 200 watts, switch SW1 should be set to HIGH (out).

Signals from SW1 are routed directly to SET-FWD switch SW4. When SW4 is in the SET (in) position, the forward (FWD) meter is temporarily disconnected from the circuit. The low-current input from the sensor is coupled directly through SW4, through Sensitivity control R1 to the contacts of SWR-REF switch SW3. The SET position of SW4 is used only in conjunction with SW3 when SW3 is in the SWR position. At that time, the REF (reflected) meter "Set" index is used to calibrate the meter for SWR readings.

When switch SW4 is in the FWD (out) position, the FWD meter is again enabled to indicate forward power, while SW3, in the SWR position, indicates the amount of standing wave apparent at the point the Wattmeter is inserted in the transmission line. When SW3 is at the REF (out) position, the power reflected through the transmission line from the antenna, dummy load, etc., is indicated on the REF meter in watts.

When switch SW4 is in the FWD position, the signals coupled from SW1 are routed to PEP-AVG switch SW2. If SW2 is set to the AVG (out) position, signals are direct-coupled to the FWD and REF meters. When SW2 is set to the PEP (in) position, the incoming signals are then routed to the meters through the PEP circuits, consisting mainly of four-section integrated circuit U1 with its associated components.

PEP CIRCUITS

The PEP circuits consist of two sections. The first is a peak detector with gain, and the second is a unity-gain buffer network with an offset adjustment.

The forward signal is coupled from switch SW1, through SW4 in the FWD position, through resistor R23 and the contacts of SW2 in the PEP position, and then into the PEP circuit. Resistors R9 and R4 form a 6 dB voltage divider while they maintain the equivalent resistance of meter M2 on the remote sensor. This preserves the calibration of the sensor. Amplifier IC U1C acts as a peak detector when combined with diode D2. There is a minimum voltage gain of 1.5 which is adjustable. This adjustment allows the gain to be varied so it will duplicate the voltage normally present at meter M1 in the AVG mode across capacitor C6 (with some small offset due to the effect from the operational amplifier).

The following stage is a unity-gain buffer into which an offset voltage has been summed from resistor R17. This permits any small voltages induced by the amplifiers to be balanced out. The result is an exact replica of the voltage from the remote sensor to appear at U1D pin 14, with one exception. The peak detector will catch and hold the peaks. Hence, on a CW signal the PEP reading is the same, but on vocal tones, there will be a great difference in readings. The time constant for the peak reading is a product of capacitor C6 and resistors R11 and R5. If a longer or shorter time constant is desired, the value of capacitor C6 may be changed. Use a good quality, low-leakage capacitor.

The output from the PEP circuit at IC U1D is routed to the FWD meter through switch SW2 and contacts 1, 2, and 3 of switch SW5.

POWER SUPPLY

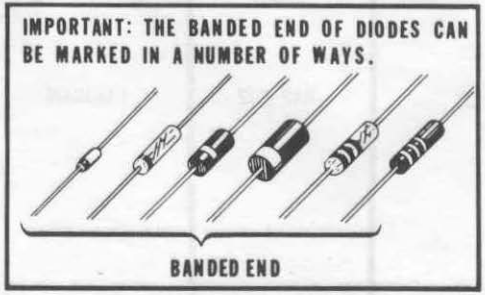
The power for the Wattmeter is taken directly from either a 9-volt NEDA Type 1604 battery or from the Heathkit AC Battery Eliminator PS-2350. When only the 9-volt battery is connected to the switch circuit board, the closed contacts of accessory jack J1 connect the positive and negative

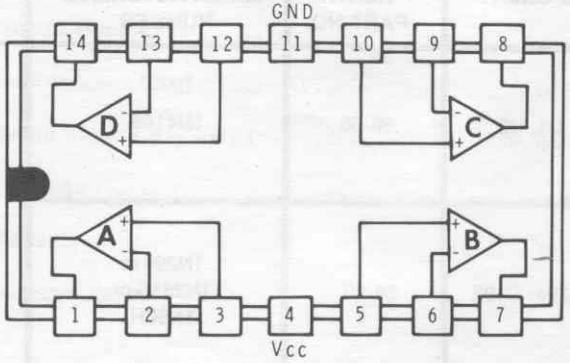
battery voltages to the circuits of integrated circuit U1. If the Converter is plugged into jack J1, power is taken only from the Converter Charger, the battery, if installed, is disconnected from the circuit. NOTE: The Converter will **not** charge the battery in your Wattmeter even if you use a rechargeable battery. The Wattmeter may be powered at all times with the Converter; however, if you wish to operate the instrument away from an AC source, you must use a battery.

When the front panel Sensitivity control is rotated fully counterclockwise until the control clicks, the battery (or Converter) power, through contacts in the PEP-AVG switch (which must be in the AVG position), may be observed on the BATT portion of the FWD meter. NOTE: If you have turned the Sensitivity control to check the battery condition, be sure to once again "Set" the REF meter to measure SWR.

IMPORTANT: Always return the PEP-AVG switch to the AVG (out) position when your Meter is not in use; this disconnects the battery from the circuit.

SEMICONDUCTOR CHART

COMPONENT	HEATH PART NO.	MANUFACTURER'S NUMBER	IDENTIFICATION
D1, D2	56-56	1N4149	
D101, D102	56-20	1N295 or 1N295S or 1N60H	

COMPONENT	HEATH PART NO.	MANUFACTURER'S NUMBER	IDENTIFICATION
U1	442-602	LM324N	

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

Replacement parts are maintained specifically to repair Heath products. Parts sales for other reasons will be declined.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to: Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH

ZENITH

HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.