

HAMTRONICS® XV4 UHF TRANSMITTING CONVERTER: ASSEMBLY, INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

DESCRIPTION.

The XV4 is designed to convert 1 mW of ten meter energy to provide 1 W p.e.p. ssb or atv (or up to 1-1/2W on cw or fm) output on uhf. The unit is supplied with a crystal to cover the 435-437 MHz OSCAR uplink part of the band; and an additional oscillator circuit is provided to allow the range to be changed somewhat by adding another crystal, for example, the 432-434 MHz crystal we stock as an option. If desired, you may also order a special crystal for a slightly different frequency scheme if the frequency ranges are close to one of the standard options listed in the catalog. Because the XV4 is a linear translator, it may be used on any mode: ssb, cw, fm, am, tv, etc. Generally, a low power tap on the exciter is used in conjunction with an attenuator circuit in the input stage of the XV4, which may be set up to operate with up to 1/2W input. For operation with higher power exciter signals, a simple external attenuator can be added to reduce the input level to 1 mW. (Attenuators are treated in detail later.)

GENERAL CONSTRUCTION NOTES.

Use a small, but hot, pencil type soldering iron for this kit. Patience is required in mounting some of the components, and it helps to install a few parts, or in some cases only one, at a time and then soldering before proceeding. The close spacing and top-side ground connections required for good uhf pc board design require a little more manual dexterity than usual for pc board assembly.

With few exceptions, components must be mounted with the shortest possible leads to the board. This is especially true with bypass capacitors. At uhf, an extra 1/16 inch lead acts as a large inductance; so a little extra care in construction makes a big difference. We have found that a little extra care can easily double the output power; so take time.

Most pertinent construction details are given on the component location and schematic diagrams. A complete parts list is given, too; but be sure to read construction notes in the text on these first two pages to be sure you do everything required. Be sure to follow all the step-by-step instructions, and don't ad lib. It may take a little longer to assemble the kit, but it will work when done.

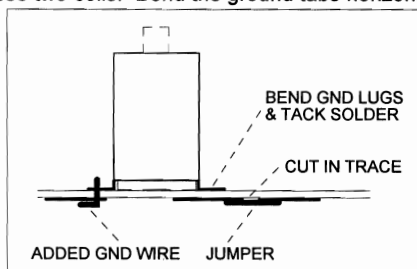
Refer to the sketches above the component location diagram for some examples of how leads are formed. Note especially that the PN5179 transistors must have their leads formed differently from what you would expect.

Note that this unit has been very popular for OSCAR and ATV activity for many years. It is one of our oldest kits, yet still very popular because it works so well. When it was designed, all the slug tuned coils we used had to be hand wound by the builder on plastic coil forms supplied. In recent years, we have been using molded plastic coils in our transmitter and receiver modules, and customers have asked if we could also use them in the XV4. We have found a way to do it without adding to the cost of the kit. It requires a few extra steps, but saves the trouble of winding those coils. We hope you agree the little extra effort in mounting these coils is worth the advantages.

CONSTRUCTION.

a. Begin construction by installing the two oscillator coils, L1 and L2, in the holes in the board and soldering them.

b. Install shields on these two coils. Bend the ground tabs horizontal and tack solder them to the ground plane on the top of the board, as shown in the following sketch. Note that the original shield cans had wider spacing; so the ground lugs of these cans will not fit to install them through the holes.



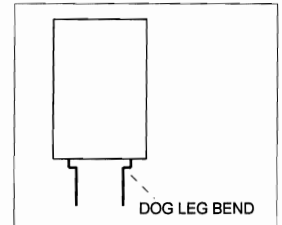
c. Looking under the board, you will note that one ground lug of each coil was meant to carry the ground connection through the board to provide grounds for other components. These are the lug holes closest to the right side of the board. Because the ground lugs of the new shield cans are tack soldered on the top of the board instead, it is necessary to run a short length of #22 bus wire through these holes, soldering both the

top and bottom of the board.

d. The pc board trace running to the left from each of these two coils has been cut as shown in the sketch. At one time, it was necessary to insert an rf choke at this point, but this is no longer necessary. However, the cut in the trace must be bridged with a short length of bus wire to close the gap. Lay the wire against the traces as shown, and tack solder.

e. Install tuning slugs in the two coils. Note that a tuning tool of the proper type must be used with the tuning slugs in this kit. The slugs are teflon coated so they will turn easily. The tool required has a .060" square bit. We sell the A28 tool for this purpose, a custom made aluminum & brass tool which will not wear out. (We find that plastic ones tend to wear out or shear off quickly, and the slugs can be cracked and seize up if this happens.)

f. The three remaining slug tuned coils require that their leads be formed a little to fit the narrower spacing of the holes on the board for the old-style coils. Do them one at a time as they are installed, but bend the leads as shown in the following sketch before installing them on the board.



g. Install L4 on the board, and then slide a shield can over the coil. The ground lugs of the shield go through the holes on the board, but they are soldered to the ground plane on the top of the board, not the bottom. Be sure that both ground lugs are soldered.

h. Coils L5 and L6 come with shield cans already over the coils, but it is easier to align the coil leads with the holes in the board if the shields are removed until the coils are installed and soldered in place. Then, slide the shields over the coils, and solder both lugs of each shield to the ground plane on top of the board as done for L4.

i. Mount double-balanced mixer U1 on the board, and seat it down against the board. U1 must be oriented with the part number stamped on top of the can nearest HF INPUT connector J1 as shown. Solder the eight leads on the under side of the board. Cut two short lengths of #22 bus wire, and install them in holes at the side and end of the double balanced mixer as shown on the component location diagram. Solder to top and bottom of board and to metal can on U1.

▶ CAUTION: The unit will not operate properly unless these two mixer ground wires are soldered in all three places.

⊗ WARNING: The metal shields you are about to install may have sharp edges. When handling, use caution not to run your fingers along edges.

j. Position long flat shield over dotted line on top foil of board as shown, and center it lengthwise. It should touch the double balanced mixer and one of the oscillator coil shields. Tack solder the bottom edge of the shield to the pc foil in several places. (It is not necessary to use a lot of solder or a continuous bead.) It may be helpful to tack solder in one place first to hold it in place and then carefully align the rest of the shield one step at a time as it is soldered.

k. Install the three short flat shields in similar fashion. Align with dotted lines, and tack solder to the pc foil and to the long shield.

l. Insert the three coax connectors in their holes. Bend center conductor tabs under board and solder to lower foil. Solder ground lugs to top side foil. Use a generous amount of solder on the ground lugs to provide mechanical strength to hold the connectors in place.

m. Install socket pins E1 through E5 and in four crystal socket positions. Cut them from carrier strip. Grasp the end carefully with fine nose pliers (one wall only to avoid crushing). Push into hole until first flange snaps through board to lock in place. Solder lower side sparingly to avoid loading up socket with solder.

n. Install driver transistor Q8. First, hold the transistor in your hand and carefully install the heatsink. Keep your thumb nail against the bottom of the plastic case to support it so you don't bend the leads. Then, form the transistor leads with the center (base) lead bent toward the flat side, and form the emitter and collector leads so the transistor can be installed with the shortest possible lead lengths. Be careful not to strain the leads where they enter the plastic package or they may break off. Seat as low as possible on board, and solder leads to lower foil.

o. Install output transistor Q9. Solder leads to bottom side foil while holding transistor flat against board. Be careful not to use too much sol-

der. Turn board over, and check to make sure transistor is tight against board. Then, carefully solder the entire base of the transistor to the top side foil. Start at one point, and run a bead of solder around base of transistor, being careful to solder uniformly but not using excessive amount of solder. The edge of the device should be soldered, but having the transistor tight against the board, very little solder should run under the transistor. (Note: The case of the output transistor is the emitter, unlike most transistors, so the emitter is grounded with low inductance. The third lead on the transistor, which is the emitter, is connected under the board to a dummy pad.)

p. Install PN5179 transistors in positions Q5-Q7. Note that special lead forming is required for the 5179's, since the board layout was originally done for the old metal-can type transistor. (The plastic type 5179 has a base-emitter-collector pin-out). A detail above the parts location diagram shows how leads should be bent.

NOTE: A small clearance area is provided in the ground plane foil for all leads which penetrate through to the bottom side of the board. It is important, when bending leads of transistors, resistors, etc. to fit holes in the board, that the lead be formed so it doesn't touch the edge of the ground plane foil where the lead goes in the board. This doesn't require anything special other than to visually check for shorts as leads are installed.

q. Install the 2N3904 transistors in oscillator and multiplier stages. Like the driver transistor, the center base lead must be formed toward the flat side of the transistor.

r. Refer to sketch above component location diagram. Install electrolytic capacitors, forming ground leads as shown. Solder ground lead to top foil and positive lead to bottom foil.

s. Install ferrite beads Z1-Z9. Beads are prestrung; so you only need to form the leads and insert them.

t. Install the resistors and zener diode, forming leads as shown in detail. do not install resistors R16 and R17 in attenuator circuit until later. Observe polarity on zener diode. Banded end is cathode.

u. Install disc capacitors, making sure all leads are as short as possible. Refer to detail above component location diagram for method of forming ground lead. It is easiest to solder top side ground leads before bottom side connections to hold parts in place when board is inverted. Orient capacitors with ground leads soldered as shown; don't turn them some other way because it may be easier. Usually there is a reason why they are oriented as shown.

NOTE: For ATV version of XV4, tack solder extra 22 pf capacitor across C12 on rear of board so that tuned circuit can be tuned to the lower injection frequency required.

v. Install rf chokes. They look like small resistors.

w. Install variable capacitors, and orient them as shown in component location diagram. The values are designated by color code. The ground lead should be bent at right angles carefully with a pair of fine nose pliers as shown in the detail. Always use the lead on the round side of the capacitor for ground; since it is the rotor. Be careful not to touch the plastic body with solder iron.

x. Wind and install air wound coils, using #22 bus wire. The coils must be wound in the proper direction to match the holes in the board so they are oriented properly. The coils must be wound with 1/8 inch i.d. Use a 1/8 inch drill bit or other forming tool for accuracy. Solder coils in place with 1/8 inch between the bottom of the coil and the metal foil on the board. Refer to detail above component location diagram.

NOTE: It is important that coils be mechanically aligned and spaced exactly as shown for proper inductance and coupling. Coils should start and end directly above the holes on the board, not bent one way or another. Turns should be spaced one wire diameter apart, i.e., just enough space between turns to allow a piece of #22 wire to slip between turns.

y. Check that all parts are installed in proper positions and that no leads are shorted to the ground plane where they penetrate the board. Resistors for the attenuator will be installed later; but otherwise no parts should be missing. If you are short a part and have a similar part left over, check to see if an incorrect value was installed somewhere.

z. Solder a jumper wire between terminals E1 and E3 (A&C on board). This activates the Y1 oscillator for testing (and for normal operation unless you wish to use the second oscillator for another band segment later). Install crystal in socket Y1.

CRYSTALS.

Crystals are standard HC-25/u, third overtone, .001%, series resonant units. Crystal frequencies for special requirements, such as other input frequencies, like 27 MHz or 50 MHz, or other output

frequencies, can be calculated with the formula:

$$(OUT\ FREQ - IN\ FREQ)/9.$$

The XV4 has two oscillators which are activated by grounding the appropriate control terminal E1 or E2 (A or B on the board). Common terminal E3 provides the ground connection. If only one rf range, example 435-437 MHz, is used, then oscillator position A is used and the crystal is installed in position Y1. A jumper should be installed between E1 and E3. If another range, such as 432-434 MHz, is to be used at times, the second crystal is installed in position Y2, and an external switch is used to ground the appropriate control terminal, either E1 or E2. The switch common would be connected to E3, and the jumper would be removed from E1-E3.

INPUT ATTENUATORS.

There are many ways to come up with 1 mW of drive at 10 or 11 meters. It is beyond the scope of these instructions to attempt to describe modifications for every possible exciter. However, general information is presented to allow you to design the attenuator connections you need for your particular situation. The primary things to remember are as follows:

1. Be very careful to start on the conservative side when experimenting to find the best values to use. If you accidentally apply a massive amount of power to the transmitting converter, you may end up with smoke signals instead of radio signals.

2. Do not reduce the audio gain of the exciter to keep drive down, except of course for fine adjustment. Design an attenuator to let you use the full range of the exciter. Then, you won't inadvertently blast the transmitting converter during operation, and you can have peace of mind.

3. Be prepared to experiment to find the ideal attenuator. You will be rewarded with a fine sounding signal with little carrier and low IM distortion. If you have too much drive, your signal will be wide and splattery.

4. Using the full dynamic range of your exciter instead of cutting back on audio gain drastically will result in minimum carrier level (maximum ssb carrier suppression) and minimum feedthrough of spurs because the relative level is lower if you use full sideband range. Provision has been made on the XV4 circuit board for an attenuator to operate with some of the newer 10 meter exciters which have transverter jacks supplying up to 1/2W p.e.p. (500 mW). The attenuator consists of shunt resistor R16 and series resistor R17. Refer to the manual for your exciter to determine output level if possible; but that information sometimes is not given. It may be necessary simply to try values for the level you think is correct and change if necessary. If you don't apply many watts of power to the XV4, you won't damage it; you simply flat top the output signal.

For 5 mW input, a 47Ω 1/2 W resistor should be installed for R16 and a bus wire jumper should be installed for R17. For 500 mW input, R16 should be 47Ω 1/2 W and R17 should be 680Ω 1/4 W. For levels between 5 and 500 mW, the value of R17 may be changed accordingly. For example, R17 should be 100Ω for 20 mW input or 270Ω for 100 mW input. Once your unit is operating, you may wish to alter the value of R17 slightly to match the characteristics of your exciter. (Note that a pot would be nice at this point, but operation of pots with rf energy of this sort can be very erratic.)

When operating with a signal generator during testing (a recommended practice rather than using an exciter drive source), R16 should not be used and R17 should be replaced with a bus wire jumper. This provides for the lowest possible input level, approximately 1 mW (0 dBm).

If your exciter has more than 1/2W p.e.p. output, but less than 50W, you can build an external attenuator to reduce the drive level to the 1/2W required when R16 is 47Ω and R17 is 680Ω. The attenuator works in conjunction with the 47Ω input resistor on the XV4 board. The attenuator consists of a shunt resistor connected across the output of your exciter and a series resistor between the exciter output and the input of the XV4. The chart below gives values for various levels of attenuation. These values are approximate, and any close value can be used in actual operation. You can vary the series value somewhat for fine adjustment by trial and error. Coax cable should be used between the attenuator (located at the exciter) and the input jack of the XV4. The attenuator can be made from composition resistors. For higher power levels, several 2W resistors can be used in parallel combination.

POWER LEVEL	SHUNT RESISTANCE	SERIES RESISTANCE
2W	100Ω/2W	47Ω/1/2W
5W	75Ω/5W	100Ω/1W
10W	65Ω/10W	150Ω/2W
50W	55Ω/50W	470Ω/5W

When building your attenuator, the best thing to do is to choose values as closely as possible from the chart. However, for trial purposes, you would like to start with less drive than necessary and work up to a safe amount. This is especially true if you are using the exciter as a test signal to align the converter in place of a signal generator. You can either turn the drive down on your

L9	3/4T loop #22 bus wire, 1/8"i.d.,1/4"high (see text)
L10	2 3/4T #22 bus wire on 1/8" i.d. (see text)
L11	3 3/4T #22 bus wire on 1/8" i.d. (see text)
L12	2 3/4T #22 bus wire on 1/8" i.d. (see text)
L13	1 3/4T #22 bus wire on 1/8" i.d. (see text)
L14	n/a
L15	2 3/4T #22 bus wire on 1/8" i.d. (see text)
L16	1 3/4T #22 bus wire on 1/8" i.d. (see text)
L17	0.33 uH rf choke (red-sil-orn-orn)
Q1-Q4	2N3904
Q5-Q7	PN5179 (note special lead formation - see text)
Q8	MPS3866
Q9	BLX-65E (Philips), SD-1444 (Thompson), or MRF-629 (Mot)
R1	1.2K
R2	680 ohms
R3	1.2K
R4	100 ohms
R5-R6	1.2K
R7	680 ohms
R8	270 ohms
R9	150K
R10	270 ohms
R11	1.2K
R12	180 ohms
R13	10K
R14	1.2K
R15	470 ohms
R16-R17	Attenuator resistors, see text
R18	1.2K
R19	180 ohms
R20	100 ohms
R21	1.2K
R22	180 ohms
R23	100 ohms
R24	2.2K
R25	270 ohms
R26	10 ohms
R27	2.2K
R28	100 ohms
U1	SBL-1 Double-balanced Mixer
VR1	1N5239B 9 V zener diode
Y1-Y2	Crystal, see text
Z1-Z9	Ferrite bead

PARTS LIST.

Note: Reference designators not shown are not used.

Ref Desig. Value (marking)

C1	.001 uf (102, 1nK, or 1nM)
C2	33 pf
C3	20 pf
C4	.001 uf (102, 1nK, or 1nM)
C5	33 pf
C6	20 pf
C7-C8	.001 uf (102, 1nK, or 1nM)
C9	62 pf
C10-C11	.001 uf (102, 1nK, or 1nM)
C12	110 pf (111) Note: For ATV operation, add 22 pf across C12 on rear of board. (See text.)
C13	220 pf (221)
C14	47 pf
C15	220 pf (221)
C16	22 pf
C17	0.5 pf
C18	220 pf (221)
C19	30 pf
C20	62 pf
C21	27 pf
C22	n/a
C23	4.7 uf electrolytic
C24	220 pf (221)
C25	4.5 pf variable cap. (white with brown screw)
C26	27 pf
C27	4.5 pf variable cap. (white with brown screw)
C28	10 pf
C29	20 pf variable cap. (pink)
C30-C31	27 pf
C32	.001 uf (102, 1nK, or 1nM)
C33-C34	27 pf
C35-C36	4.5 pf variable cap. (white with brown screw)
C37	20 pf
C38	27 pf
C39	7 pf variable cap. (blue)
C40	n/a
C41	27 pf
C42	n/a
C43	27 pf
C44	7 pf variable cap. (blue)
C45	27 pf
C46-C47	n/a
C48	27 pf
C49	n/a
C50-C52	27 pf
C53	20 pf variable cap. (pink)
C54	27 pf
C55	n/a
C56	4.7 uf electrolytic
C57	.01 uf (103)
C58	7 pf variable cap. (blue)
C59	20 pf variable cap. (pink)
E1-E5	Socket pins
J1-J3	RCA jacks
L1-L2	14 1/2T (yellow)
L3	0.33 uH rf choke (red-sil-orn-orn)
L4	6 1/2 T (blue)
L5-L6	2 1/2T (red)
L7	2 3/4T #22 bus wire on 1/8" i.d. (see text)
L8	3 3/4T #22 bus wire on 1/8" i.d. (see text)

exciter at first or use a higher value of series resistor in the attenuator temporarily. Using a higher value in the attenuator should not affect the load impedance on the exciter enough to matter; so don't worry about changing to the correct value of shunt resistor until you are through testing.

To deal with exciters with output levels over 50 Watts, and indeed for better operation anytime your exciter has more power than needed, we recommend that a low power tap be made at the plate of the driver stage in your exciter. Connect a 20 pF variable capacitor with sufficient voltage rating from the driver plate to the center conductor of a piece of coax connected to the XV4 input. A coax connector can be installed on the rear of your exciter if desired. The PA screen voltage should be switched off or some other means should be found to disable the PA stage when using the exciter to drive the XV4. If you also have a vhf transmitting converter, like the XV2, this output can also be used for it with an appropriate external attenuator. The variable capacitor can be adjusted by trial and error to provide about 20 mW output. R17 should be about 100 ohms to start, and it can be changed to allow the proper level to be obtained within the adjustment range of the variable capacitor added in the exciter.

ALIGNMENT.

Equipment needed for alignment is as follows:

- Dummy Load, 50 ohms, 2 Watts, good vswr at UHF
- Vtm with lowest dc range of at least 0.5V and preferably 0.15 V.
- RF Probe for vtm
- A28 Tuning Tool for coils (0.060" square bit)
- RF output indicator, relative meter like vswr bridge or power meter
- Signal source to supply 300 mV at 28-30 MHz; signal generator with variable attenuator preferable but exciter signal source ok
- Power Supply, 13.6 Vdc regulated, 500 mA
- Milliammeter, 500 mA, can be part of power supply or separate VOM.
- Frequency Counter (optional) - to check 45 MHz oscillator frequency.

If a signal generator is not available, the ten meter exciter to be used for transmission may be used to drive the converter; however, caution must be used to avoid overdriving the converter, and some means of varying the carrier level must be provided. If the exciter is used for alignment, refer to the section in this instruction sheet which describes attenuators to be used with various exciters.

The slug tuned coils in the converter always should be adjusted with the proper tuning tool (model A28). The variable capacitors should be adjusted with a small metal blade on an insulated shaft, such as the model A2 tuning tool.

All adjustments should be preset to the center of their ranges before applying power. Note that plastic cased variable capacitors have a small arrow stamped on the rotor plate. Maximum capacitance occurs when the arrow is aligned with the round end of the capacitor. Midrange occurs when the arrow is toward one side or the other instead of one of the ends. The white variable capacitors with ceramic cases have a small solder bead on the rotor. When this bead is at the flat end of the capacitor, maximum capacitance occurs, and midrange occurs with the solder bead toward one side or the other. The slugs in oscillator coils L1 and L2 should be preset flush with the tops of the oil forms.

NOTE: When power is applied and while tuning, do not allow rf output to exceed 1 1/2 Watts or supply current to exceed 350 mA. Monitor current in the B+ line at all times to detect potential problems before a transistor or other part is destroyed. If you are

testing with a current regulated power supply, set current limit control to 400 mA for safety. Idle current with no drive should be approximately 80-150 mA. If current is well above this level or if output meter indicates substantial output with no drive, the unit is either oscillating or tuned to mixer injection frequency. The problem should be corrected by retuning or other measures before proceeding. Never, under any circumstances, leave the unit "cooking" at B+ levels over 350 mA for extended periods of time. More information about unwanted output signals is discussed later. It is not necessary to become overly concerned, but you should be aware of what is happening at all times. When properly tuned, the unit should have no measurable output with no input signal applied. The output level and current drain should vary smoothly as the input level is varied.

Always follow alignment procedure as given. Do not repeak every control at full output. Some adjustments must be done under specific conditions to determine true peak for that stage. To guide you in setting up your vtm to the required range when using the rf probe, approximate dc voltages are mentioned. These should not be considered performance standards, since readings vary widely due to many conditions. It is nearly impossible to make accurate rf voltage measurements under these conditions. You should only use the vtm as a tuning indicator.

Power transistors Q8 and Q9 run quite warm, but not so hot you can't comfortably hold onto it. Do not operate without heatsink on Q8. If the transistors get hotter than described or if they do not cool down and current does not decrease when drive is removed, you may have caused a thermal runaway condition to happen, although the design is not prone to that happening. In such a case, remove power immediately and proceed with caution. After cooling, transistors should operate normally.

It is necessary to use a vtm with an rf probe for making several adjustments. Since components are small, the rf probe should have a small tip for easy access. You will not be able to clip the probe to the components; so if your probe has a clip type end, you may wish to secure a small piece of bus wire under the clip to use as a probe tip extension.

a. Adjust power supply for +13.6 Vdc output. Connect power supply to TX B+ terminal E4, and check for approximately 50-110 mA idle current. Reconnect to OSC B+ terminal E5, and check for approximately 30-40 mA current. Then, connect power supply to both terminals for remaining procedures.

b. Connect 50 ohm dummy load to UHF OUTPUT jack J2 through rf output indicating device. Connect driving source to HF INPUT jack J1, but do not apply drive at this point.

c. Connect vtm to TP1 (lead of R12), and peak buffer coil L4 for maximum indication (roughly 0.5V). Pull crystal momentarily, and check that oscillation stops.

d. If a frequency counter is available, connect it to RX OSC jack J3 and adjust oscillator trimmer coil for the correct oscillator frequency, eg., 44.8889 or 45.2222. If a frequency counter is not available, you can adjust the coil if necessary later by adjusting the coil to correct any slight frequency error in the output signal. (Since most transverters on the market don't have any method of trimming their oscillators at all, don't be too concerned about just leaving the coil at midrange if you have no counter.) If the frequency cannot quite be trimmed low enough, you can add a turn or two to the oscillator coil, and you can remove a turn or two if you can't quite adjust the frequency high enough. If a second crystal is to be used in Y2, you can ground E2 and adjust L2 at this point. Return to the primary crystal (Y1) before proceeding with tuning.

e. Connect vtvm to TP2 (lead of R15). Alternately adjust L5 and L6 for maximum indication (about 0.7V). You may not get any indication until both coils are somewhere near proper tuning point.

NOTE: Before proceeding, check that all capacitors are set to midrange as previously explained.

f. Connect rf probe to the hot lead of C28. Alternately peak C25 and C27 for maximum.

NOTE: For the following steps, a signal generator set for cw output or a similar driving source should be used with variable output of about 0 to 300 millivolts rms. Be careful, if using exciter, to take steps to avoid damage to converter from severe overdrive. Some means of adjusting the drive level from the exciter will be required for alignment. Since a signal generator is so much easier to use, an attempt should be made to borrow one before using exciter; although an exciter can be used if you can vary the output level of a carrier or sidetone signal. The frequency of the signal generator should be the center of the normal exciter frequency range to be used. For example, if your exciter will be used over a range of 28-30 MHz, set signal generator to 29 MHz.

g. Connect rf probe to hot lead of C37. Apply full drive from signal generator, and peak C29 for maximum. Then, alternately repeak C25 and C27.

NOTE: From this point on, you will be monitoring the level of the output signal from the mixer. Since it is possible to tune to the 404 or 407 MHz injection frequency if the capacitors are set too high in C, each time you finish a tuning step, remove the drive from the signal generator to see that the output is reduced. You may still have a small residual level in stages close to the mixer, but by the time you have all stages tuned and look at the output, this signal will be down 60-70 dB; so you should not see anything with a regular vtvm. If the output doesn't drop at all, you are probably tuned to the injection frequency. Try retuning, keeping in mind that it will take less capacitance to tune to the higher desired frequency. (Minimum C occurs with the rotor arrow pointing at the squared off end of the capacitor.)

h. Connect rf probe to rotor plate of C44. Peak C35, C36, and C39 alternately for maximum output. Check that output drops when drive is removed.

i. Monitor output level to dummy load. Alternately peak C44, C39, C53, C59, and C58 for maximum output. Reduce drive if necessary to keep total current drain at 350 mA or less, which correlates roughly with 1 1/2 Watts output. Repeat all adjustments again to work out interactions.

j. Note the rf output level. Some rf adjustments will now be fine tuned with drive level set to provide 1/2 the previous output level to avoid saturation and loading effects.

k. Adjust C29 for maximum gain while keeping drive reduced to 1/2 output.

l. For this step, keep drive level reduced if necessary to allow full output but not over 350 mA. (Tuning points for the driver and PA capacitors are affected by the power level; so you want to peak them for best efficiency at normal full output, but you never want to exceed 350 mA in normal operation.) Peak C39, C44, C53, C59, and C58 alternately. When done, output with full drive should be at least 1 Watt (about 300 mA). Typical output is 1-1/2 Watts (about 350 mA). Although you may be able to obtain considerably more output with more drive, don't try. The unit is designed conservatively to give you a wide safety factor and to provide linearity. Keep the reserve as a safety factor. (So you won't bother to try it, we can tell you we have been able to get as much as 2 Watts from some units, but we want to watch everything closely to do it safely.) Note that full 1-1/2W output may not be possible with less than 13.6V B+. Power output falls rapidly as B+ is reduced. This does not necessarily mean that the unit cannot be used, however, since it is hard to distinguish even a 2:1 reduction in power on the air. Alignment should be done, though, at the B+ level you will use in actual operation.

When the whole unit is properly tuned and ready for operation, the output level should vary smoothly from 0 to 1-1/2 Watts with no hesitations or sustained output when drive level is reduced. At this point, you can determine what drive level will be required for full output. During normal ssb operation, maximum drive should be held just under the full capability of the unit to remain in the linear region. (More information on operation is presented later.) If the output signal remains when drive is removed, the unit is either tuned to the mixer injection frequency or one of the stages is oscillating. Careful retuning should solve the problem as previously described. If there is some noise output with no input signal even though no measurable output level, the first amplifier stage may be loaded too lightly. Check that L10 and L11 are spaced properly.

In any case, where you need to retune, there is sufficient reserve gain to allow tuning at somewhat less than full gain. Therefore, you should feel free to give up a little gain to tune for a rock stable output signal.

TROUBLESHOOTING.

The usual troubleshooting techniques of checking dc voltages and signal tracing with an rf voltmeter probe will work well in troubleshooting the Converter. A dc voltage chart and an rf voltage chart are given to act as a guide to troubleshooting. Although voltages may vary widely from set to set and under various operating and measurement conditions, the indications may be helpful when used in a logical troubleshooting procedure. The unit should draw about 80-150 mA at idle and no more than 350 mA at full 1-1/2 Watts carrier output.

Be careful when operating or troubleshooting to avoid driving the unit to levels over 350 mA. Also be careful to avoid continuous operation if an oscillation drives the unit to near full output. Keep an eye on an ammeter in the B+ line. Don't ever allow the unit to draw over 350 mA. Although it is possible to obtain more than 1-1/2 Watts output, doing so may overheat the driver or PA transistors. Allowing these transistors to overheat may cause a thermal runaway condition, something which will not occur in normal operation. An unchecked thermal runaway can destroy a transistor. The symptom is a sudden drop in output power and current drain.

The full rated output may not be obtained if your B+ is reduced, because the gain of each stage is reduced. If you cannot get a full 13.6 Vdc from your power supply, you can still operate ok. A small reduction in output may not even be noticed on the air. Whatever the power supply, though, it should be well regulated for ssb operation.

The most common troubles in all kits, based on our experience, are interchanged components (so you don't notice while building), cold solder joints, solder splashes, and incorrectly wound coils. Another common trouble is blown transistors due to reverse polarity or power line transients. It is a good practice to use a fuse and a reverse diode at the input of any homebrew gear. This practice can save much work and expense after an inadvertent mistake later on. Any relay coils on the B+ line should also have a reverse diode connected right across the coil to absorb the reverse transients which relays produce. Remember if you encounter problems during initial testing that it is easy to install parts in the wrong place. Don't take anything for granted. Double check everything in the event of trouble.

If all else fails, factory service is available at modest cost. Consult us first to obtain cost information before shipping unit back to the factory. Because we cannot do much that you can't, and because much of what we can do is checking everything described above, troubleshooting is time consuming. You can save the expense of factory service by your own diligent effort and that of friends. We are always available by phone to give technical advise.

TYPICAL DC VOLTAGES.

The following dc levels were measured with an 11 megohm vtvm (fet vm) on a sample unit with 13.6 Vdc B+ applied and 6.8 V on the regulated oscillator bus. All voltages may vary considerably without necessarily indicating trouble. The chart should be used with a logical troubleshooting plan. All voltages are positive with respect to ground except as indicated. The first set of numbers are voltages measured with crystal removed or drive removed (depending on circuit, to remove signal). The numbers in brackets [] indicate levels with crystal plugged in and oscillating and proper drive applied to obtain 1-1/2W cw output.

STAGE	E	B	C
Q1, Q2	3.0 2.5 [3.2]	3.2 4.5	6.4 8.5
Q3	1.2 [1.0]	2.0 [1.7]	13.6
Q4	0 [0.5]	0 [-0.15]	13.6
Q5	2.2 [0.7]	1.4 [1.5]	13.6
Q6	1.0 [1.1]	1.8 [1.8]	13.6
Q7	1.0 [1.4]	1.8 [1.8]	13.6
Q8	0.7 [0.6]	1.35 [1.3]	13.6
Q9	0	0.6 [0.2]	13.6

TYPICAL RF VOLTAGES.

The following measurements are rough checks of typical rf voltages (rms) at various points. These levels may be helpful to you. Although most hams do not have accurate rf voltmeters, a simple device, such as the rf probe in the ARRL Handbook, may be used with a vtvm for simple signal tracing to find the point at which the signal may be blocked. These measurements were made with a Boonton 92C RF Millivoltmeter with the XV4 operating at full output. Regardless of what instrument is used, high impedances at some points result in sufficient loading so that the PA rf output is reduced or eliminated when the probe is connected, or at least, probe loading results in inaccurate voltage measurements. Nevertheless, indications may be helpful in troubleshooting.

STAGE	E	B	C
Q1, Q2	1	1.2	0.5
3	.02	.04	5
4	.01	1.1	1.3
Q5	0.3	0.9	0.7
Q6	0.25	0.15	0.4
Q7	0.25	0.3	1.25
Q8	0.3	0.7	6
Q9	0	0.7	8

If it ever becomes necessary to replace PA transistor Q9, desolder the leads under the board. Then, heat and carefully remove all the solder on the top side of the board around the base of the transistor. With a minimum of solder left, heat the area around the transistor, and rock the transistor loose. Remove any remaining solder to provide a flat surface for mounting the replacement device.

MOUNTING.

The XV4 pc board is designed to be mounted in any convenient cabinet using 4-40 screws and standoffs in the six mounting holes provided in the corners and center of the board. Because of the sensitive amplifier circuits on the XV4, shielding should be provided between the XV4 and any power amplifier used in the system.

After tuning the XV4 into a known good 50 ohm dummy load, it should not be retuned when the unit later is connected to the antenna or linear amplifier. Of course, the antenna or pa should present a good 50 ohm load to the XV4. Check to see that the current drain of the XV4 does not exceed 350 mA at full drive on cw and that the output level goes up and down smoothly when the cw drive level is varied (no oscillations.) Then, simply operate.

SYSTEM OPERATION.

Operation is fairly simple. You apply the correct level of 28MHz ssb, cw, am, or fm energy, and the XV4 provides 1W p.e.p. output on UHF (1-1/2W on fm or cw). The frequency is controlled by the frequency of the vfo on the exciter. The calibration can be checked by listening on a separate UHF receiver in the shack.

+13.6 Vdc should be applied to OSC B+ terminal E5 during both transmit and receive to maintain stability of the crystal oscillator. Also, the B+ should be well regulated, despite the fact that the oscillator supply is regulated again at the oscillator stage. TXB+ terminal E4 should have +13.6 Vdc applied whenever you want to transmit. Switching it off during receive is optional. It isn't necessary because removing the drive signal removes the output signal, but some prefer to switch off B+ too; so a separate terminal was provided.

The XV4 should not be set on top of a tube type exciter or receiver or in any other location where it will be heated or cooled. Vhf oscillators and the subsequent multiplying to get up to UHF require a conscious effort to minimize voltage and temperature variations for best stability. Otherwise, the person listening at the other end may be annoyed by having to retune due to transmitter drift, especially on ssb or cw. The ideal situation is to operate from a well regulated power supply, to keep B+ applied constantly, and to be located in a constant room temperature environment. Fortunately, these conditions are easily met with solid-state equipment. If the XV4 is housed in the same cabinet as a linear power amplifier unit, adequate ventilation should be provided around the inside and outside of the cabinet so the PA does not heat up the crystal oscillator when drive is applied.

After tuning the XV4 into a known good 50 ohm dummy load, it should not be retuned when the unit is later connected to the antenna or linear amplifier. Of course, the antenna or pa should present a good 50 ohm load to the XV4. Check to see that the current drain of the XV4 board does not exceed 350 mA at full drive on cw, and check that the output level goes up and down smoothly when the cw drive level is varied (no oscillations). Then, simply operate.

It is a good practice to have a 500 mA or similar panel meter connected in the B+ line to the XV4 at all times. It is a handy operating aid, and it may help to avoid trouble from overdrive or load impedance troubles developing later during operation. The milliammeter is even handier to watch than an output indicator as an all around operating aid.

The point which must be stressed most about any ssb device, such as the XV4, is that you must regulate the drive level applied from the exciter to a point below the maximum capability of the XV4 or PA. Normally, it is good practice to keep the peak output of the signal at a level below about 75% of the level at which it saturates to avoid intermodulation distortion (IM) caused by flat topping. 1 Watt p.e.p. is a good level to use as a guide for ssb operation with the XV4. This corresponds to 300mA when using a single tone, but the current reading will average much less on voice.

On tube type exciters, it is easy to determine when overdrive occurs because the PA tube begins to draw grid current. In fact, in some rigs, the grid current is detected and fed back to earlier stages as ALC to cut back the gain automatically to reduce distortion. However, once you use a separate power amplifier or a device such as a transmitting converter with the exciter, automatic regulation of exciter gain (drive) is impractical. Therefore, it is up to you to determine the proper drive level to run so that you don't create a troublesome splattery signal on the air. Solid state devices, such as the transmitting converter, are especially prone to causing IM rapidly as the drive limit is exceeded. You can easily check this out by listening on your own receiver. As you increase the audio gain on your exciter, you will notice a

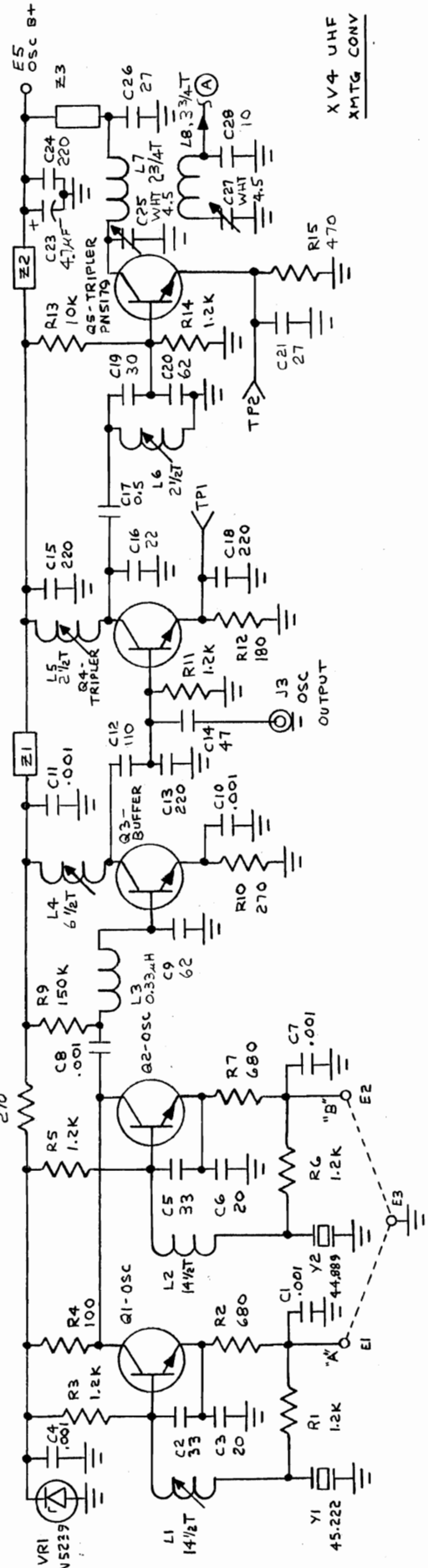
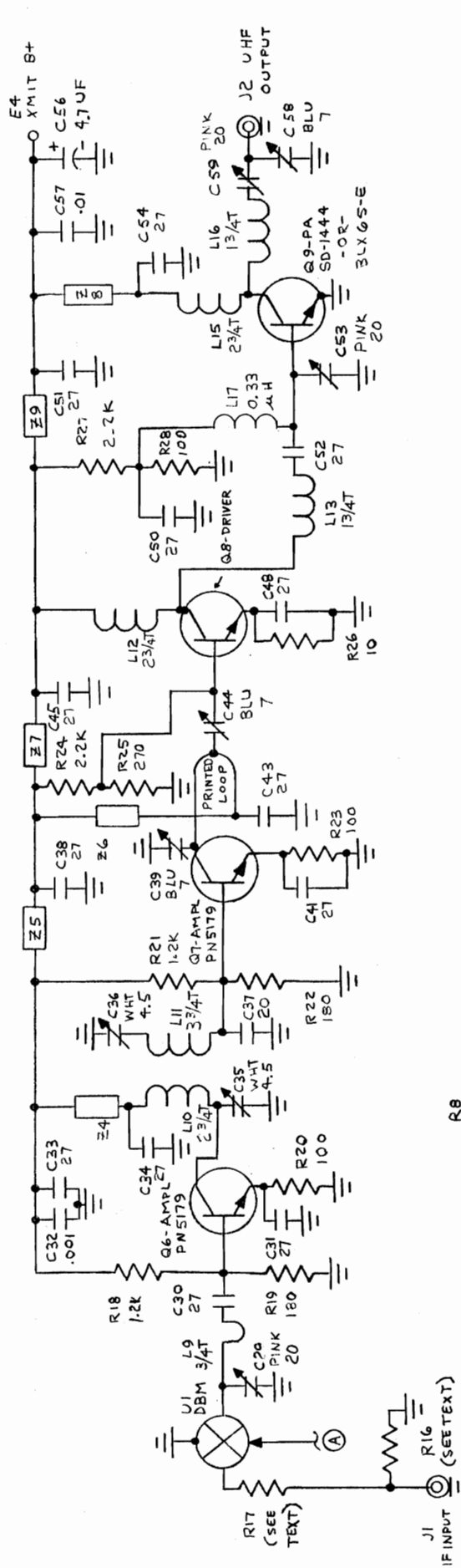
point beyond which the signal begins to widen. Once you find this point, you should make note of the gain control setting and other conditions affecting drive so that you know exactly how to operate in the future to avoid splatter.

DUAL RANGE OPERATION.

To be able to easily change output ranges, eg., between 432 and 435, two complete oscillators are provided. With crystals installed in positions Y1 and Y2, an external switch can be used to ground the appropriate control terminal, E1 or E2, to change ranges. There may be a slight difference in gain between the two ranges. If that causes a problem, the low level (high Q) stages can be retuned slightly to compensate.

LINKING OSCILLATOR WITH RECEIVING CONVERTER.

If a uhf receiving converter with an oscillator at the same frequency is used in your station, for example our model C432, you may want to operate the receive converter from the XV4 oscillator if you will be transceiving on the same transmit and receive frequency. To ensure that the mixer frequency is exactly the same on both converters, RX OSC jack J3 may be connected through a short length of 50 ohm coax to the oscillator in the receive converter. With the oscillator circuit used in our receive converters, you should remove the crystal from its socket, remove the capacitor connected between base and emitter of the oscillator, and connect the coax from the XV4 to the crystal socket pins. Make sure that the coax shield is connected to the grounded pin. The capacitor connected from emitter to ground should remain in the circuit.



XV4 UHF
XMTG CONV