HAMTRONICS® R451 UHF FM RECEIVER: INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

GENERAL INFORMATION.

The R451 is a premium commercial grade single-channel uhf fm receiver, for the 420-450 MHz amateur band, the 450-475 MHz commercial band, and the 400-420 MHz government band. It features a sharp tuned-line front end, an 8-pole crystal filter plus a ceramic filter for superior if selectivity, hysteresis squelch circuit to lock onto fading signals, and automatic frequency control to compensate for off-frequency transmissions.

CRYSTALS.

The channel crystal plugs into sockets identified in component location diagram as Y1. We can order crystals for any frequency desired. If you order your own, be sure to supply the following specs.

The receiver uses 32 pF parallel resonant crystals in HC-25/u holders. Crystals operate in the fundamental mode at a frequency of (F-10.7)/27. Frequency tolerance is .001%. We recommend that any new crystals be ordered directly from us to be sure that they will perform properly over the -30 to +60°C range for which the unit was designed. This is especially true for commercial receivers with the TCXO option, since the crystal must be matched exactly to the compensation circuit in the receiver. If you use an OV-1 crystal oven, specify a crystal with a 60°C breakpoint.

POWER CONNECTIONS.

The receiver operates on +13.6 Vdc at about 150 mA peak with full audio. Current drain with no audio is only about 40-50 mA. A crystal oven adds about 450 mA peak current drain when cold and only about 25 mA when warm. A well regulated power supply should be used. Positive and negative power leads should be connected to the transmitter at E3 and E1, respectively. Be sure to observe polarity. Be sure that the power source does not carry high voltage or reverse polarity transients on the line, since semiconductors in the receiver can be damaged.

SPEAKER.

An 8 ohm loudspeaker should be connected to E2 with ground return to E1. Use of lower impedance speaker or shorting of speaker terminal can result in ic damage. The receiver can also drive higher impedances, like 1K to 10K input impedances of COR boards, etc. There is no need to load down the output to 8 ohms.

ANTENNA CONNECTIONS.

The antenna connection should be made to the receiver with a phono plug. Use very short unshielded ends of coax at other end to connect to a "UHF" or "N" or "BNC" chassis jack if needed. We recommend a short length of RG-174/u coax and a good phono plug with cable clamp (see catalog). We do not recommend trying to use direct coax soldered to board or another type of connector. The method designed into the board results in lowest loss practical.

ALIGNMENT.

Equipment needed for alignment is an fet voltmeter, an rf signal generator, a regulated +13.6Vdc power supply with a 0-200 mA meter internally or externally connected in the supply line.

The slug tuned coils in the transmitter should be adjusted with the proper .062" square tuning tool to avoid cracking the powdered iron slugs. A tool is available as an accessory (model A28, $2.50). Variable capacitors should be adjusted with a plastic tool with a small metal bit on the end. Tools for adjusting the variable capacitor (model A2, $2.50) and transformer L11 (model A1, $1.00) are also available.

The variable capacitors should be set to the center of their range (turn them 90° if they have not previously been aligned). The squelch pot should be set fully cw.

a. Install channel crystal in socket Y1.

b. Connect speaker, ground, and +13.6 Vdc. You should hear white noise.

c. Connect dc voltmeter to TP1. Adjust first L2, then L1 and L2 alternately, for maximum response. (Typical indication is +2 to +4 Vdc.)

d. Connect dc voltmeter to TP2. Adjust L3 and L4 alternately for maximum response. (Typical indication is +1 to 2 Vdc.)

e. Connect stable signal generator to L6 near variable capacitor C18, using coax clip lead. Connect coax shield to pcb ground. Set generator to exactly 10.7000 MHz. Use a frequency counter or synthesized signal generator. Set level just high enough for full quieting. (At 100 uV, you should notice some quieting, but you need something near full quieting for the test.)

f. Adjust discriminator transformer L12 for +4Vdc with meter connected to AFC test point TP4. Note that the voltage changes very rapidly with tuning. Full AFC swing of about 1.5 to 9V occurs within a few kHz, and a little drift may be noticed. It is only necessary to be within about 0.3V of 4V.

Note: There are two methods of tuning the mixer and front end. One is to use an fet voltmeter with test point TP3, which is the rear lead of R18. The voltage is proportional to the noise detected in the squelch circuit; so it gives an indication of quieting. A signal peak, therefore, is indicated by minimum noise voltage. The other method is to use a regular professional SINAD meter. In either case, a weak to moderate signal is required to observe any change in noise. If the signal is too strong, there will be no change in the reading as tuning progresses; so keep the signal generator turned down as the sensitivity of the receiver increases during tuning. If you use TP3 with a voltmeter, the signal can be modulated or unmodulated. If you use a SINAD meter, the standard method is a 1000 Hz tone with 3 kHz deviation.

g. Check that signal generator is still on 10.7000 MHz. With weak signal applied to L6 as before, adjust L11 for a peak. This step is critical to get lowest distortion in the crystal filter.

h. Reconnect signal generator to J1. Adjust to exact channel frequency, and turn output level up fairly high. Adjust frequency trimmer capacitor C2 to net the crystal to channel frequency, indicated by 4V at AFC test point TP4. If you can't find the signal at all, tune your signal generator up and down the band slightly. (Also check that oscillator is peaked as per step c.)

If your crystal has the wrong load correlation or is slightly out of tolerance, you may be able to compensate by changing the value of C1 so C2 can net the crystal on frequency. The AFC circuit will be pulling to counteract any adjustment you make on C2. You can observe this AFC action at TP4.

The proper adjustment results in 4Vdc, the same as preset for the exact 10.700 MHz i-f frequency earlier. After adjustment, you can tune the generator up and down to watch AFC action. You should be able to pull the carrier signal about 10 to 12 kHz high or low in frequency; and beyond that, you will notice a popping out of passband and the necessity to get within the i-f passband of +-7 kHz again for AFC to recapture the signal.

i. Connect fet dc voltmeter to TP3 (rear lead of R18). Set signal generator for relatively weak signal, one which shows a little change in the dc voltage indication. Alternately peak C17, C18, C21, C23, C24, and C25 until no further improvement can be made.

When properly tuned, the sensitivity of the R451 should be about 0.25 uV for 12 dB SINAD and about 0.3 uV for 20 dB quieting.

Following is a procedure which we use in the factory for fine tuning the AFC circuit after all other alignment is done. You may want to try it, although the improvement may only be minor. It helps to center the discriminator exactly in the center of the i-f passband. Connect fet voltmeter again to AFC test point TP4. With no input signal, only noise, adjust L12 for 4Vdc (don't touch L11). Then, reapply full quieting signal at exact channel carrier frequency, and adjust crystal trimmer C16 for 4V.

DEFEATING THE AFC.

In some installations, such as 15 kHz splits, AFC may not be desirable. In such a case, you can remove varicap diode CR1 and replace it with a ceramic capacitor of about 12 pF.

SQUELCH CIRCUIT.

The squelch circuit has about 3 to 6 dB of hysteresis built in, so that once the squelch opens, the signal must drop 3 to 6 dB below the opening threshold before squelching again. This allows for some fading on mobile stations and prevents squelch pumping on heavy modulation. Of course, this requires setting the threshold a little higher than if there was no hysteresis so that it will close with no signal. If you prefer the older type squelch, you can simply remove Q6 from the circuit. If you want more or less hysteresis, you can decrease or increase the value of R27.

REPEATER USE.

E4 provides a "carrier operated switch" output which may be connected to a COR module to turn a transmitter on and off. The output level is about +7V unsquelched and 0V squelched. There is a 27K resistor in series with the output to limit current. Refer to COR module instructions for details.

MULTICHANNEL OPERATION.

An A24-451 Multichannel Adapter is available to provide operation on up to 5 channels. Refer to catalog for proper type to operate with this receiver. When the adapter is used, AFC operation is defeated, and ovens and TCXO option may not be used.

AUDIO MUTING.

If the receiver is used as a part of a transceiver, audio muting can be accomplished without switching the power or speaker lines. If the transmitter is keyed by applying B+ to the exciter, simply connect the keyed B+ through a 100K resistor and a diode to the junction of R19 and R20 on the receiver board. The dc level will be sufficient to trigger the squelch circuit in U2, regardless of the rf signal level coming into the receiver. Of course, some means of disconnecting the receiver from the antenna must be provided, and we recommend our TRR Coax Relay Module if the power level is under 25 Watts. Otherwise, a larger coax relay will be required.

DISCRIMINATOR METER.

If you wish to use a discriminator meter and you are handy in designing with op-amps, you can run a sample of the dc voltage at the junction of R29 and C45 to one input of an op-amp and tie the other input to a voltage divider pot set to provide a reference voltage of about 4 Vdc. Values in the circuit depend on your meter and are beyond the scope of this discussion. (Sorry, we do not have a circuit, and there is no easy way to make an S-meter circuit.)

MOUNTING.

Some form of support should be provided under the pc board, generally mounting the board with spacers to a chassis. 3/8 inch holes should be provided in a front panel for the bushings of the SQUELCH and VOLUME controls. After sliding bushings through panel, washers and nuts are installed on the outside of the panel. Be sure to provide support for the board; do not rely on the controls to support the board. For repeater applications, the receiver should be mounted in an rf tight box, such as our model A16.

TROUBLESHOOTING.

The usual troubleshooting techniques of checking dc voltages and signal tracing work well in troubleshooting the receiver. A dc voltage chart and a list of typical audio levels 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 most common troubles in all kits are interchanged components, cold solder joints, and solder splashes. Another common trouble is blown transistors and ic's due to reverse polarity or power line transients. 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 the receiver is completely dead, try a 10.700 MHz signal applied to L6 with a coax cable clip lead. You should be able to hear the quieting effect of a 100 uV carrier at 10.700 MHz. You can also connect the 10.700 MHz clip lead through a blocking capacitor to various sections of the crystal filter to see if there is a large loss of signal across one of the filter sections. Also, check the 10.245 MHz oscillator with a scope or by listening with an hf receiver or service monitor.

A signal generator on the channel frequency can be injected at various points in the front end. If the mixer is more sensitive than the rf amplifier, the rf stage is suspect. Check the dc voltages looking for a damaged fet.

If audio is present at the volume control but not at the speaker, the audio ic may have been damaged by reverse polarity or a transient on the B+ line. If no audio is present on the volume control, the squelch circuit may not be operating properly. Check the dc voltages, and look for noise in the 10 kHz region, which should be applied to noise detector CR2 with no input signal. (Between pins 12 and 13 of U2 is an op-amp active filter tuned to 10 kHz.)

TYPICAL DC VOLTAGES.

The following dc levels were measured with an 11 megohm fet vm on a sample unit with 13.6 Vdc B+ applied. All voltages may vary considerably without necessarily indi cating trouble. The chart should be used with a logical troubleshooting plan. All voltages are positive with respect to ground except as indicated. Voltages are measured with no signal applied but oscillator running properly and with squelch open unless otherwise specified.

XSTR	E	B	C
Q1	3.3	3.1	8.6
Q2	3	0	13.6
Q3	1.7	0	13.6
Q4	0	0.8	6.5
Q5	(S) 2.2	(G) 0	(D) 13.6
Q6 Sq	0	0	0.65
Q6 Unsq	0	0.7	0

TYPICAL DC VOLTAGES (CONT)

U1	1	6	8	14	
	7	0	6.5	13.6	
U2	1	2	3	4	5
	9.1	8.9	8.4	9.1	1.1
U2	6	7	8	9	10
	1.1	1.1	9.1	5.4	4.5
U2	11	12	13	14	
	1 to 9	2.5	2.5	0.3 to 0.7	
U2	15		16	17	18
	0(SQ), 8.5(UNSQ)		0	0	2.2

TYPICAL AUDIO LEVELS.

Following are rough measurements of audio circuits, using an 11 megohm fet vm. Measurements were taken with no input signal, just white noise so conditions can be reproduced easily.

U2 pin 10:	400 mV rms
U2 pin 13:	2 V rms
Top of volume control	70 mV rms
Across 8 ohm spkr term	3V rms

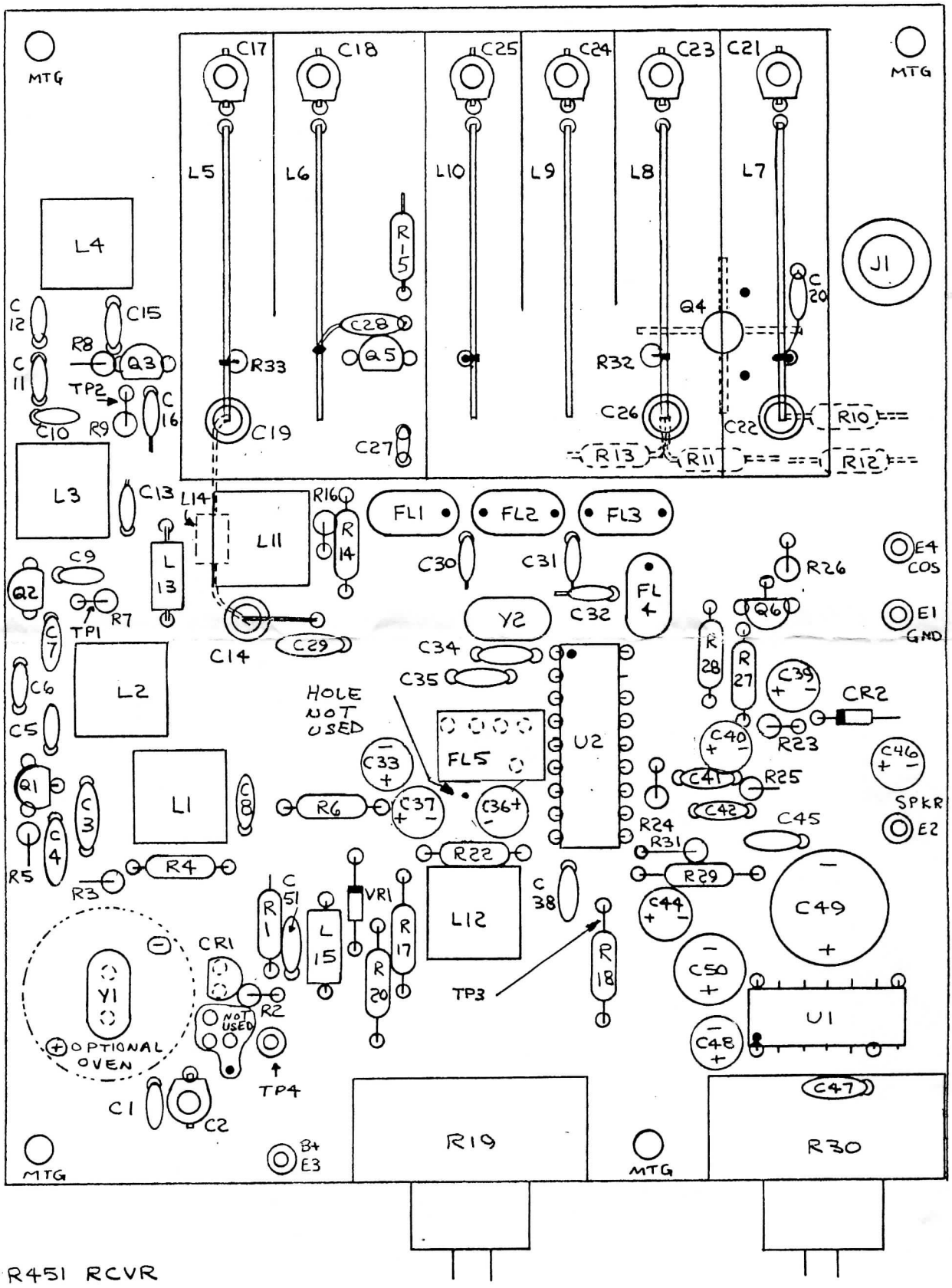
PARTS LIST FOR R451 UHF FM RECEIVER

Ref #	Value (marking)
C1	27 pf
C2	10 pf white plastic var. cap
C3-C4	150 pf (marked 151)
C5	62 pf*
C6	1 pf
C7	62 pf*
C8	.01 uf (103)
C9	220 pf (221)
C10	18 pf*
C11	0.5 pf
C12	15 pf*
C13	220 pf (221)
C14	Feedthrough cap
C15-C16	27 pf
C17-C18	4.5 pf white ceramic var.cap with brown screw*
C19	Feedthrough cap
C20	100 pf
C21	4.5 pf white ceramic var.cap with brown screw*
C22	Feedthrough cap
C23-C25	4.5 pf white ceramic var.cap with brown screw*
C26	Feedthrough cap
C27	27 pf
C28-C29	.01 uf (103)
C30-C32	4 pf
C33	0.47 uf electrolytic
C34	82 pf
C35	470 pf (471)
C36-C37	0.47 uf electrolytic
C38	220 pf (221)
C39	0.47 uf electrolytic
C40	0.47 uf electrolytic
C41-C42	680 pf (681)
C43	Not assigned
C44	0.47 uf electrolytic
C45	.01 uf (103)
C46	0.47 uf electrolytic
C47	.01 uf (103)
C48	47 uf electrolytic
C49	470 uf electrolytic
C50	100 uf electrolytic
C51	.01 uf (103)
CR1	MV2101 varicap (6.8 pf nominal at 4 Vdc)
CR2	1N4148 (may be unmarked)
FL1-FL4	Matched set crystal filters (see text)
FL5	Ceramic filter (blue)
J1	RCA Jack
L1-L2	6-1/2 turns (blue)
L3-L4	2-1/2 turns (red)
L5-L10	Formed from #20 bus wire (see text)
L11	857-9 IF transformer
L12	831-5 IF transformer
L13-L15	Ferrite bead
Q1	2N4124
Q2-Q3	PN5179
Q4	NEC 21937
Q5	J308 FET
Q6	2N4124
R1	330K
R2	47K
R3-R4	15K
R5	680 ohms
R6	100 ohms
R7	180 ohms
R8	1.2K
R9	180 ohms
R10	22K
R11	4.7K
R12	2.2K
R13	680 ohms
R14	47 ohms
R15	2.2K
R16	4.7K
R17	100 ohms
R18	68K
R19	100K pot
R20	2 meg
R21	not assigned
R22	47K
R23	150K
R24	330K
R25	1.2K
R26	150K
R27	1 meg
R28-R29	27K
R30	100K pot
R31	4.7K
R32	10 ohms
R33	27 ohms
U1	LM-380N
U2	MC-3359P
VR1	1N5239B
Y1	Channel Xtal (see text)
Y2	10.245 MHz xtal

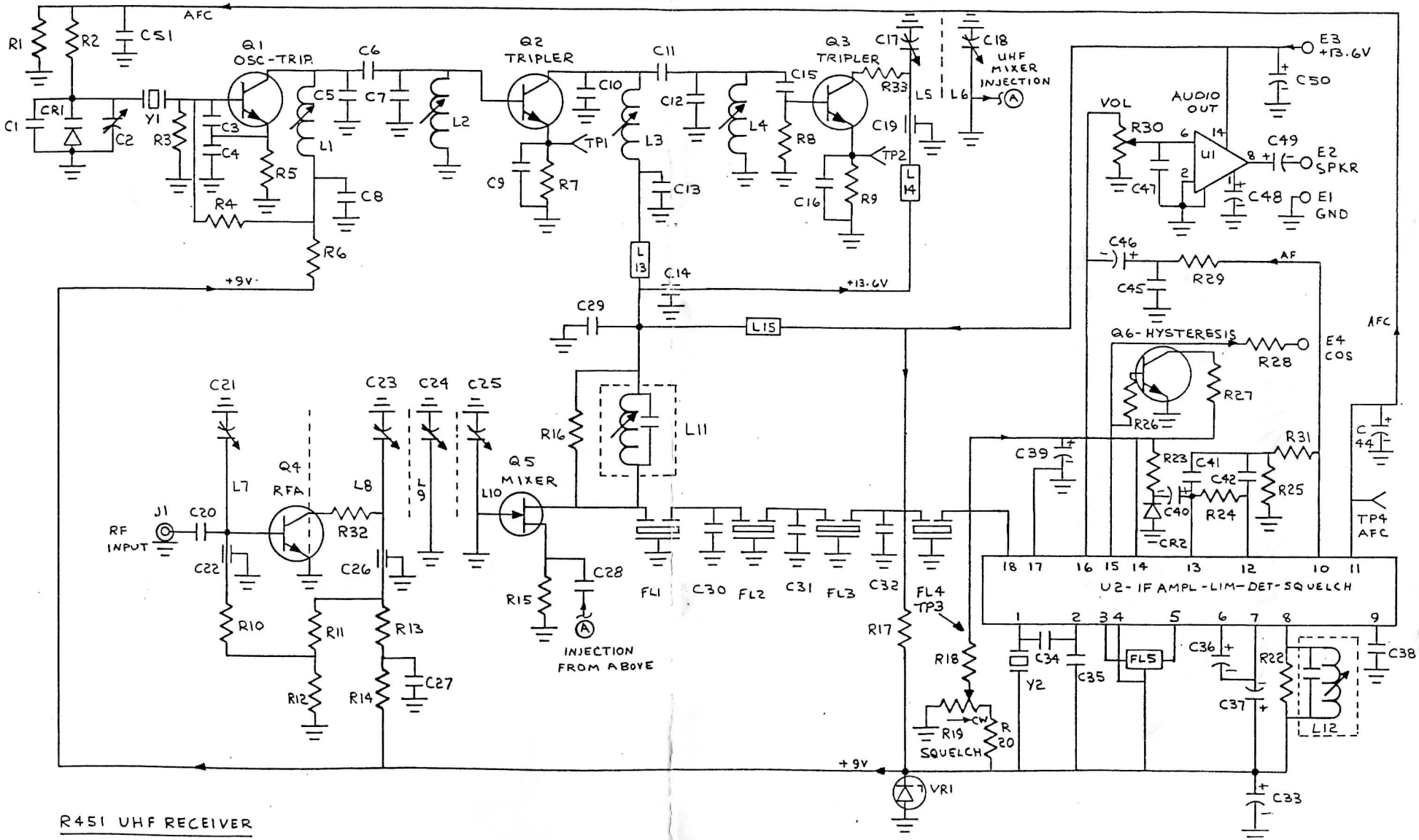
*Note: Following are value changes for operation from 400-430 MHz. (Parts normally **not** supplied in kits.) If close to 430 MHz, try tuning first with standard parts. Value can be increased either by changing original part or tack soldering additional capacitor under board.

C5	82 pf
C10	20 pf
C7	82 pf
C12	18 pf

In addition, it may be necessary to pad some of the variable capacitors in the front end with 2 pf disc caps tack soldered under board, using short leads. Rotor mark pointing at flat end of body indicates max. capacitance.


MTG
MTG
MTG
MTG
C17
C18
C25
C24
C23
C21
L5
L6
L10
L9
L8
L7
J1
L4
R15
C28
Q5
R33
Q3
R8
C15
C12
C11
TP2
C10
R9
C16
C19
C27
C20
Q4
R32
C26
C22
R10
R13
R11
R12
L3
C13
L14
L11
R16
R14
FL1
FL2
FL3
C30
C31
C32
FL4
Y2
C34
C35
C9
Q2
TP1
R7
L13
C14
C29
C7
C6
C5
L2
HOLE NOT USED
FL5
U2
C33
C37
C36
R6
Q1
L1
C8
C3
C4
R5
R3
R4
R22
L12
C38
R18
TP3
C51
R1
L15
VR1
R17
R20
CR1
R2
NOT USED
TP4
Y1
OPTIONAL OVEN
C1
C2
B+
E3
R19
R30
C47
U1
C48
C50
C49
C44
R24
R31
R29
C45
C42
C41
R25
C40
R23
CR2
C39
R28
R27
Q6
R26
E4
COS
E1
GND
C46
SPKR
E2

R451 RCVR



R451 UHF RECEIVER