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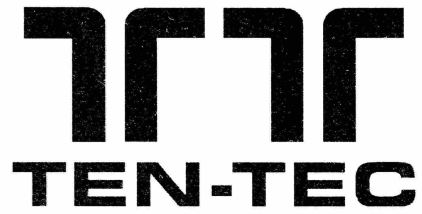
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MODEL 1225 WATTMETER KIT ASSEMBLY & OPERATIONAL MANUAL

Rev. B 9/2/10

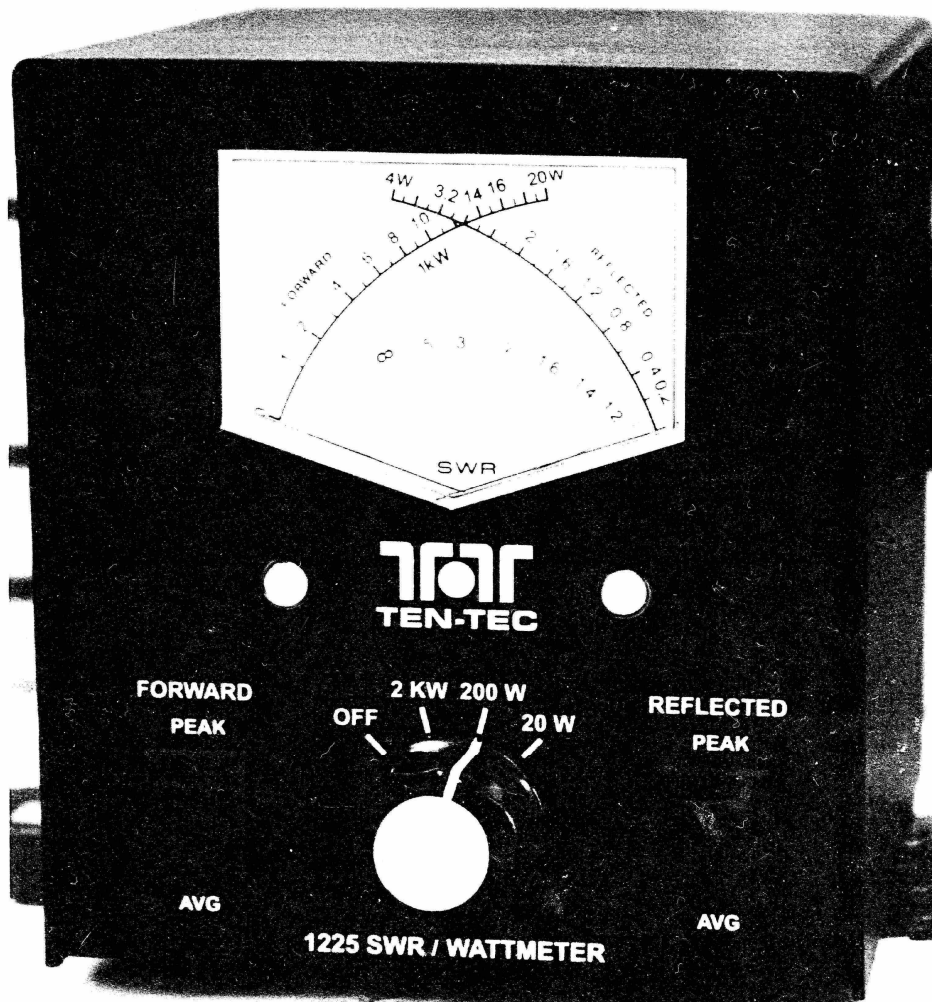


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NOTE: This manual is divided into two sections, the "Reference Section" which covers the meter's specifications and general information and the "Assembly Section" which covers the actual assembly and check-out of the kit. The "Assembly Section" is last since it will seldom be referenced after the wattmeter is built and tested for the first time. The "Reference Section" is essentially the owner's manual for the completed unit.

- **REFERENCE SECTION**
 1. Wattmeter Specifications
 2. General Introduction
 3. Circuit Overview
 4. Operating Tips
 5. Troubleshooting Chart
 6. Parts List
 7. Schematics

- **ASSEMBLY SECTION**
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 1. Assembly figures

MODEL 1225 WATTMETER SPECIFICATIONS

METER:	Cross-needle, moving coil (100 uA movements)
POWER RANGES:	20 , 200 and 2000 Watts (Forward Power) 4, 40 and 400 Watts (Reflected Power)
ACCURACY:	5% of full scale reading
FREQUENCY RANGE:	1.8 – 30 MHz
INPUT IMPEDANCE:	50 Ω
POWER REQUIREMENT:	13 – 20 VDC @ 150 ma (max)
SIZE:	5.0" x 4.5" x 5.0" (HWD) Excluding knobs & connectors
WEIGHT:	2 lb (1 kg)

GENERAL INTRODUCTION

The Model 1225 is a full featured wattmeter utilizing a cross needle meter allowing simultaneous display of forward power, reflected power and SWR. Full scale ranges of 20 watts, 200 watts and 2000 watts make it ideal for all hams, from QRP enthusiasts to high power contesters. Both peak and average power measurements can be made and are independently selectable for both forward and reflected power readings. This allows the operator to simultaneously monitor the performance of both the transmitter and antenna system. A tri-color backlight is included which allows the user to adjust the color of the meter illumination.

For those who may not be familiar with the operation of cross needle meters, one of the needles indicates forward power and the other indicates reflected power. Where the two needles cross indicates the corresponding SWR. The "vertical" red lines are calibrated in SWR, so use them to determine the actual SWR based on the intersection of the forward and reflected needles.

Our goal is to provide the builder with the satisfaction of "doing it yourself" and, in the process, furthering his or her understanding of the operation and usefulness of an SWR Bridge and Cross Needle Wattmeter. A technical description of the circuit operation is included for those interested in the "how it works" aspect of kit building. A digital voltmeter or accurate reference wattmeter is all that is required to calibrate the completed unit.

Follow the assembly instructions carefully and you will be rewarded with a wattmeter with professional performance and appearance. Should you have any questions, the Ten-Tec Customer Service Team is available to help.

CIRCUIT OVERVIEW

The 1225 wattmeter consists of two major circuit boards:

1. SWR Bridge Board
2. Wattmeter Amplifier Board

The SWR Bridge board is mounted on the rear of the enclosure and contains the two SO-239 RF connectors, "Radio" and "Antenna". A toroidal RF transformer is used to sample both the forward and reflected power and apply each to a pair of 1N34A germanium diodes which produce DC signals that are then routed to the Wattmeter Amplifier board and fed to the forward and reflected power meters. The use of germanium diodes improves the meter accuracy on the low power (20W) scale.

The Wattmeter Amplifier board contains two buffer amplifiers for both the forward and reflected power meters. An adjustment pot in each chain calibrates the meters at the lowest power levels (20 watts forward and 4 watts reflected). The forward power amplifier chain will be discussed as the reflected chain is identical in operation.

In the "Average" mode, the DC voltage from the SWR board is simply buffered by two op-amps, IC1A and IC1B, and applied to the forward power meter. Potentiometer R11 is connected in series with the meter and is used to calibrate the meter to 20 watts full scale. In the "Average" mode, resistor R5 and capacitor C1 are not in the circuit since Pin 4 of JP3 is open. The average level of the incoming RF signal is displayed. For normal SSB operation, the average power is noticeably lower than the peak (CW) power.

To measure peak power, pin 4 of JP3 is grounded via the Forward Power "Peak / Average" switch on the front panel. When this occurs, capacitor C1 and resistor R5 are connected from the input of IC1B (pin 5) to ground. Amplifier IC1A rapidly charges C1 to a level corresponding to the peak power level being detected by the SWR Bridge board. This peak power level occurs for an extremely short time, however C1 is charged to the peak value and "holds" it for a short time. This allows the meter movement to quickly rise to the peak level and then decay slowly afterwards. The rate at which the meter decays is determined by capacitor C1 and resistors R3 and R5. In this mode, the peak SSB power should approach the full CW power level which the transmitter was set for (assuming proper microphone gain settings and normal ALC control).

With the forward power in the "Peak" mode and the reflected power in the "Average" mode, the actual SWR will be difficult to read as the reflected power meter reading will not correspond to the forward peak power levels. This can be remedied by placing the reflected power meter in the "Peak" mode as well. The two meters will then be in "sync" with each other. Note that the reflected power meter should be in the "Average" mode if it is being used while tuning a manual antenna tuner. The slow decay of the meter when in the "Peak" mode makes adjusting an antenna tuner difficult.

One item of note, and often confusion, is that when the meter is in the "Peak" mode, the initial

response of the meter is not affected. Using a CW carrier of, say 100 watts, the forward power meter will rise from 0 to 100 watts just as quickly regardless of whether it is in the "Peak" or "Average" mode. For CW, the peak and average levels are equal. The difference shows up when the carrier is removed. The "Average" mode results in an almost immediate meter reading reduction to zero whereas the "Peak" mode takes several seconds to decay to zero.

The power range is selected via the front panel rotary switch. This switch selects 20, 200 or 2000 watts full scale and also selects the associated reflected power scales (4, 40 or 400 watts). When the 200 watt range is selected, potentiometer R7 is connected from the input of IC1A (pin 3) to ground. R7 forms a variable voltage divider with resistor R1. R7 is adjusted to produce a full scale meter reading when a 200 watt input signal is applied. Similarly, potentiometer R8 is used to calibrate the 2000 watt scale. A calibration procedure, using an external reference wattmeter or the built-in DC reference is presented later in the "Alignment" section of this manual.

The built-in DC reference control has been provided for those instances when a calibrated wattmeter or RF power source is not available to calibrate the 1225. The DC reference consists of the 12 volt regulator, IC3, which powers the wattmeter, resistor R17 and potentiometer R16.

The wiper of R16 provides the variable DC voltage and it is connected to the center pin (Pin 2) of the three pin header, JP4. A push on jumper connects Pin 2 with either Pin 1 (Forward Power) or Pin 3 (Reflected Power). When the calibration is complete, the jumper is left on Pin 2 only.

A table of expected DC voltages from the SWR bridge is provided in the alignment section of the assembly manual. When calibrating the wattmeter without an available reference wattmeter, R16 is adjusted to provide the required DC voltage corresponding the power range being calibrated. The tabulated DC voltages are a result of measurements made on numerous SWR bridges at each of the required power levels.

OPERATING TIPS

The Model 1225 wattmeter is a very useful accessory to any ham station. The following tips will help you get the most out of it:

- Set the meter power range switch prior to transmitting.
- When using the meter as a tuning aid, place both the forward and reflected meters in the "Average" mode. Transmitter and antenna tuner adjustments are simplified in that mode.
- For each antenna, make a log showing SWR vs frequency. This will be beneficial in checking antenna performance or degradation over time.
- When measuring peak power on SSB, be sure to watch the transmitter's ALC indicator and, if possible, use a monitor scope to check modulation. The wattmeter can't differentiate between a clean SSB signal with high average talk power and one which is being over driven resulting in audio distortion and splatter.
- For casual monitoring of SWR, leave the Reflected Power meter in the "Average" mode.
- For observation of intermittent high SWR events, place the Reflected Power meter in the "Peak" position. Should a short duration, high SWR event occur, the meter will "hold" the high reading long enough for it to be noticeable.

TROUBLESHOOTING CHART

PROBLEM	OTHER INFO	PROBABLE CAUSE	CHECK
Unit completely dead	No light or meter readings	Unit not turned on. No DC power applied. 12 volt regulator (IC3) failed.	DC voltage at connector from transformer. Measure voltage at input pin of IC3 (approx. 18 – 20 VDC) and output of regulator (+12 VDC).
No meter readings	Backlight OK	No RF applied. No DC from SWR Bridge to Wattmeter board.	Verify that RF is applied Check wiring between SWR Bridge and Wattmeter board.
Erroneous meter readings		Load mismatch causing apparent reading errors. Meter in need of calibration.	Check readings with a good 50Ω termination on wattmeter. If good, the load mismatch is causing the error (This is normal). If in error, check meter calibration.
Issues with "Active" or "Peak" readings		Wiring or switch issues with "Peak / Average" switch or switches.	"FWD Peak" switch should pull JP3-4 to ground for "peak" reading. "Ref Peak" switch should pull JP3-5 to ground for "peak" reading.
Backlight dead	Wattmeter performs normally.	No DC voltage to backlight assembly.	Verify DC voltage at backlight. If good, replace backlight assembly. If bad, check wiring between backlight and wattmeter circuit board "Light +" pad.
Different readings between two meters connected in-line		Cable length(s)	Replace the system load with a known good 50Ω termination capable of handling the transmitter power. If the readings on the meters then agree, within the calibration error of each meter, there is a mismatch in the antenna system and the cable lengths between the meters will affect the readings. Minimize the cable length between the meters.
Can't calibrate the forward power	Reverse power calibrates OK	Internal calibrator jumper installed on Pins 1 & 2 of the CAL terminal header.	Move CAL jumper so that it is on Pin 2 only.
Can't calibrate the reverse power	Forward power calibrates OK	Internal calibrator jumper installed on Pins 2 & 3 of the CAL terminal header.	Move CAL jumper so that it is on Pin 2 only.
"Forward" and "Reflected" readings reversed		RF transformer, L2, wound backwards; wiring between SWR Bridge & Wattmeter board.	Compare L2 with Figure 1 photo in Appendix.; Check orange & blue wiring between SWR Bridge and Wattmeter Board.
No Forward Power reading		SWR Bridge	Check DC voltage at orange wire on SWR bridge. Should be approximately 1.2 – 2.6 volts for 20 – 100 watts input.
		Wattmeter Board	Place the "CAL" jumper in the "Forward" position and adjust the CAL pot per the alignment procedure. If it produces a nearly correct reading, the wattmeter board is OK.
No Reflected Power reading		SWR Bridge	Check DC voltage at blue wire on SWR bridge. Should be approximately 0.4 – 1.8 volts for 4 – 40 watts reflected.
		Wattmeter Board	Place the "CAL" jumper in the "Reflected" position and adjust the CAL pot per the alignment procedure. If it produces a nearly correct reading, the wattmeter board is OK.

PARTS LIST

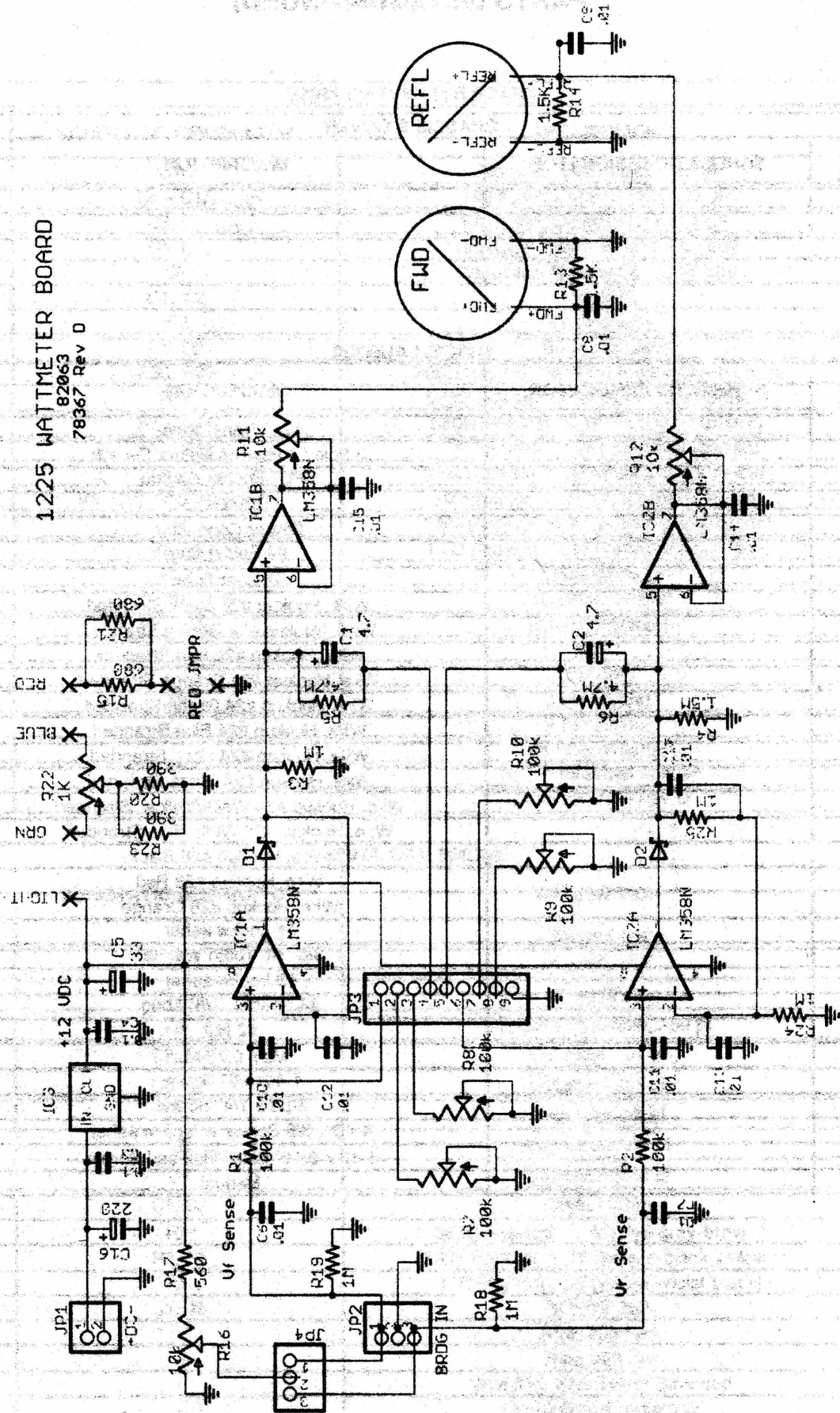
82063 WATTMETER BOARD			
PART NUMBER	SCHEMATIC DESIGNATOR	DESCRIPTION	QTY
23202	C16	Capacitor, Electrolytic 220 uF	1
23260	C6 – C15	Capacitor, Ceramic Disc .01 uF	11
23261	C3, C4	Capacitor, Ceramic Disc 0.1 uF	2
23310	C1, C2	Capacitor, Electrolytic 4.7 uF 35V	2
23407	C5	Capacitor, Electrolytic 33 uF 35V	1
25117	IC1, IC2	LM-358N	2
25232	IC3	12V Regulator	1
28071	D1, D2	BAT41 Diode	2
30133	R20, R23	390Ω Resistor ¼ W (orange-w hite-brow n)	2
30135	R17	560Ω Resistor ¼ W (green-blue-brow n)	1
30136	R15, R21	680Ω Resistor ¼ W (blue-gray-brow n)	2
30140	R13, R14	1.5k Resistor ¼ W (brow n-green-red)	2
30161	R1, R2	100k Resistor ¼ W (brow n-black-yellow)	2
30173	R3, R18, R19, R24, R25	1M Resistor ¼ W (brow n-black-green)	5
30175	R4	1.5M Resistor ¼ W (brow n-green-green)	1
30181	R5, R6	4.7M Resistor ¼ W (yellow -violet-green)	2
30806	R22	1k Potentiometer	1
30857	R11, R1, R16	10k Potentiometer	3
30858	R7 – R10	100k Potentiometer	4
34066	-	Meter	1
34069	-	Backlight	1
35066	JP4	3 Pin Header	1
35285	-	2 Pin Jumper	1
51062	-	#4 Fiber Washer	3
53043	-	1/2" Al threaded spacer	3
78367-D	-	Circuit Board – Rev D	1
82076 SWR BRIDGE			
PART NUMBER	SCHEMATIC DESIGNATOR	DESCRIPTION	QTY
21003	-	Toroid Core	1
21007	L1	1 mH Choke	1
21160	L3, L4	47 uH Choke	2
23061	C1	Capacitor, Variable 5-60 pf	1
23260	C8, C9	Capacitor, .01 uF	2
23261	C6, C7	Capacitor, 0.1 uF	2
23372	C2	Capacitor, 15 pf	1
23563	C5	Capacitor, 180 pf	1
23570	C4	Capacitor, 220 pf	1
28120	D1, D2	Diode 1N34A	2
30136	R2	680Ω Resistor ¼ W (blue-gray-brow n)	1
30161	R3, R4	100k Resistor ¼ W (brow n-black-yellow)	2
30408	R1	47Ω Resistor 2W (yellow -violet-black)	1
35007	J1, J2	SO-239 Jack	2
46022	-	Wire, #28 Red	1
46070	-	Wire, #28 Grn	1
46081	-	Wire #16, Blue Teflon Stranded	6"
82078	-	Circuit Board Assembly	1

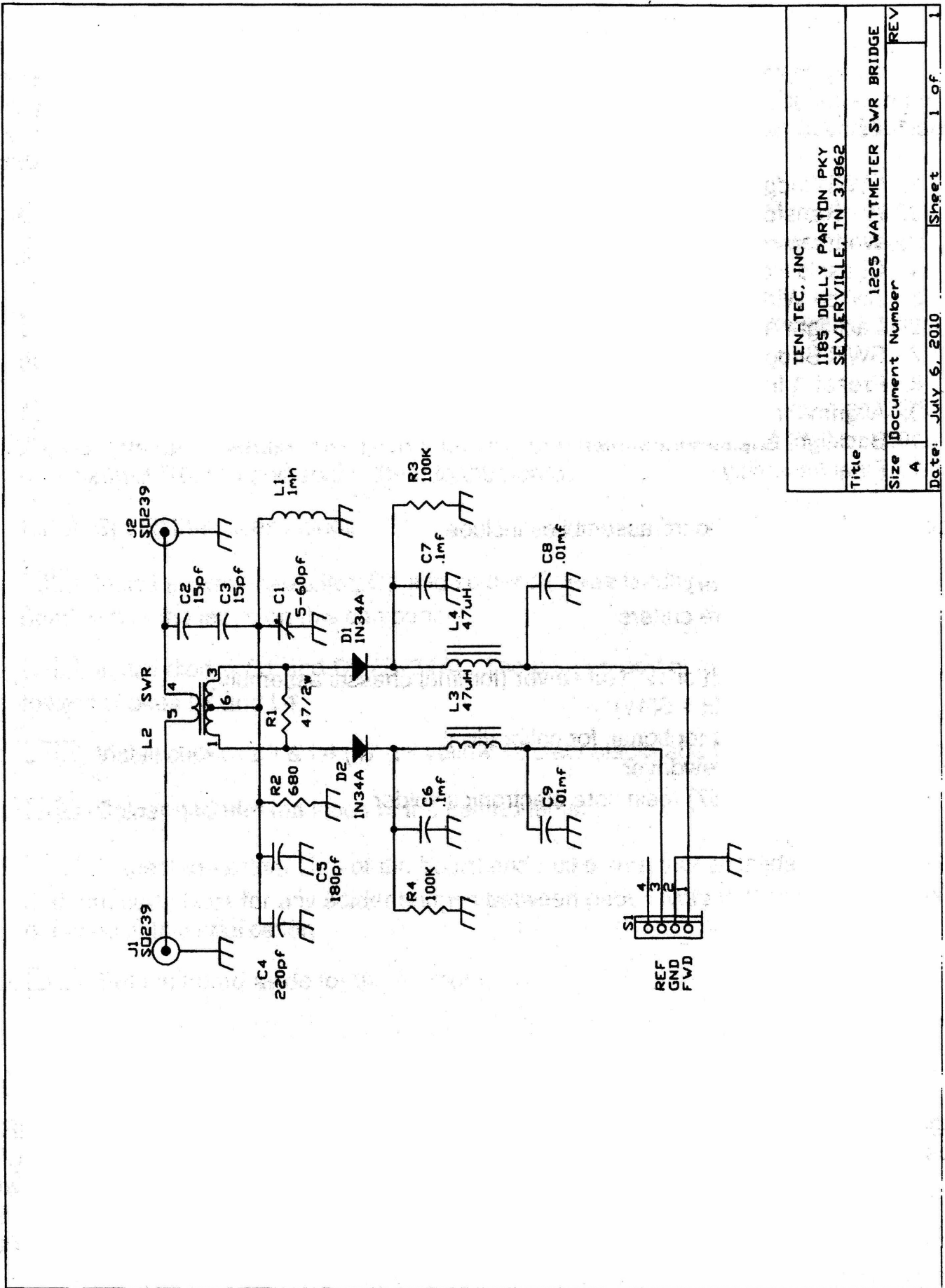
PARTS LIST (CONTINUED)

CHASSIS & COVER			
PART NUMBER	SCHEMATIC DESIGNATOR	DESCRIPTION	QTY
93966	-	Chassis	1
93967	-	Cover	1

MISCELLANEOUS			
PART NUMBER	SCHEMATIC DESIGNATOR	DESCRIPTION	QTY
21195	-	Wall Transformer	1
32077	-	3 Pole / 4 Position Rotary Sw itch	1
32087	-	DPDT Rocker Sw itch	2
34072	-	Knob	1
35132	-	Pow er Connector	1
41039	-	#4 Solder Lug	1
42003	-	Rubber Foot	4
46010	-	Wire, Hookup #24 Black Stranded	24"
46011	-	Wire, Hookup #24 Brow n Stranded	24"
46012	-	Wire, Hookup #24 Red Stranded	15"
46013	-	Wire, Hookup #24 Orange Stranded	24"
46015	-	Wire, Hookup #24 Green Stranded	12"
46016	-	Wire, Hookup #24 Blue Stranded	24"
46018	-	Wire, Hookup #24 Grey Stranded	12"
46019	-	Wire, Hookup #24 White Stranded	12"
46057	-	Wire, Hookup #24 White/Yellow Stranded	12"
46059	-	Wire, Hookup #24 White/Blue Stranded	12"
46153	-	Wire, Hookup #28 Black	12"
46154	-	Wire, Hookup #28 Red	12"
46155	-	Wire, Hookup #28 Orange	12"
51002	-	#4 Lockw asher	5
51048	-	3/8" Int. Tooth Washer	1
51056	-	#2 Lockw asher	2
53044	-	#4 Spacer 1/8" Long	3
54029	-	#2 Nut	2
54048	-	M9 x 0.75 Nut	1
60003	-	4-40x3/8" Screw	6
60067	-	2-56 x 1/4" Screw	2
60069	-	4-40 x 3/8 Screw w /split w asher	4
60080	-	4-40 x 3/16" Black Flathead Screw	8
74448	-	Manual	1

1225 WATTMETER BOARD
82063
78367 Rev D





TEN-TEC, INC	
1185 DOLLY PARTON PKY	
SEVIERVILLE, TN 37862	
Title	1225 WATTMETER SWR BRIDGE
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PHASE 1: SWR BRIDGE BOARD ASSEMBLY

Kit Assembly Note: *In this section, as in all the others, two check boxes are provided at each step of the assembly. Check off each step as it is completed. Should you need to go back to re-check your work, use the second check-off box as each previously completed step is verified.*

1. Install resistors R1 (47 Ω , 2W – yellow / violet / black), R2 (680 Ω , 1/4 W, blue / gray / brown), R3 and R4 (100k, 1/4 W – brown / black / yellow) onto their screened locations on the board.
2. Turn the board over, solder the protruding resistor leads to the board and clip off the excess leads.
3. Install capacitors C2 & C3 (15 pf – marked “15 J”), C4 (220 pf – marked “221 J”), C5 (180 pf – marked “181”), C6 & C7 (0.1 uf – marked “104”) and C8 and C9 (.01 uf – marked “103M”) and solder them to the board.
4. Cut off the excess leads.
5. Install trimmer capacitor, C1 and solder all three leads to the board. There is no need to trim the leads on this component.
6. Install diodes D1 and D2 (1N34A). The banded end of the diodes must face toward chokes L3 and L4.
7. Install chokes L3 & L4 (47 uH yellow / violet / black) and L1 (1mH brn / blk / red)
8. Solder and trim the leads of the components.
9. Inspect the solder side of the board and make sure that all leads are soldered and trimmed. Look for any solder bridges between pads. Note that capacitor C10 is not used in this application.
10. Set the board aside for the moment.

PHASE 2: RF TRANSFORMER ASSEMBLY

The RF transformer is used to sample the forward and reflected power levels so that they can be displayed on the front panel meter. The main winding is known as “bifilar” and consists of two twisted parallel wires wound on the core, as compared to “conventional” transformers which have “single wire” primary and secondary windings. The primary side of this transformer will consist of a single loop of wire passing through the center of the coil.

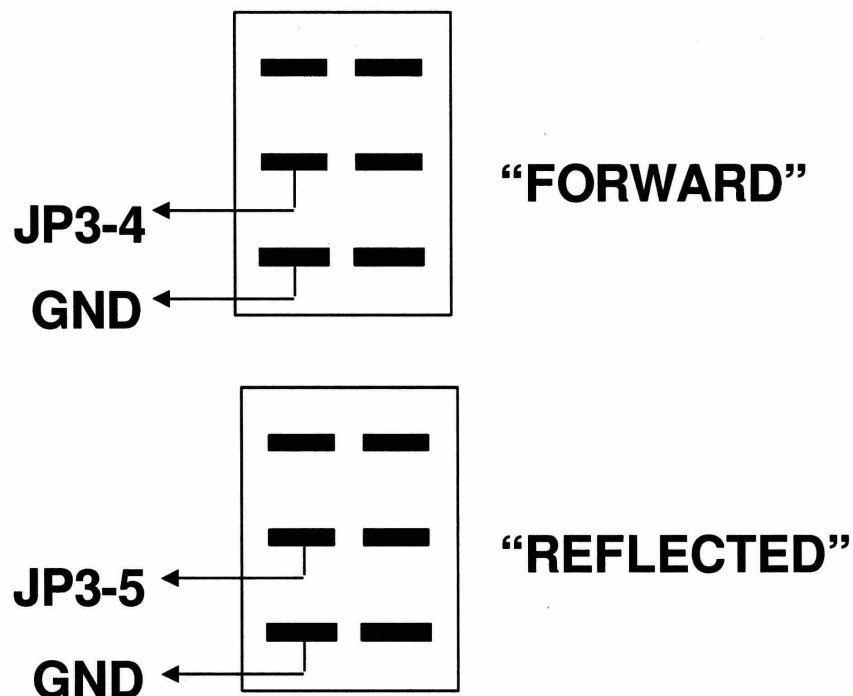
The first step is to prepare the main winding.

1. Take the supplied pieces of Red #28 enameled wire (Part #46022) and Green #28 enameled wire (Part # 46070) and hold them parallel to each other.
2. Twist one end of each together and clamp them with a small vise or anything which will hold them in position.
3. Pull the two wires horizontally toward you and begin twisting them together by turning the free ends together. Twist them until you see about 3 – 4 twists per inch. The wire is now ready for winding onto the toroid assembly.
4. Remove from the vise and separate the two ends which were originally twisted together.
5. Using the *bifilar* wire you have just twisted, wind 14 turns on the core, as follows: The *start*, *bottom*, and *clockwise* directions for these windings are key to getting the phasing correct in this directional coupler. *START* by leading the twisted wire through the center of the core from the *bottom*. Pull the wire through until about 1-inch of the two *START* wires remains outside the core. (See Figure 1 in the Appendix of this manual).
6. Continue winding around the core in a *clockwise* direction. ***Count each time the wire pair goes through the center hole as a turn.*** Space the turns to take up most of the core, as Figure 1 shows. The *FINISH* end will exit down through the center and come out through the bottom of the core. (See Figure 1)
7. Form a center-tap for the transformer by twisting together “Red *Start*” to “Green *Finish*” (scrape the color off the enamel wire first!). Refer to Figure 1. Before proceeding, check out this wiring with your ohmmeter or continuity checker as follows. “Red *Finish*” must have continuity to “Green *Start*” ***AND ALSO*** to the center-tap. After assuring that your connection is correct, solder the center-tap wires together.
8. Mount the toroid on the circuit board, over the standoff post, and solder the three leads to the pads as shown in Figure 2.
9. As shown in Figure 2. solder a 2-1/4” piece of #16 Blue Teflon wire (strip 1/4” of insulation off each end) to the plated through hole coming from the SO-239 connector (J1) and route it down through the standoff in the center of the toroid. The standoff is threaded and it is a somewhat tight fit for the wire.
10. Route the wire on the solder side of the board up through the plated through hole next to the “J2” SO-239 connector and solder it to the board. Clip off any excess at both ends of the wire.

1225 WATTMETER PEAK / AVG SWITCH WIRING			
WIRE START	WIRE FINISH	COLOR	LENGTH (IN)
FWD PEAK WIPER	JP3-4	WHITE / BLUE	7-3/4"
REFL PEAK WIPER	JP3-5	WHITE / YELLOW	3-3/4"
FWD PEAK GND CONTACT	REFL PK GND CONTACT	BLACK	3-3/4"
REFL PEAK GND CONTACT	JP3-9	BLACK	3-3/4"

Pre-wiring the switches will simplify the connections to the wattmeter board. Route each of the wires down to the bottom of the chassis and then over to the left (as viewed from the rear).

From the rear, the following is a pictorial of the "Peak / Average" switch contacts:



NOTE: When connecting the Peak / Average and Range switch leads to the wattmeter board, insert the wires from the "front" (solder side) of the board and solder them where they protrude on the component side of the board. This will make for a neater appearance and make any necessary troubleshooting easier. Leave some slack in the wires as they will be moved somewhat when the back light is installed. See Figure 5.

RANGE SWITCH WIRING

Refer to Figure 7 for a representation of the range switch wiring. In the following steps, cut the hook-up wire to the listed length and strip 1/4" of insulation off of each end. Loop the red wire through terminals C2 – C4 and solder each terminal.

The following table lists the wire lengths to be used. Pre-cutting and stripping the wire will help save some time. Connect all of these wires prior to installing the switch in the chassis. Solder each wire to the switch (S1) as it is installed. Route the wires to the left as shown.

1225 WATTMETER RANGE SWITCH WIRING			
WIRE START	WIRE FINISH	COLOR	LENGTH (IN)
"A"	JP3-1	ORANGE	6"
"A2"	JP3-3	BROWN	6-1/2"
"A3"	JP3-2	GREEN	6-1/2"
"B"	JP3-6	BLUE	5-3/4"
"B2"	JP3-7	GRAY	5-3/4"
"B3"	JP3-8	WHITE	5"
"C"	DC CONNECTOR +	RED	7"
"C2 – C4"	DC TO BOARD	RED	4"

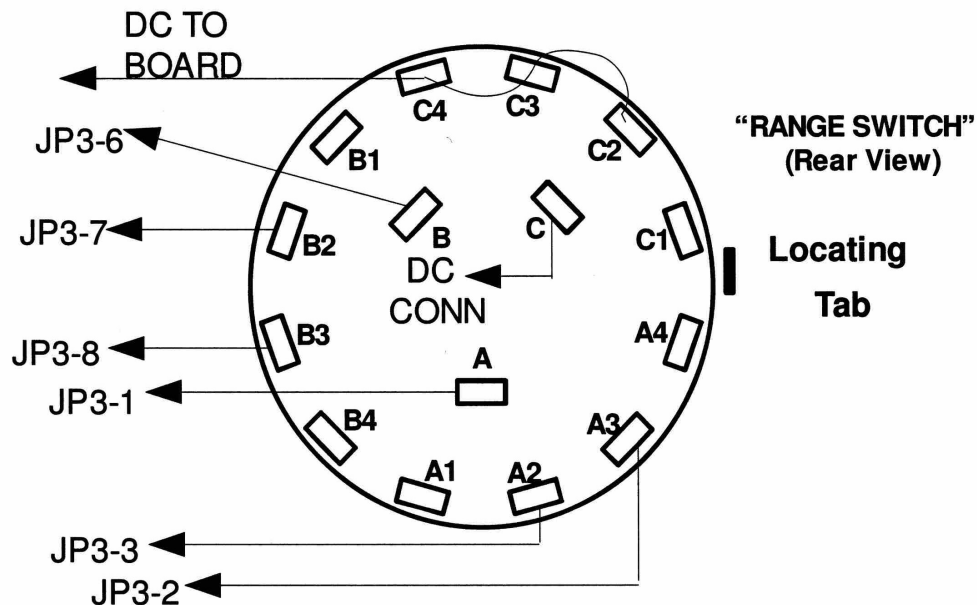


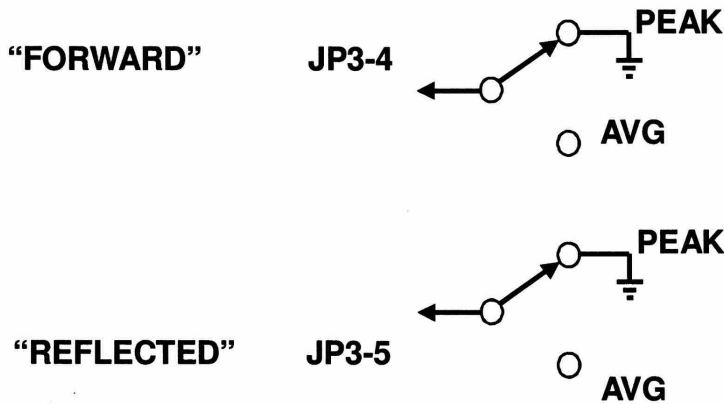
FIGURE 7

RANGE SWITCH INSTALLATION

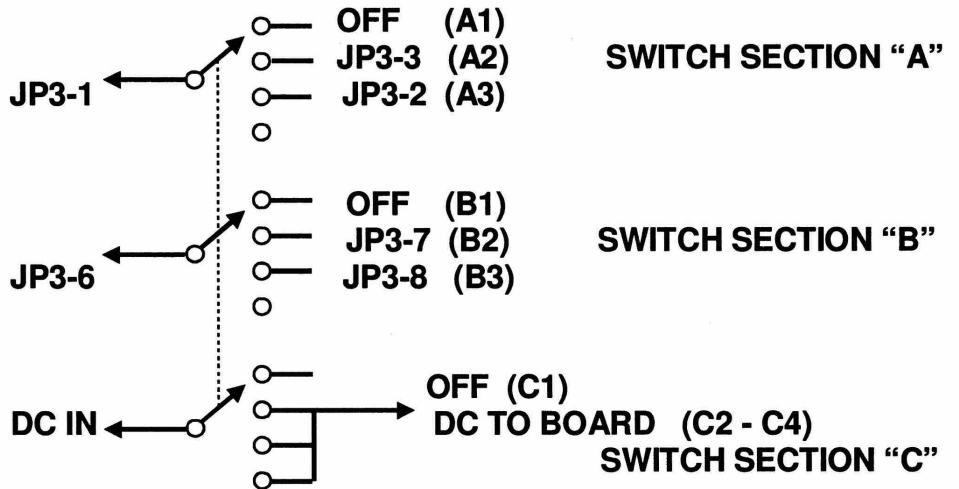
The Range switch will be installed in the chassis and then the individual wires will be routed up to the wattmeter board. The wires will be inserted from the solder side of the board and soldered on the component side. Clip off excess leads on the component side.

The following shows, schematically, how the "Range" and "Peak / Average" switches are wired.

SWITCH WIRING



"PEAK / AVERAGE" SWITCHES



RANGE SWITCH ("OFF", "2000W", "200W", "20W")

PHASE 6: BACKLIGHT ASSEMBLY & INSTALLATION

The backlight, part # 34069, is a flat panel measuring 3-7/16"W x 1-13/16"H. Viewed from the front, there is a 5/8" gray "stripe" on the right hand side along with 4 small solder tabs. A clear protective film is affixed to the front and needs to be removed prior to installation.

1. Loosen the three screws holding the wattmeter board to the front panel.
2. Viewed from the front, position the backlight assembly with the gray stripe on the right hand side of the meter.
3. Remove the protective film from the front of the backlight
4. Slide the backlight into position between the meter and the three standoffs protruding from the solder side of the circuit board.
5. Slide the backlight down until it rests on the meter. The top of the backlight should be level with the top of the meter.
6. Position the backlight so that the gray stripe is aligned with the right side of the meter. This will place the white portion of the light over the full width of the meter.
7. Tighten the three screws holding the wattmeter board to the front panel of the meter chassis.
8. The backlight should now be firmly held in place against the back of the meter. Note that the three spacers mounted on the wattmeter circuit board may not all press against the backlight, however it should be secure.

The four backlight solder tabs are labeled "A", "R", "B" and "G". Each of these tabs will have a wire soldered to it for connection to the wattmeter board. The tabs are small and don't require a lot of heat to "tin" them with solder. The wire lengths and colors are listed below. As before, strip 1/4" of insulation off each end of the wire.

Wire Color	Size	Total Length
=====	=====	=====
Red	#28	2-1/2" and 6-1/4"
Orange	#28	6"
Black	#28	5-1/4"

At the backlight, each wire should be folded around the tab and soldered (Tin the tabs first!). Use care so as not to overheat the display tabs when soldering. Solder the wires to the following tabs: (Refer to Figure 8)

1. Short red wire to the tab marked "A" (S1).
2. Orange wire to the tab marked "R" (S1)
3. Black wire to the tab marked "B" (S1)
4. Long red wire to the tab marked "G" (S1)
9. Dress the four leads from the backlight between the back of the light and the solder side of the wattmeter circuit board.
10. Solder the backlight leads to the component side of the wattmeter board as follows:
 1. Short red wire to the solder pad marked "LIGHT +" (S1) (upper left corner of the board)
 2. Black wire to the solder pad marked "BLUE" (S1) (upper right corner of the board)
 3. Orange wire to the solder pad marked "RED" (S1) (upper right corner of the board)
 4. Long red wire to the solder pad marked "GRN" (S1) (upper right corner of the board)

PHASE 7: SWR BRIDGE INSTALLATION

1. Looking at the SWR Bridge from the component side with the toroid at the bottom, locate the four solder pads in the upper left corner of the board. The four pads are found within a white rectangle. (Figure 9)
2. Cut and strip three #24 wires, one orange, one black and one blue to a length of 14"
3. Solder the orange wire to the upper left hand solder pad on the SWR Bridge board. (S1)
4. Solder the black wire to the pad next to the orange wire. (S1)
5. Solder the blue wire to the pad next to the black wire. (S1)
6. Remove the two screws and washers holding each of the RF connectors in place.

7. From the inside of the chassis, insert the two RF connectors through the holes in the back wall. Connector "J2" should protrude through the hole marked "Radio". Connector "J1" will then protrude through the hole marked "Antenna".
8. From the rear of the chassis, insert the two screws and split washers for each RF connector and tighten securely.
9. Route all three of the SWR Bridge wires straight down to the chassis bottom, then over to the right by the DC power connector and then straight along the chassis edge to the front behind the "Reflected" switch. Bring all three leads straight up along the edge of the wattmeter board.
10. Locate the three "BRDG IN" solder pads on the edge of the wattmeter board. They are located just below JP3-9 and above the "DC -" pads. The wires in the next three steps will be inserted from the solder side and soldered on the component side of the wattmeter board (Figure 5).
11. Solder the orange wire from the SWR Bridge to the lower of the three "BRDG IN" pads. (S1)
12. Solder the Black wire from the SWR Bridge to the middle of the three "BRDG IN" pads. (S1)
13. Solder the Blue wire from the SWR Bridge to the upper of the three "BRDG IN" pads. (S1)

THIS COMPLETES THE WIRING OF THE 1225 WATTMETER!

PHASE 8: WATTMETER PRESET AND INITIAL CHECKOUT

The following steps will preset the wattmeter prior to calibration and verify basic operation.

There is a drawing on page 36 which shows the locations of all the adjustment pots.

1. Set potentiometers R11, R12, R16 & R22 fully counterclockwise.
2. Set potentiometers R7, R8, R9 & R10 fully clockwise.
3. Rotate the Range switch fully counterclockwise.

4. Install the knob on the Range switch and align the indicator with the “OFF” position.
5. Rotate the Range switch clockwise to ensure that the indicator on the knob correctly indicates each position (“OFF”, “2 KW”, “200 W” and “20 W”).
6. Return the knob to the “OFF” position.
7. Plug the wall transformer into a live outlet and connect the output cable to the DC connector on the rear of the wattmeter.
8. Turn the Range switch to the “2 KW” position. The meter should illuminate with a solid green light (unless the “Red” jumper was installed in which case the illumination will be a yellow / green color). The meter pointers may move off of “0”.
9. Rotate R22 (the pot which faces vertically upwards from the wattmeter board) clockwise. The display should change from green (fully CCW) to blue (fully CW). Or, from yellow / green to purple if the “Red” jumper was installed.
10. Adjust the Forward and Reflected zero adjustments (on the front panel just below the meter) for a zero reading on each pointer. Note that the “Forward” zero adjust is on the right side and the “Reflected” zero adjust is on the left side.
11. Rotate the Range switch to the “200 W” and “20 W” positions and verify that the meters remain at zero on each range.

PHASE 9: WATTMETER ALIGNMENT

Alignment of the 1225 is fairly straightforward and should seldom be required after the initial setting. There are two options for calibration of the unit. The first requires only a digital voltmeter and utilizes the 1225's built in calibration circuitry. The second can be used if an accurate external wattmeter is available. This “external” wattmeter can be the wattmeter built into your rig if you are confident of its accuracy. The unit can be calibrated using the internal reference and then later checked, and readjusted if necessary, when an external wattmeter is available. *A known accurate external wattmeter will provide the best calibration accuracy, however use of the internal reference will yield a finished product which meets the published specifications. If you wish to check the accuracy of your voltmeter, connect the ground lead to the solder lug on the lower corner of the wattmeter board and touch the “+” lead of the meter to the “Light +” solder pad along the top of the board (next to R16). The voltage should read 12 volts \pm 0.1 volts DC.*

In either case, the SWR Bridge is aligned first, followed by alignment of the wattmeter forward and reflected power settings. Whenever an alignment is being performed with an external wattmeter, it is best to calibrate the unit towards the upper end of the power scale in use. Calibrating at low levels may introduce significant error in high power measurements. The internal reference calibration procedure calibrates all ranges at full scale.

ALIGNMENT OF THE SWR BRIDGE

1. Connect a transmitter to the "RADIO" port on the wattmeter and a 50Ω load to the "ANTENNA" port.
2. Set the "RANGE" switch to 20 Watts
3. Adjust R11, on the wattmeter board, fully CCW
4. Adjust R12, on the wattmeter board, fully CCW
5. Set the radio to the middle of the 20 meter band and key it. Adjust the power so that some indication is seen on the "Reflected" scale of the wattmeter. If necessary, adjust R12 clockwise until a useful reflected reading is seen on the wattmeter (the reading should decrease noticeably when the radio is de-keyed).
6. On the SWR Bridge board, adjust the trimmer capacitor, C1, for a minimum reflected power reading on the meter.
7. This completes calibration of the SWR Bridge. De-key the radio.

POWER CALIBRATION USING THE INTERNAL REFERENCE

There is a drawing on page 36 which shows the locations of all the adjustment pots.

Calibrating using the internal reference involves setting the **CAL** jumper and adjusting **R16** for the specified DC voltage for the range being calibrated. For Forward Power calibration, pins 1 and 2 of CAL need to be jumpered together. For Reflected Power, pins 2 and 3 of CAL need to be jumpered together. **NOTE: Pin 3 of CAL is the pin closest to the top of the wattmeter board, Pin 2 is in the center and Pin 1 is the lower of the three pins.** Once the calibration is completed, no pins on CAL are to be jumpered together. Place the jumper on the center pin, Pin 2, of CAL for future use. Perform all calibrations with both the forward and reflected power switches in the "Average" position.

For forward power calibrations, connect a DC voltmeter to the Orange lead on the SWR Bridge board. For reflected power, connect the voltmeter to the Blue lead leaving the SWR Bridge board. The negative lead of the voltmeter can be connected to the ground lug attached to the lower corner of the wattmeter board.

With no RF power applied, set the 1225 to the "20 Watt" scale and check to see that both meter needles are resting at "0". ***If not, adjust the associated front panel zero adjust***

screw (directly below the meter face) until the pointer rests at “0”.

The following table lists the DC voltages used for each of the range calibrations. Perform the calibrations in the order shown in the table (lowest power level first, working up to the highest power level). Potentiometer R16 is adjusted for the required DC test voltage and then the potentiometer associated with each range is adjusted for the wattmeter reading listed below. Note that it may be difficult to get the exact DC voltages shown. Levels within 5% of those shown are acceptable.

NOTE: After performing the 20W forward calibration and the 4W reflected calibration, remove the calibrating jumper and verify that the associated meter returns to “0”. If not, adjust the front panel zero adjust for a zero reading and repeat the calibration. This only needs to be done on the low power calibration for both the forward and reflected directions. Finish the calibration procedure after this has been completed.

RANGE SETTING	FWD / REFL	CAL JUMPER	DC CAL VOLTAGE	ADJUSTMENT	METER READING
20W	FWD	1 – 2	1.208	R11	20W
200W	FWD	1 – 2	2.622	R7	100W
2000W	FWD	1 – 2	8.817	R8	1000W
20W	REFL	2 – 3	0.453	R12	4W
200W	REFL	2 – 3	1.814	R9	40W
2000W	REFL	2 – 3	5.730	R10	400W

NOTE: Be sure to move the calibration jumper to the “neutral” position (on Pin #2 only) when finished calibrating the meter!

FORWARD POWER CALIBRATION WITH AN EXTERNAL REFERENCE WATTMETER

There is a drawing on page 36 which shows the locations of all the adjustment pots.

NOTE: Perform this calibration with the radio transmitting in the 20 meter band. Also, make sure that the CAL jumper is placed only on pin 2. If it is shorting any of the calibrating pins together, it will prevent accurate calibration using an external meter.

- Connect the radio to the input of the reference wattmeter. Using the shortest possible cable, connect the 1225 “Radio” port to the output side of the reference wattmeter. Set the 1225 on the “20 Watt” scale.
- Connect a known good 50Ω load, capable of handling the required power for calibration, to the “Antenna” port on the 1225. Use the shortest possible cable length.
- With no RF power applied, set the 1225 to the “20 Watt” scale and check to see that both meter needles are resting at “0”. **If not, adjust the associated front panel zero adjust screw (directly below the meter face) until the pointer rests at “0”.**

4. With the 1225 on the “20 Watt” scale and adjust the radio for 20 watts output (on the reference wattmeter).
5. On the 1225 wattmeter board, adjust R-11 for a 20 watt reading.
6. Dekey the radio and verify that the forward meter pointer returns to zero. If not, reset it to zero using the front panel zero adjust screw and repeat Step 5.
7. Set the 1225 to the “200 Watt” scale.
8. Key the radio and adjust the power to 100 watts on the reference meter.
9. On the 1225 wattmeter board, adjust R-7 to match the reading on the reference wattmeter.
10. Dekey the radio and set the 1225 to the “2000 Watt” scale.
11. Key the radio and adjust the power to 500 watts or greater (1000W will provide the best calibration). If you do not have high power capability, use the “Internal Calibration” procedure for the 2000 Watt scale.
12. On the 1225 wattmeter board, adjust R-8 to match the reading on the reference wattmeter.
13. Dekey the radio, the forward power calibration is complete.

REFLECTED POWER CALIBRATION

1. Reverse the coaxial connections to the 1225 wattmeter. Leave all other connections as they were.
2. Key the radio and adjust the output power to 4 watts as shown on the reference wattmeter.
3. Set the 1225 to the “20 Watt” scale and adjust R-12 for a 4 watt (full scale) reading on the reflected power scale.
4. Dekey the radio and verify that the reflected meter pointer returns to zero. If not, reset it to zero using the front panel zero adjust screw and repeat Step 3.
5. Set the 1225 to the “200 Watt” scale.
6. Key the radio and adjust the output power to 40 watts.

7. Adjust R-9 on the 1225 for a 40 watt (full scale) reading on the reflected power scale.
8. Dekey the radio and set the 1225 to the "2000 Watt" scale.
9. Key the radio and adjust the output power to 400 watts (or as high as possible without exceeding 400 watts). If you do not have high power capability, use the "Internal Calibration" procedure for the 400W reflected power calibration.
10. Adjust R-10 on the 1225 for a 400 watt (full scale) reading or adjust it to correspond to the power level shown on the reference wattmeter.
11. Dekey the radio. The 1225 calibration is now complete.

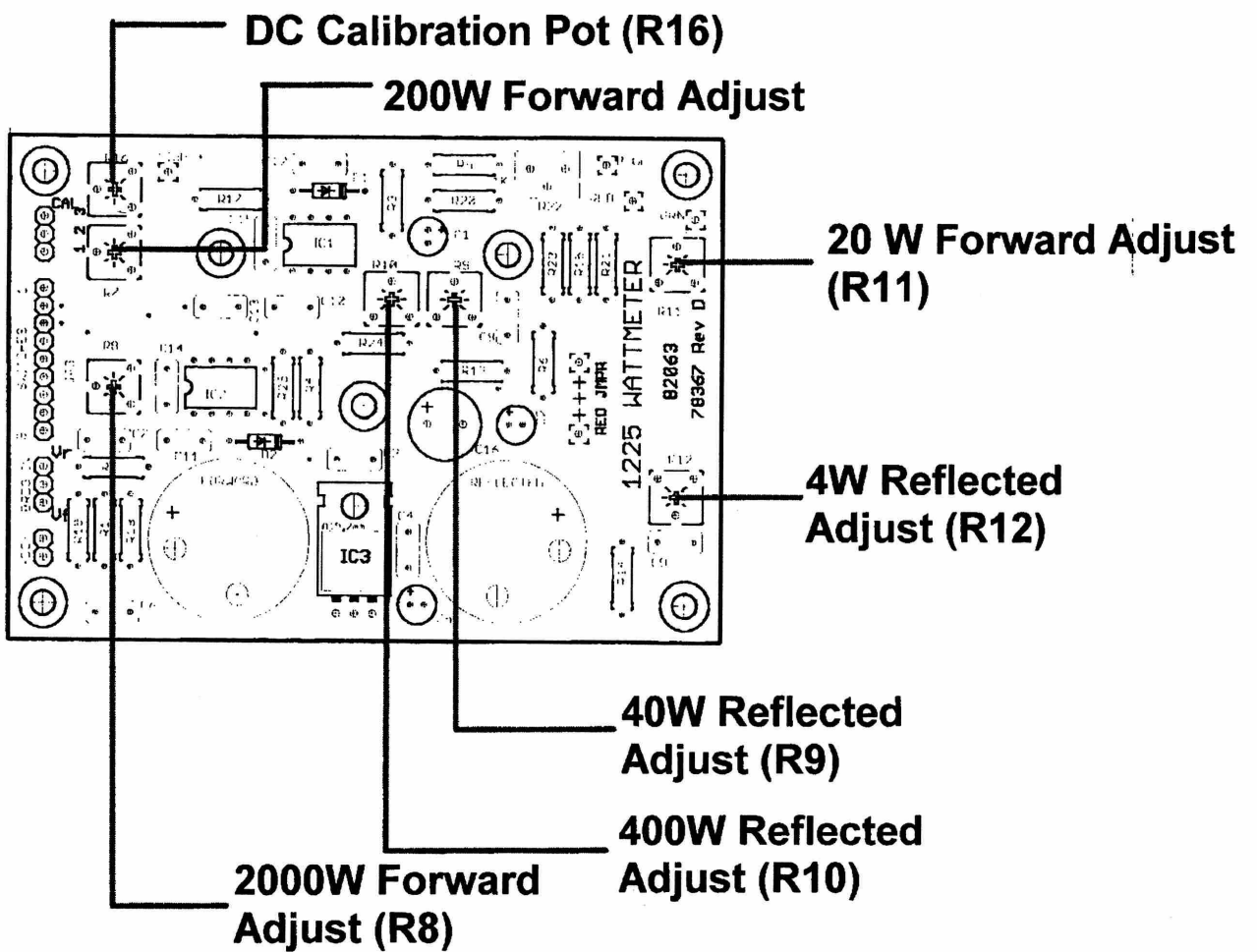
PHASE 10: BACKLIGHT ADJUSTMENT

The backlight is a tri-color device, but operates with the red LED's off and a pot adjustment which varies the green and blue levels. Counterclockwise adjustment of R22 will change the color to green and clockwise adjustment will shift the color toward blue. As built, the Red LED use is optional in the 1225. Should you wish to enable the red LED, install a jumper at the indicated spot on the board. (The jumper position is indicated by "+++") This will provide a fixed level of red light at all times. If you wish to reduce the amount of red, replace the jumper with a fixed resistor (or potentiometer) in the 0 to 1000 Ohm range. The option for adding the jumper is described during the assembly phase. **Note: Do not reduce the value of the backlight current limiting resistors, R15, R20, R21 & R23 as short or long term damage to the backlight may occur.**

PHASE 11: FINAL ASSEMBLY

Once the meter has been calibrated, install the cover using eight 4-40x3/16" black flat head screws. Note that the cover is designed with an "overhang" in the front. Be sure to orient the cover in that way.

This completes the assembly and alignment of your Model 1225 wattmeter. Connect the unit between your radio and antenna, or antenna tuner, and enjoy the ability to monitor the performance of both your radio and antenna system equipment.



APPENDIX



FIGURE 1

On the left is the toroid coil after being wound with 14 turns of bifilar wire. The “Start” of the winding is on the left. The coil on the right shows the Red “Start” lead connected to the Green “Finish” lead to form the center tap. Figure 2 shows the coil mounted onto the SWR Bridge board.

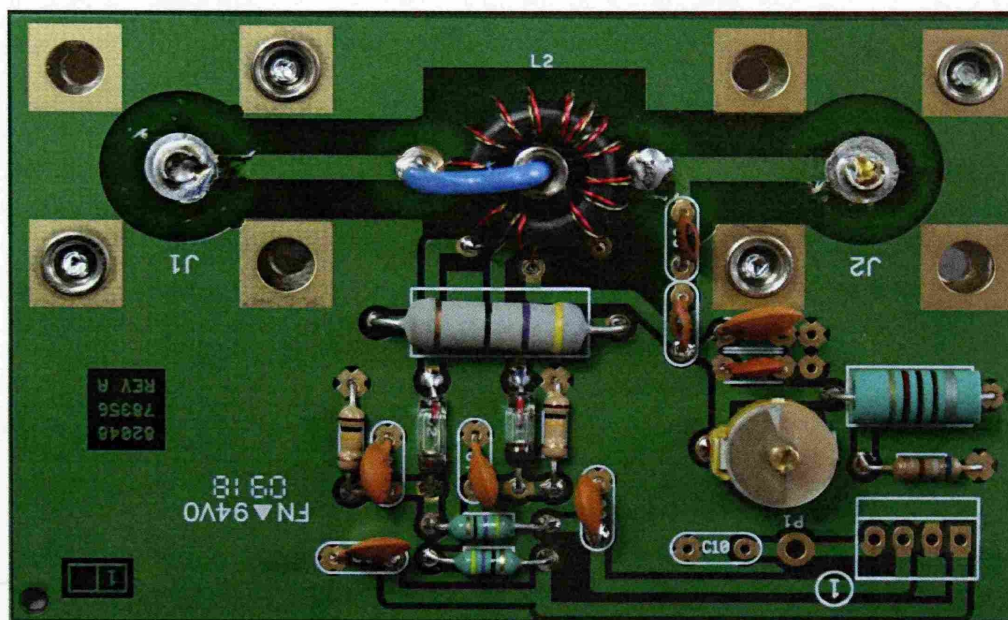


FIGURE 2

This is the assembled SWR Bridge board. Note that the banded ends of the two diodes point toward the bottom of the board. Also note the orientation of the toroid. The “Green” lead is to the left, the center tap in the middle and the “Red” lead to the right.

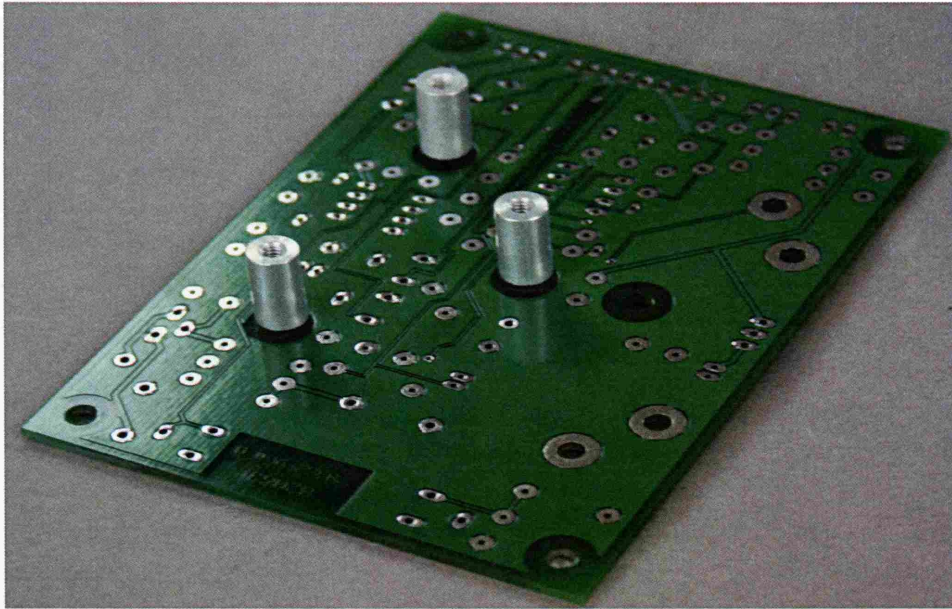


Figure 4

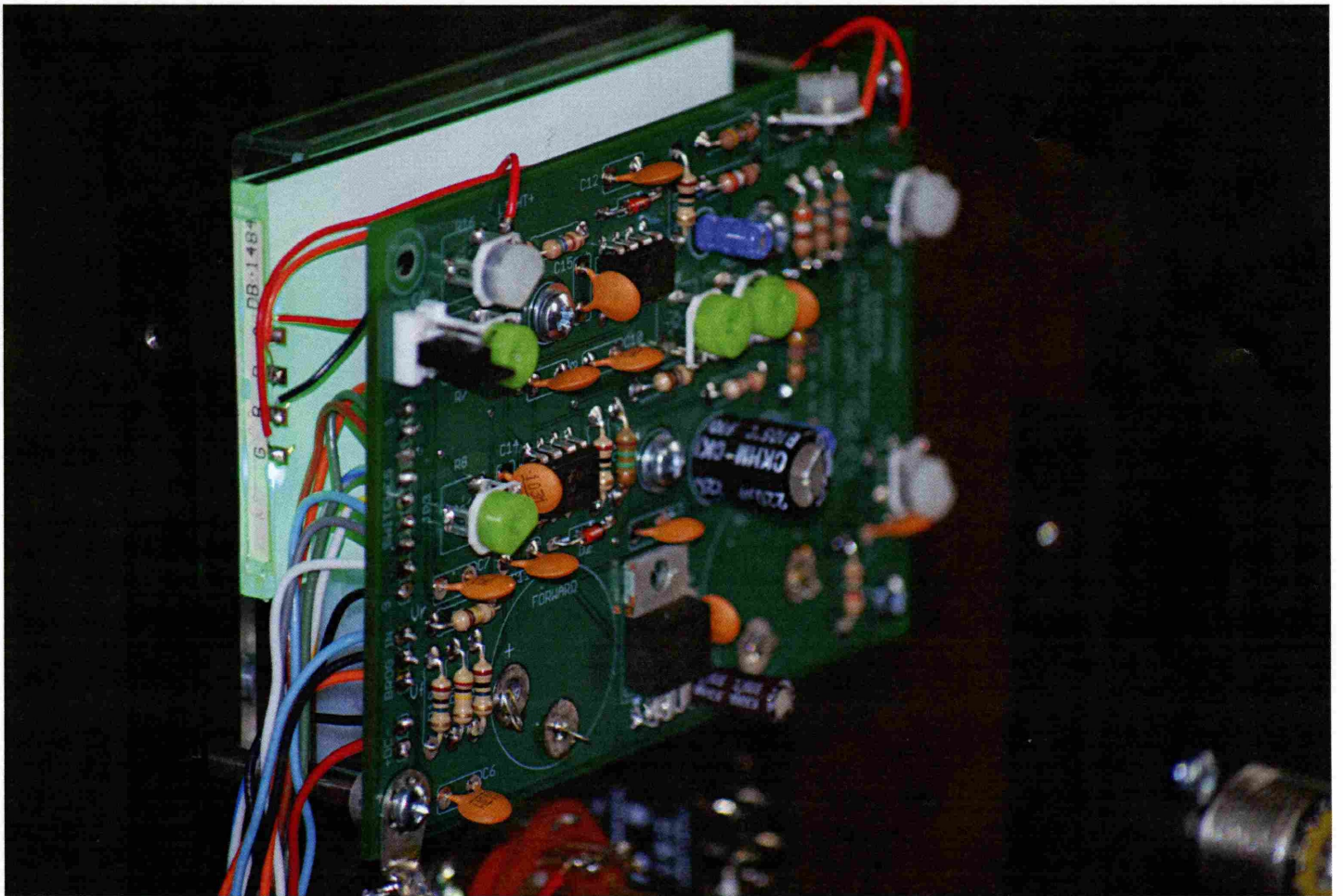


FIGURE 5

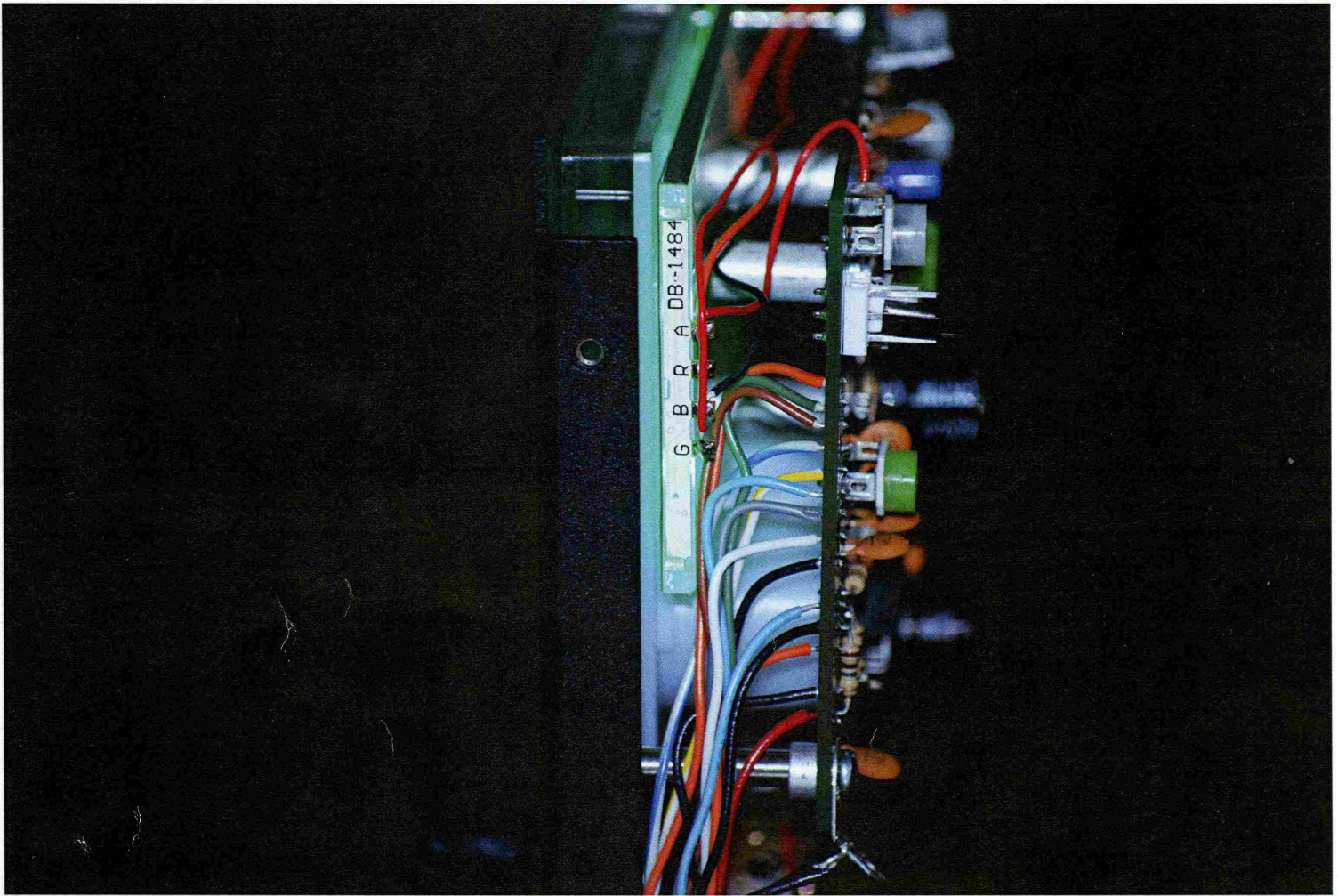


FIGURE 8

The four backlight connections are clearly visible here. #28 wire is used for the connections to the wattmeter board. Figure 5 shows how the wires are routed and then brought around to the component side for connection to the wattmeter board.

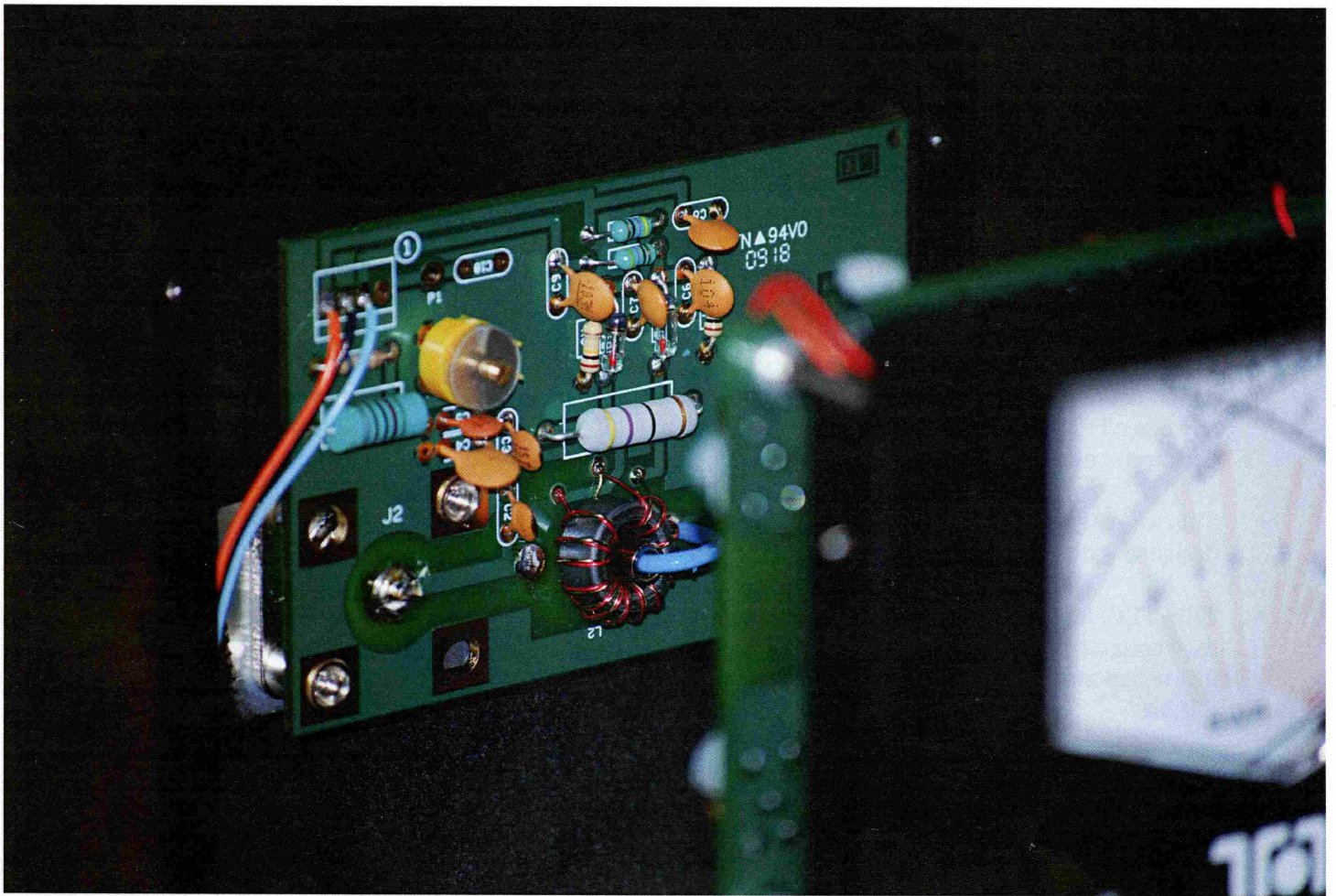


FIGURE 9

External wiring connections to the SWR Bridge board.