HAMTRONICS® TA451 UHF FM TRANSMITTER ASSEMBLY, OPERATION, & MAINTENANCE

GENERAL INFORMATION.

The TA451 is a single-channel uhf fm transmitter designed to provide 2 to 2½ Watts output (continuous duty) into a 50 ohm antenna system in the 400-470 MHz band. It is designed for narrow-band fm with 5 kHz deviation. Audio input is designed to accept a standard low-impedance dynamic microphone or any low-impedance audio source capable of providing 30mV p-p into a 2K load. Operating power is +13.6 Vdc +/-10% at 600-650 mA.

The sequence of presentation of the following information assumes that you purchased a wired transmitter, ready to operate. If you purchased a kit, refer to page 2 for Alignment instructions prior to performing audio level or frequency adjustments.

ASSEMBLY.

Refer to the component location diagram and the parts list during as-sembly. Following is a general guideline for the sequence of assembly and notes on items to give special attention.

a. Install the two crystal sockets. Cut them from the metal carrier strip. Install from top of board, and rock them while pressing into holes. They will snap in place when fully seated. Solder lightly to avoid wicking solder up into top of pins.

b. Install two potentiometers, R1 and R15.

c. Install transistors Q1-Q9 as low as possible without breaking leads.

d. Install predriver transistor Q10 on top of board as shown. The base and collector leads on each end of the transistor should be formed to go through holes on the board. The center emitter lead should be bent horizontal and tack soldered to the ground plane.

e. Install driver transistor Q11, orienting as shown in the illustration. Seat the transistor as low as possible, but be careful not to bend the leads so sharp that they break.

f. Install rf output transistor Q12 flat against the board, and solder the leads on the bottom of the board. Then, solder the bottom of Q12's metal can to the pcb ground plane with a continuous bead of solder flow-ing around the can. (Soldering the can to the ground plane is necessary to provide heatsinking and a low im-pedance emitter ground; the transistor is designed to be installed this way. No other heatsink is required.)

g. Install phono jack J1. For the shortest rf path, orient the jack with the center terminal toward the upper-left (toward the output coils). Solder all lugs under the board.

h. Install variable capacitors, ori-enting as shown for minimum interac-tion with tuning tool.

i. Install electrolytic capacitors, observing polarity.

j. Install ceramic capacitors. It may be necessary to form capacitor leads to fit holes in board. Keep leads as short as possible.

k. Neither C59 nor the jumper wire next to C59 are normally used. They are used only with the TCXO option, which is rarely used. Just omit them.

l. Install resistors and diodes, observing polarity on diodes. Note that there are 2 kinds of diodes. On verti-cal parts, form top lead directly over for shortest leads. The circle on the location diagram indicates where the body of the part should be. For resis-tors used as test points (TP1-TP3), form as shown in the detail drawing at the top of the component location dia-gram to leave a small test point loop for connection of a meter probe.

m. Wind air wound coils L7 and L9 L14 as indicated on schematic and location diagrams, using #22 tinned bus wire supplied. L7, L10, L11, L12, L13, and L14 are 1¾ turn coils; and L9 is a 4¾ turn coil. They are all wound on an 1/8 inch diameter form-ing tool (such as the shank of a drill bit) and then soldered with the bot-toms of the coils 1/8 inch above the board. (See detail above component location diagram.) Be sure to wind the coils in the direction shown. Note that L10 is wound in direction opposite to that of the other coils. The coil turns should be spaced one wire diameter between turns. It is easiest to space them after the leads are soldered in place.

n. Install rf choke L8 as shown.

o. Install rf chokes L15 and L16 with a ferrite bead over the ground lead, and mounted on angle as shown in the detail above the component lo-cation diagram. Be sure the ferrite bead is on the ground lead (position as shown on main component location diagram). Clip factory installed leads from ferrite beads so they can be in-stalled on choke leads.

p. Ferrite beads Z1-Z9 are supplied with wire leads already attached. In-stall them as shown.

q. Install slug tuned coils as shown. Install coil shields. The 2-1-2 turn (red) coils come with shields al-ready on the coils. The 6-1-2 turn (blue) coils have shields supplied separately. Make sure the coils and shields are fully seated, and solder both shield lugs. (Do not bend lugs over, but you can bend the coil leads over a little to hold them in place while soldering.)

r. Check over all components and sol-der connections before proceeding. If you are short any parts, check to see if any are left over; you may have installed a wrong value somewhere.

CRYSTALS.

The TA451 uses 32 pF parallel resonant crystals in HC-25/u holders. Crystals operate in the fundamental mode at a frequency of F/36, which results in a crystal frequency of 12.5 to 13.056 MHz. 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 transmitters with the TCXO option, since the crystal must be matched exactly to the compensation circuit in the transmitter.

If you use an OV-1 crystal oven, specify a crystal with a 60°C breakpoint. The crystal is inserted into sockets on the board. The oven is installed on the board over the crystal, observing polarity by matching the 3-lead pattern to the holes in the board (see component location diagram). Then, the pins of the oven are soldered to the board.

POWER.

The TA451 Transmitter operates on +13.6Vdc at about 600-650 mA. A well regulated power supply should be used. Positive and negative power leads should be connected to the transmitter at E1 and E3. Be sure to observe polarity. If a crystal oven is used, +13.6Vdc should be connected to the oven separate from E1, since E1 is keyed on and off to transmit. Oven power should remain on constantly during any period when transmission is expected.

MOUNTING.

The four mounting holes provided in the corners of the board can be used in conjunction with screws and standoffs to mount the board in any cabinet or panel arrangement. See catalog for A26 PC Mounting Kits. There is no need for a shielded cabinet except if the transmitter is used in a repeater or in duplex service.

AUDIO CONNECTIONS.

The TA451 Transmitter is designed for use with a low impedance dynamic microphone (500-1000 ohms) or any low impedance audio source capable of supplying 30 mV p-p across 2000 ohms. The microphone should be connected with shielded cable to avoid noise pickup. Mic connections are made to pads E2 and E3 on the pc board. *Be sure to dress the audio cable away from the piston trimmer capacitor; since close proximity could affect channel frequency.*

RF OUTPUT CONNECTION.

The antenna connection should be made

to the pc board with an RCA plug of the low-loss type made for rf. We sell good RCA plugs with cable clamp. See A5 plug on website.

If you want to extend the antenna connection to a panel connector, we recommend using a short length of RG-174/u coax with the plug and keep the pigtails very short.

AUDIO DEVIATION ADJUSTMENTS.

To adjust the audio controls, start by setting potentiometer R1 to maximum and R15 to midrange. Apply B+ to E1 to key the transmitter and talk into the microphone or apply audio of normal expected level to the transmitter. If the unit is setup with tones from a service monitor, use a tone frequency of 1000 Hz. Observe the deviation meter or the scope on a service monitor, and adjust R15 for a peak deviation of 5 kHz. Then, adjust mic gain control R1 so that the transmitter deviation just swings up to 5 kHz on modulation peaks.

This will provide the optimum setting, with sufficient audio gain to achieve full modulation but with the limiter occasionally clipping voice peaks to prevent over-modulation. Avoid setting the audio gain higher than necessary. Although the deviation limiter will prevent over-modulation, microphone background noise is increased and some distortion from excessive clipping may result.

Note that when the exciter is used in repeater service, instructions in the manuals for the COR and Autopatch modules should be used to set the exciter audio controls, since each repeater system requires a specific audio adjustment method.

FREQUENCY ADJUSTMENT.

The crystal frequency is precisely set on the channel frequency with variable capacitor C13, using an accurate service monitor or frequency counter.

Note that the tuning range of piston capacitor C13 was deliberately limited to provide optimum frequency stability. With some crystals, the frequency may not be adjustable high enough. If this is the case, clip the jumper to disconnect C59 from the circuit, which raises the frequency range of the variable capacitor.

SUBAUDIBLE TONES.

If you want to transmit a CTCSS (subaudible) tone, you can connect the output of the tone encoder to the modulator, bypassing the speech processing circuits. The best way to do it is by connecting to the junction of C10 and C11, and the easiest way to make the connection is at the right hand leg of C11. A 47K resistor should be connected in series with the subaudible tone audio to avoid loading down the regular voice audio. Tone encoders normally have an output pot to adjust the deviation of the subaudible tone separate from the voice level. (Our TD-3 and TD-5 Tone Decoder/Encoder modules already have a resistor on board; so it does not require an extra resistor, but you may need to change the value of the resistor to make it 47K for this exciter.)

The level of the subaudible tone should be set no higher than about 300 Hz deviation for best results. Otherwise, a buzz may be heard on the audio at the receiver. Since the deviation from a phase modulator is proportional to the modulating frequency, the low frequency of the tone makes it difficult to get large deviation levels without distortion. Since most decoders only need about 50 Hz deviation to detect, this should not be a problem.

THEORY OF OPERATION.

The TA451 is a fairly straight forward fm transmitter, with a phase modulated 12-13 MHz signal multiplied by 36 to reach the 400-470 MHz output range. Crystal oscillator Q4 operates as a Colpitts oscillator at the fundamental frequency of approximately 12 MHz. When supplied with TCXO option, a thermistor compensates for cold temperatures by gradually reducing the amount of load capacitance in series with the crystal at temperatures below 10 degrees C. The oscillator output is fed into reactance modulator Q5, which phase modulates the carrier with audio from the speech processor circuits.

Q6 operates as a tripler to multiply the carrier frequency to a range of 33 to 39 MHz. Q7 triples again to a range of 100 to 117.5 MHz. This, in turn, is doubled in Q8 to a range of 200 to 235 MHz and doubled again in Q9 to the final output range of 400 to 470 MHz. Q10 acts as a predriver amplifier.

The signal is further amplified by driver Q11 and pa Q12 to provide the 2 Watt output signal to the 50 ohm antenna. Spurious signal rejection is provided by double tuned circuits between multiplier stages and a low pass filter in the output of the pa stage.

The audio processor circuits consist of microphone amplifier Q1-Q2, peak limiter CR1-CR2, and active filter Q3. The audio input, at a level of about 30 mV p-p, is amplified and applied to the limiter circuit. R1 provides adjustment of the audio gain. Processed audio, limited in peak amplitude, contains a small amount of harmonic distortion from the clipping process.

Active filter Q3 is a low pass filter which greatly reduces the effects of any distortion from the limiter to prevent splatter of sidebands outside the bandwidth allowed for one channel. Deviation potentiometer R15 allows for adjustment of the peak audio level applied to the modulator stage. C11/R17 is an rf filter to keep the carrier signal at 12 MHz from getting back into the active filter stage. R16-C11 acts as an additional low pass filter. Together with the active filter stage, it provides an 18 dB/octave rolloff for any frequencies over 3000 Hz.

Dc power for the transmitter is applied at E1 when the unit is required to transmit. +13.6 Vdc is applied to all stages, except the oscillator, modulator, and audio stages. A 9.1 Vdc regulator provides power for those stages for stability of the carrier frequency under varying input voltages and for noise and hum filtering. Power supplied through R18 is regulated by zener diode VR1 and filtered by C18 to isolate the sensitive stages from the outside world.

ALIGNMENT.

Equipment needed for alignment is a sensitive dc voltmeter, a good 50 ohm rf dummy load, a relative output meter, and a regulated 13.6Vdc power supply with a 0-1000 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.

All variable capacitors should be set to the center of their range (turn them 90 degrees) if they have not previously been aligned.

NOTE: Following are some ground rules to help avoid trouble. Always adhere to these guidelines.

1. Do not operate without a 50 ohm load.

2. Do not exceed 2½ Watts output (650 mA total current drain) for continuous duty operation. Reduce the drive by detuning C51 slightly if necessary.

3. Always follow alignment procedure exactly. Do not repeak multiplier coils for maximum output. Each multiplier stage has its own best monitoring test point.

4. Rf power transistors Q11 and Q12 run quite warm at full drive, but not so hot that you can't touch the transistors without being burned. The transistors should be cold with crystal removed from socket.

a. Connect 50 ohm dummy load to phono jack J1 through some form of relative output meter.

b. Check output voltage of power supply, adjust it to 13.6 Vdc, and connect it to B+ terminal E1 and ground terminal E3 on the pc board. It is permissible to use the braid of the coax cable or the mounting hardware to the chassis as a ground if the power supply has a good low-impedance connection through this path to the ground on the board. *Be sure to observe polarity!*

A 1000 mA meter or suitable equivalent should be connected in the B+ line to monitor current drawn by the transmitter. This is important to indicate potential trouble before it can overheat transistors. Better yet, if using a lab supply for testing, set the current limiter on the power supply to limit at 700 mA.

c. Connect voltmeter to TP1 (top lead of

R31) in second tripler stage Q7. Peak L1 and L2 alternately for maximum indication. Typical reading is about +1.5 to 2.5Vdc.

d. Connect voltmeter to TP2 (top lead of R32) in doubler stage Q8. Peak L3 and L4 alternately for maximum indication. Typical reading is about +1.0 to 2.5 Vdc.

e. Connect voltmeter to TP3 (top lead of R34) in second doubler stage Q9. Peak L5 and L6 alternately for maximum indication. Typical reading is about +0.7 to 1.5 Vdc.

f. Alternately peak C43, C48, C51, and C52, in that order, for maximum current on the ammeter. (This assumes the unit has not been tuned before and that no useable rf output indication is available. If the unit has been tuned before, peak these controls for maximum rf output instead.)

g. At this point, you should have a small indication on the relative power meter. Alternately peak C56 and C57 for maximum indication on the power meter. Then, repeak C43, C48, C51, and C52 for maximum output. Note that there are interactions between C51 and C52 and between C56 and C57; so it may be necessary to try several combinations of each to find the optimum settings.

h. At full drive, the total current drawn by the transmitter should be 600-650 mA, and the rf output should be about 2¼ to 2¾ Watts (a little less at frequencies above 450 MHz or after the unit has been on some time and heated up considerably).

Do not operate at a level above 650 mA on a continuous basis, but up to 700 mA is OK on a 25% duty cycle. The drive level may be adjusted by detuning C51 slightly from its peak.

Note that full output may not be possible with less than 13.6 Vdc B+. Power output falls rapidly as operating voltage is reduced. This does not necessarily mean that the unit cannot be used on lower B+ voltage, however; since it is hard to distinguish even a 2:1 reduction in power on the air.

Good low-loss coax must be used at uhf frequencies, even for short runs. A 2-foot test lead of small coax can drop as much as 1/2 Watt from a 2 Watt signal.

After tuning the transmitter into a known good 50 ohm dummy load, it should not be retuned when later connected to the antenna or power amplifier. Of course, the antenna or pa should present a good 50 ohm load to the exciter.

h. Perform the carrier frequency and audio level adjustments given on page 1 to complete the alignment of the transmitter.

TROUBLESHOOTING.

The usual troubleshooting techniques of checking dc voltages and signal tracing with an rf voltmeter probe will work well in troubleshooting the TA451. 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 transmitter should draw about 40 mA at idle, with the crystal pulled out, and about 600-650 mA at full output.

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 indicating 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 crystal plugged in and oscillating and transmitter fully tuned to provide 2W output.

Note that meter probe must have 1 megohm or similar resistor in probe to isolate from rf signals. Even then, the type of meter and probe has an effect on the readings taken on points where rf is present. Voltages in [brackets] are measurements taken with the crystal pulled, no rf.

TYPICAL DC VOLTAGES:

STAGE	E	B	C
Q1	0.04	0.7	1.4
Q2	0.75	1.4	4.5
CR1,C	(A)	(C) 0.6	
R2	1.1		
Q3	4.2	5.0	9.1
Q4	3 [2]	2 [2.8]	8.2
Q5	3 [2.8]	3.5 [3.5]	5.8
Q6	1.8 [1.5]	2.1 [2]	13.6
Q7	2.0 [0]	0	13.6
Q8	2.0 [0]	0	13.6
Q9	1.0 [0]	-0.3 [0]	13.6
Q10	0	0.25 [.75]	13.6
Q11	0	0	13.6
Q12	0	0	13.6

TYPICAL AUDIO VOLTAGES.

Following are rough measurements of audio voltages (in mV rms) which may be measured with a sensitive voltmeter or an oscilloscope when a low impedance dynamic microphone or other audio source is connected and modulating to full 5 kHz deviation. Measurements given were taken with a scope with mic gain and deviation controls fully cw and sufficient audio input applied for full deviation of the rf signal. Measurements are typical of what might be indicated during a sustained whistle or with an audio signal generator. Of course, readings may vary widely with setup; but levels given are useful as a general guide.

TYPICAL AUDIO VOLTAGES (mV RMS):

Mic Input 30

STAGE	E	B	C
Q1	0.5	1	10
Q2	0	10	700
Q3	500	500	-
Q5	-	30	-

PARTS LIST, TA451 UHF FM TRANSMITTER

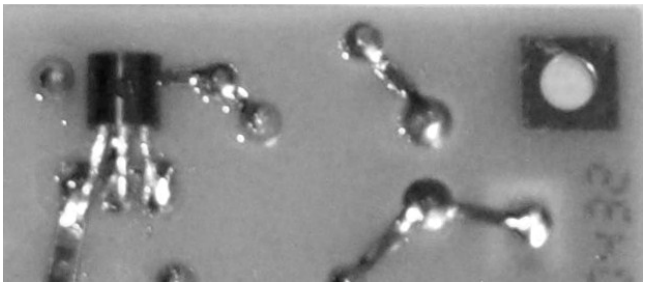
Notes:

* R6 consists of two resistors joined and tack soldered at top.

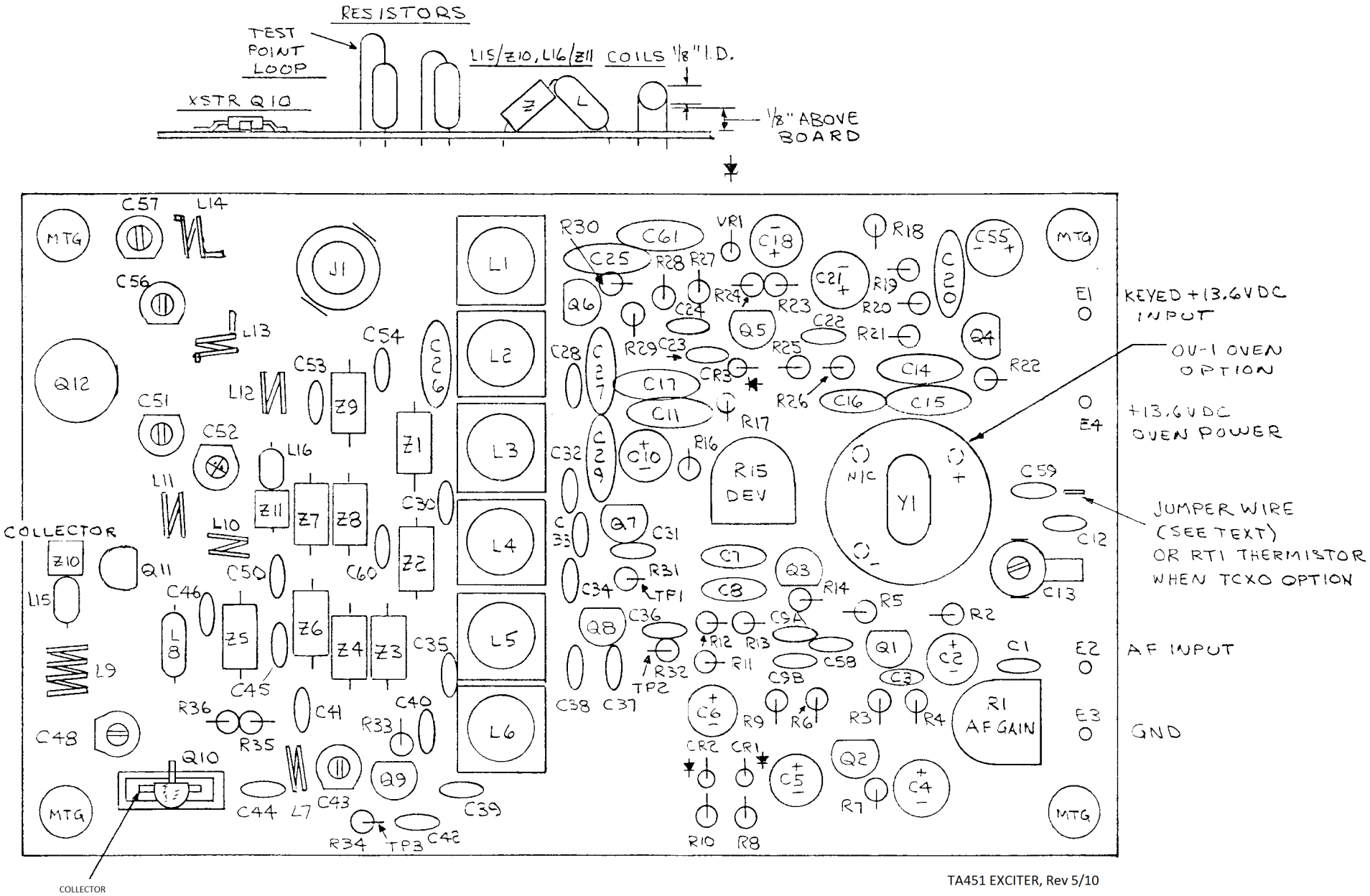
** Note: 0.5pf disc cap is no longer available. Carefully tack solder surface mount capacitor on bottom of board. Hold it carefully with tweezers to avoid dropping it.

*** Due to parts shortage, C27 and C29 consist of two caps in parallel, with one installed on top of board and one tack soldered under board.

Ref #	Value (marking)
C1	30pf
C2	1 uf electrolytic
C3	220 pF(221)
C4	10 uF electrolytic
C5	1 uf electrolytic
C6	1 uf electrolytic
C7-C8	.0047 uf (472)
C9A	.0022 uf (2.2nK or 2n2K)
C9B	not used
C10	1 uf electrolytic
C11	.01 uf disc (103)
C12	39 pf
C13	10 pf piston var cap
C14-C15	150pf (151)
C16	47 pf
C17	150pf (151)
C18	4.7 uF electrolytic
C19	not used
C20	.01 uf disc (103)
C21	10 uF electrolytic
C22	.001 uf (102)
C23	220 pf (221)
C24-C25	.001 uf (102)
C26	.0022 uf (2.2nK or 2n2K)
C27	2 x 56pf ***
C28	2 pf
C29	2 x 56pf ***
C30	.001 uf (102)
C31	100 pf
C32	30 pf
C33**	0.5 pf chip cap
C34	30 pf
C35-C36	100 pf
C37	4 pf
C38**	0.5 pf chip cap
C39	7 pf
C40	18 pf
C41	30 pf
C42	100 pf
C43	4.5 pf var. (white ceramic with brown cap.)
C44	2 pf
C45	100 pf
C46	30 pf
C47	not used
C48	4.5 pf var. (white ceramic with brown cap.)
C49	not used
C50	30 pf
C51	4.5 pf var. (white ceramic with brown cap.)
C52	11 pf var. (white plastic)
C53-C54	30 pf
C55	10 uF electrolytic
C56-C57	11 pf var. (white plastic)
C58	30 pf
C59	not used
C60	.001 uf (102)
C61	.01 uf disc (103)
CR1-CR3	1N4148
J1	RCA Jack
L1-L2	6-1/2 turns (blue)
L3-L6	2-1/2 turns (red)
L7	Air wound (see text)
L8	0.33 uH rf choke (red-sil-orn-orn)
L9-L14	Air wound (see text)
L15, L16	0.33 uH rf choke (red-sil-orn-orn)
Q1-Q3	2N3904
Q4-Q8	2N5770
Q9	PN5179
Q10	PN5179
Q11	2 each MPS5179 (see detail)
Q12	APT MS1649
R1	1K pot (102)
R2	100k
R3	150k
R4	180 ohms
R5	47K
R6 *	6.8K in series with 1K
R7	1k
R8	4.7k
R9	47k
R10	4.7k
R11-R13	10k
R14	330k
R15	1k pot (102)
R16-R17	10k
R18	180 ohms
R19	100 ohms
R20	10k
R21	4.7k
R22	680 ohms
R23	15k
R24	10k
R25	470 ohms
R26-R27	2.2k
R28	27k
R29	4.7k
R30-R32	270 ohms
R33	1k
R34	100 ohms
R35	22k
R36	1k
RT1	Thermistor (tcxo option only; otherwise jumper)
VR1	1N5239B Zener Diode 9.1V
Y1	Channel crystal
Z1-Z11	Ferrite Beads



Q11 consists of two MPS5179 to get more drive. Install one on top of the board as normal. Tack solder the second under the board in parallel, with the flat side toward the board as shown above. **Caution: MPS5179 is different from PN5179, which also is used in this unit. They have different pinouts.**



TA451 EXCITER, Rev 5/10