HAMTRONICS® VHF RECEIVING CONVERTERS CONSTRUCTION, ALIGNMENT, & INSTALLATION INSTRUCTIONS

GENERAL DESCRIPTION.

The CA( ) series of VHF Receiving Converter modules are designed to amplify and convert the frequency of vhf signals in specific bands to 28-30 MHz.

The input and output connectors are BNC type when the unit is supplied in a case and RCA type when the unit is supplied without a case.

The Converter is used to convert vhf frequencies in a block down to 28-30 MHz so they can be heard on a 10 meter receiver.

CONSTRUCTION.

Refer to schematic and component location diagrams during assembly and the list of frequency-sensitive parts for your particular model. Note that there are variations depending on the use and packaging of the module. The correct parts have been supplied for your particular model to avoid confusion.

General Construction Notes.

Proper polarity must be observed on diodes and electrolytic capacitors. The banded end of a diode is the cathode. This corresponds to the bar on the diode schematic symbol used on component location diagram.

Resistors and diodes installed vertically on a pc board are shown on component location diagrams as a circle, denoting the position of the body of the component, with a line representing the top lead going over to the other pc board hole.

Capacitors may be marked in pf with two significant figures and a multiplier, much as resistors are marked. For instance, a 220 pf capacitor may be marked "221", a .001 uf capacitor may be marked "102" (1000 pf) or it may be marked 1nK (for 1 nano-farad with 10% "K" tolerance), and a .01 uf capacitor may be marked "103" (10,000 pf).

A tuning tool of the proper type must be used to avoid cracking the slugs in the coils. This is a .060" square slot type tool. (See "A28 Tuning Tool" in catalog.) The slugs are teflon coated; so they turn easily. However, if a loosely fitting tool or a tool only partially inserted in the slot is allowed to slip in the slot, the sideways force cracks the powdered iron slug. Should this happen, the slug must be drilled out and replaced.

Assembly Procedure.

a. Install RCA jacks J1 and J2 on pc board except when optional cabinet is used. Be sure to solder all tabs. If the connector has only one tab on the center conductor, position the connector with that tab closest to the circuit side of the hole in the board. Note that the CA120-10.7 does not use J2 because the output is tied directly to an adjacent IF board.

b. Install all resistors on top of the board. R5 and R6 usually are not used. Leave small loop at top of R14 to used as test point. If you are building the 50 MHz version of the converter, please read notes on parts list pages for discussion of parts not used on that model.

c. Install transistors and zener diode, being careful to observe proper orientation. Be sure to keep lettering (not color bars) up on Q1, and bend the leads at a 90° angle to fit the board. Components are not especially heat sensitive, but Q1 and Q2 are static sensitive; so precautions should be taken, including using a soldering iron with a grounded tip.

d. Refer to parts list for capacitor values for your particular model, and install them. The size and shape of capacitors may vary with frequency. For example, C6, C8, and C24 may be disc type capacitors instead of tubular type illustrated. It may be necessary to form the leads of capacitors to fit the hole spacing of the board.

C26 must be tack soldered under the board with very short leads as direct as possible from the gate-2 lead of Q1 to ground along the ***front*** edge of the board. Its purpose is to provide a good bypass at 900 MHz to keep the transistor stable; so short leads are a must. The body of the capacitor should hang straight down below the board, not laid over flat against the pc board traces to avoid coupling to other circuits.

When the module is to be used in optional cabinet, C1, C27, C13, and C14 are connected between the pc board and the BNC jacks. Connect one lead of each to the pc board as shown. The other end will be connected later, using shortest and most direct routing.

e. Install variable capacitor C15 on the top of the board as shown. After soldering, tack solder C28 across the leads of C15 under the board, using shortest possible leads.

f. Install crystal Y1. Insert leads through board and solder, using care not to apply excessive heat. Normal soldering heat is OK, but avoid "cooking" the crystal by heating pads for excessive periods of time.

g. Install ferrite bead Z1 as you would a resistor. It is supplied prestrung on a piece of bus wire.

h. Coil L5 is no longer used. Install a jumper wire on the top of the board in place of L5, using #22 bus wire from a discarded component lead clipping. Keep the jumper as short as possible. No shield is used.

i. Install slug tuned coils as shown, and install coil shields. The 2-1/2 turn (red) coils come with shields already on the coils; however, in some cases, the shield must be removed and rotated 90° in order to fit holes in pc board. Other coils have shields supplied separately.

Be sure L4 is oriented as shown; the board is designed to accommodate several types of coils.

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.) Note that some coils are slightly taller than others; so some coil shield lugs may just barely go

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through the board. Hold those in place carefully while soldering to make sure solder bonds to the ground lugs and that the shield remains tight against the board.

Install tuning slugs in any coils which do not already have them.

j. Install R15 under the board as shown. Tack solder it with very short leads directly across leads of coil L2.

k. Install any remaining parts, and check over all parts carefully. If any parts are left over, be sure they don't belong somewhere. Check solder connections.

CASE ASSEMBLY.

If the converter was purchased with optional case, perform these additional steps.

a. Set lower half of case on bench oriented as shown.

b. Fasten one angle nut to hole half way back on each side, between the two pc board mtg holes shown in diagram. (See detail.) Insert 4-40 x 1/4" screw from bottom of case; then install angle nut from top of case. The leg with the longer dimension from the bend to the hole goes over the screw, leaving the side with the shorter dimension for the cover screws to engage. Before tightening the screws, carefully align the angle nuts flush with the edge of the chassis.

c. Install pc board in case as shown, using four threaded standoffs with 4-40 x 1/4 inch screws to secure the standoffs to the case and four more screws to fasten the board to the standoffs.

d. Install the two BNC jacks as shown. Put connector through hole, and align "D" shaped shoulder with hole. Then, secure with mating nut. (Note: solder lugs may be supplied with case kit, but they are not used on vhf converters.)

e. Install feedthrough cap from front of case, and secure with mating nut and lockwasher.

f. Tack solder leads of C1, C27, C13, and C14 to respective BNC connector center conductors, using shortest and most direct routing.

g. Solder length of #22 hookup wire from pad E1 on the board to the B+ feedthrough terminal on the front panel, routing neatly as shown. Keep wire away from C13 and C14, and route it such that it won't get damaged by the screw installed later to fasten the cover to the angle nut.

h. Remove backing paper from the rubber feet, and stick one in each corner on the bottom of the case about 1/2 inch in each way.

i. This completes assembly. After alignment, slide top cover over case, and secure with one 4-40 x 1/4 inch screw in each side.

CRYSTALS.

The converter has recently been redesigned so it can use either the traditional third overtone crystals or fundamental crystals. Your unit may be supplied with either type, depending on which type was available when shipped.

Both are supplied in either HC-49/u holder (solid pins) or HC-50/u (wire leads). Either type is soldered to the board, using care not to apply excessive heat. Normal soldering heat is OK, but avoid "cooking" the crystal by heating pads for excessive periods of time.

We can provide either standard or special frequency crytals for the converter. If you order a special crystal, you may wish to use a fundamental crystal rather than overtone because they generally cost a little less at most crystal labs. They also provide a little more trimming range. You may also want to specify HC-50/u holder, which has the wire leads that are a little easier to solder.

If you use **third overtone** crystals, specify **series resonance** for the crystal. The standard crystal frequency, and the formula should you want to order a crystal for a special application, is as follows.

Model	Crystal	Formula
CA137-28	36.000	X = (RF-IF)/3
CA144-28	38.667	X = (RF-IF)/3
CA145-28	39.000	X = (RF-IF)/3
CA146-28	39.333	X = (RF-IF)/3

If you use **fundamental** crystals, specify **parallel resonance with 30 pf load** capacitance, and use the following table instead.

Model	Crystal	Formula
CA50-28	22.000	X = RF-IF
CA137-28	12.000	X = (RF-IF)/9
CA144-28	12.889	X = (RF-IF)/9
CA145-28	13.000	X = (RF-IF)/9
CA146-28	13.111	X = (RF-IF)/9

For purposes of determining crystal frequency on a broadband block converter (any other than 10.7 IF), substitute the frequency of the low end of the band of interest. I.e., the lowest frequency in the input band is "RF" and the lowest output frequency is "IF". For example, for the CA144-28, 144 MHz is the bottom end of the input band and this is translated to 28 MHz in the output band; so those frequencies are used for the formula.

Hamtronics stocks crystals for the popular frequency schemes (listed above), and we will be glad to order any special crystals.

MOUNTING AND INTERCONNECTIONS.

If the unit was not ordered with optional case, the pc board is easily mounted to a chassis or panel with 4-40 screws and threaded standoffs using the holes provided in the four corners. A mounting kit is available (see rear of catalog).

The i-f output should be connected to the antenna input of the hf receiver.

+13.6Vdc should be connected to power pad E1.

ALIGNMENT AND TESTING.

The most difficult part of alignment is obtaining a stable test signal. If you don't have access to a vhf signal generator, it is possible to use a strong signal on the air.

➠ A tuning tool of the proper type must be used to avoid cracking the slugs in the coils. This is a .060" square slot type tool. The slugs are teflon coated; so they turn easily. However, if a loosely fitting tool or a tool only partially inserted in the slot is allowed to slip in the slot, the sideways force cracks the powdered iron slug. Should this happen, the slug must be drilled out and replaced. Variable capacitor C15 is adjusted with an insulated tool with a small metal (slot type) bit in the end. (See A2 and A28 Tuning Tools in catalog.)

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a. Connect a source of +13.6Vdc to E1.

b. Adjust slugs in all coils to the center of their tuning ranges (half inserted in windings). If you just finished building a kit, turn rotor on variable capacitor C15 90° either way to center it.

c. Connect signal source to J1, and connect J2 to receiver used as an i-f.

d. Connect dc voltmeter to TP1.

e. Adjust oscillator coil L6 for a peak (about 1 to 2 Vdc). Note that oscillation may stop when tuning far off peak on either side.

Note that a special procedure is used for oscillator adjustment for the six meter converter. See notes at end of parts list.

f. With a moderately strong signal applied to the converter, tune in the signal on the receiver.

g. Alternately adjust multiplier coils L7 & L8, rf coils L1, L2, and L3, and IF coil L4 for maximum response. Repeat adjustment to work out any interactions between coils. Reduce input signal to a fairly low level for final adjustment. There may be some benefit to readjusting input coil L1 slightly for best noise figure, which you can do by ear by tuning for best quieting on a weak signal.

Note: In rare cases, a spurious oscillation may occur if the oscillator or multiplier stages are mistuned. When the unit is properly tuned, oscillation will stop. Also note that it is ok for tuning slugs to extend above the top of the coils, provided they are not too loose.

h. If a frequency counter is available, connect it to TP1 and adjust variable capacitor C15 for proper oscillator frequency. If counter is not available or if preferred, adjust C15 for "on channel" reception.

Note: If crystal cannot quite be adjusted to frequency, C28 can be changed to a slightly higher or lower value to extend the pulling range of C15.

The final sensitivity of the converter should be about 0.1 to 0.2 uV after tuning, assuming an i-f receiver of good sensitivity is used with the converter.

OPERATION.

Operation is so simple, it is hardly necessary to describe it. However, some explanation of the way broadband converters operate may be helpful to you if you have not used one before.

The converter operates by heterodyning (mixing) an entire block of frequencies down to a new band of frequencies which your receiver is already capable of hearing. It does this by mixing an oscillator/multiplier signal with the incoming signals to produce the sum or difference of the two frequencies.

Thus, all the frequencies in the incoming band are converted to new frequencies a set value away from the original frequencies. All the frequencies still have the same relationship to each other in the new spectrum.

As an example, use the CA144-28 Converter frequency scheme. To listen to 144.000 MHz, you would tune your receiver to 28.000 MHz. To hear 144.100 MHz, tune to 28.100; to hear 144.105, tune to 28.105, etc.

TROUBLESHOOTING.

If some coils do not peak within the range of slug adjustment, as may happen if the converter is modified for use on a different frequency range, an adjustment in the value of the capacitor in the tuned circuit may be necessary. However, be careful not to tune to an image frequency or tune the multiplier to the wrong multiple of the oscillator frequency. If the slug is fully inserted in the winding, more capacitance is required. If the slug is all the way out of the coil, less capacitance is required. The value should be changed by only about 5% at a time, since that is about the tuning range of the coil.

The usual troubleshooting techniques of checking dc voltages at transistor elements and tracing oscillator injection signals with an rf probe and voltmeter are appropriate for this converter. A dc voltage chart is given to indicate typical voltages measured on a good converter; although voltages may vary widely from unit to unit without necessarily indicating a problem. Also, measurements taken at points with rf applied will depend on the type of meter used and how it reacts to rf.

Current drain is typically about 30mA; this is a very good indication of any problems on the B+ line.

If no voltage is measured at TP1, the emitter of the multiplier stage, that is an indication that the rf level from the oscillator is too low to drive the base of the transistor into conduction.

Probably the most common trouble, based on our experience, is the interchange of components, bad solder joints, and solder splashes. The next most common trouble is blown transistors due to reverse polarity or transients on the B+ line. Any relay coils connected across the B+ line should have a reverse diode connected directly across the relay coil to absorb the reverse transient produced when the relay is unkeyed.

Remember, if you encounter any difficulties in initial test, 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.

Typical Dc Voltages.

Following are positive dc voltages with respect to ground, measured with an fet voltmeter on a sample unit operating on 13.6Vdc. While readings can vary widely without necessarily indicating trouble, these readings can be used in conjunction with an organized troubleshooting plan to help isolate the trouble.

XSTR	E(S)	B(G1)	G2	C(D)
Q1	0.5	0	6	12
Q2	3	0	-	13.6
Q3	2.5	3	-	9.1
Q3*	2.3	3	-	9.1
Q4	1.3	0	-	13.6
Q4*	0	0	-	13.6

* Crystal pulled out or oscillator signal otherwise absent.

PARTS LIST FOR COMPONENTS COMMON TO ALL MODELS.

(See next page for values which vary with frequency range.)

Ref Desig Value (marking)

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C12	4.7 µf electrolytic	Q2	2N5486	R11	470Ω

PARTS LIST FOR FREQUENCY-DEPENDENT COMPONENTS.

MODEL ⇒	**CA50-28**	**CA137-28**	**CA144-28 CA145-28 CA146-28**
INPUT RANGE (MHz) ⇒	50-52	136-138	144-146 or 145-147 or 146-148
OUTPUT ⇒	28-30	28-30	28-30
REF DESIG. ⇓	(Note 1)		
C1	15	22	18
C2-C4	.001uf (note 2)	220	220
C5	39	2	1
C6	1	0.5	0.5
C7	39	18	15
C8	2	0.5	0.5
C9	.001uf (note 2)	.001uf (note 2)	.001uf (note 2)
C10	.0047 uf	.001uf (note 2)	.001uf (note 2)
C11	.001uf (note 2)	220	220
C13	62	62	62
C14	220	220	220
C18	.01 uf	.001uf (note 2)	.001uf (note 2)
C20	150	110	110
C21	not used	220	220
C22	.01 uf	220	220
C23	not used	10	8
C24	jumper	0.5	0.5
C25	not used	39	33
C27	220	62	62
L1	11-1/2T brn	2-1/2T red	2-1/2T red
L2	8-1/2S gry	6-1/2T blu	6-1/2T blu
L3	8-1/2S gry	2-1/2T red	2-1/2T red
L4	14-1/2T yel	14-1/2T yel	14-1/2T yel
L5	jumper	jumper	jumper
L6	10-1/2T blk	6-1/2T blu	6-1/2T blu
L7	not used	6-1/2T blu	6-1/2T blu
L8	not used	2-1/2T red	2-1/2T red

(See prior page for values common to all models.)

C15	30 pf variable capacitor (green)	Q3, Q4	2N3904	R12	270Ω
C16-C17	150 pf (151)	R1, R2	100K	R13	3.3K
C19	.001 µf	R3	180Ω	R14	180Ω
C26	10 pf (under board)	R4	470Ω	R15	1.2K (under board)
C28	33 pf (under board)	R5, R6	*not used*	Y1	Crystal *(see chart on p.2)*
J1, J2	See "Construction" text	R7	2.2K	Z1	Ferrite bead
L1-L8	*(see next page)*	R8	270Ω		
Q1	3SK122	R9	10K		
		R10	22K		

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NOTES:

1. For model CA50-28, the multiplier stage is not used. Therefore, the following changes are made in pc board wiring for this model only:

   These parts are not used on this model: R13, Q4, C21, R14, L7, C23, C24, C25, and L8.

   A jumper should be installed in place of Q4 base-collector. A second jumper should be installed in place of C24. This effectively connects the junction of L6/C20 to C8. When wiring is finished, check the circuit on the pc board to assure yourself that there is a complete circuit bypassing the usual multiplier stage.

   A 10K resistor (R16) should be soldered to the pad normally used for the hot lead of L8. The resistor should stand up on the pc board vertically, and the top lead should be trimmed to 1/8 inch to be used as a test point.

   To peak oscillator coil L6, it is necessary to use an rf probe and voltmeter or an oscilloscope. Connect probe to the top of test point resistor R16, and peak L6 as otherwise stated in step (e.) of alignment instructions.

2. .001µF capacitor may be marked "102", "1nM", or "1nK".

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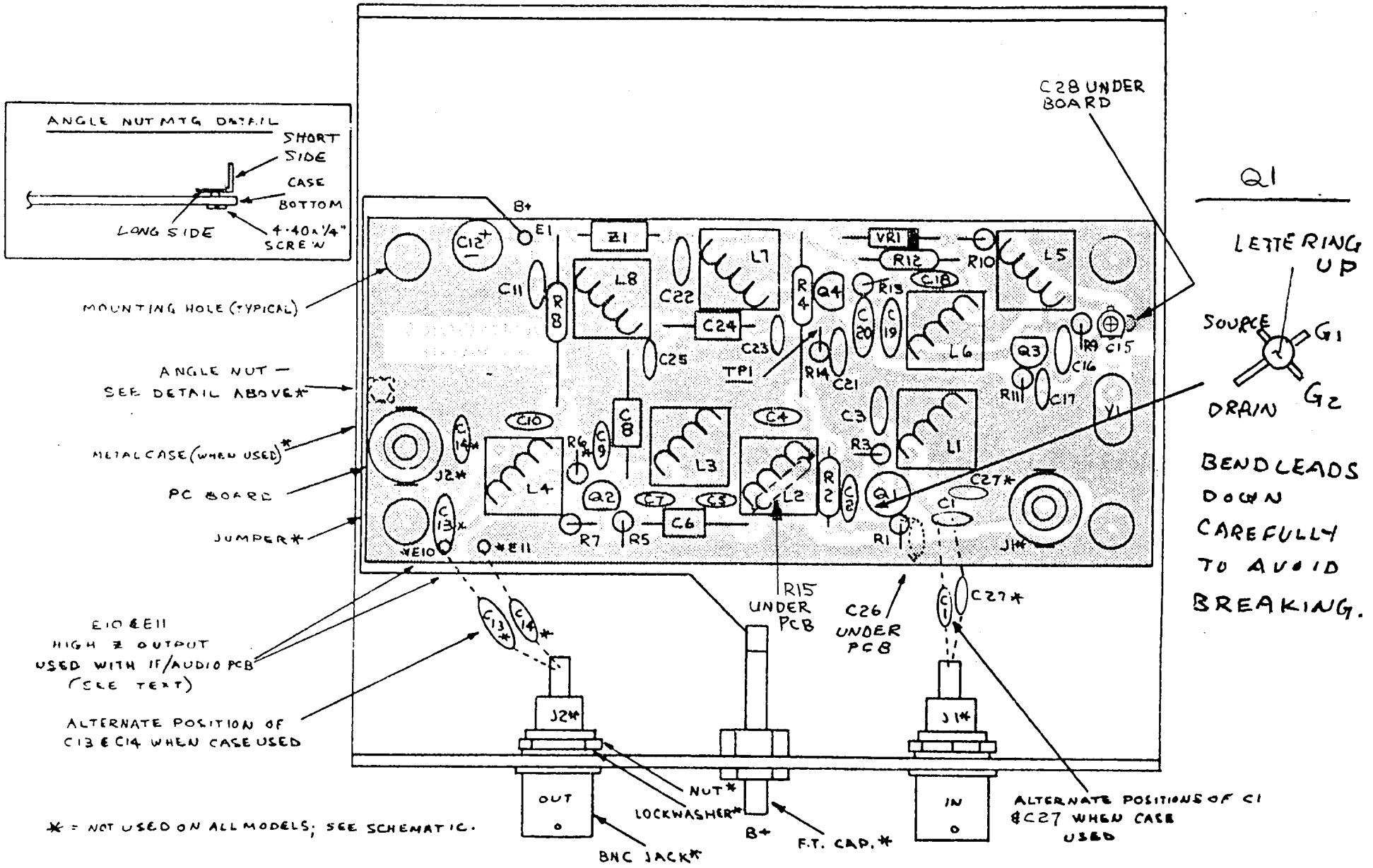

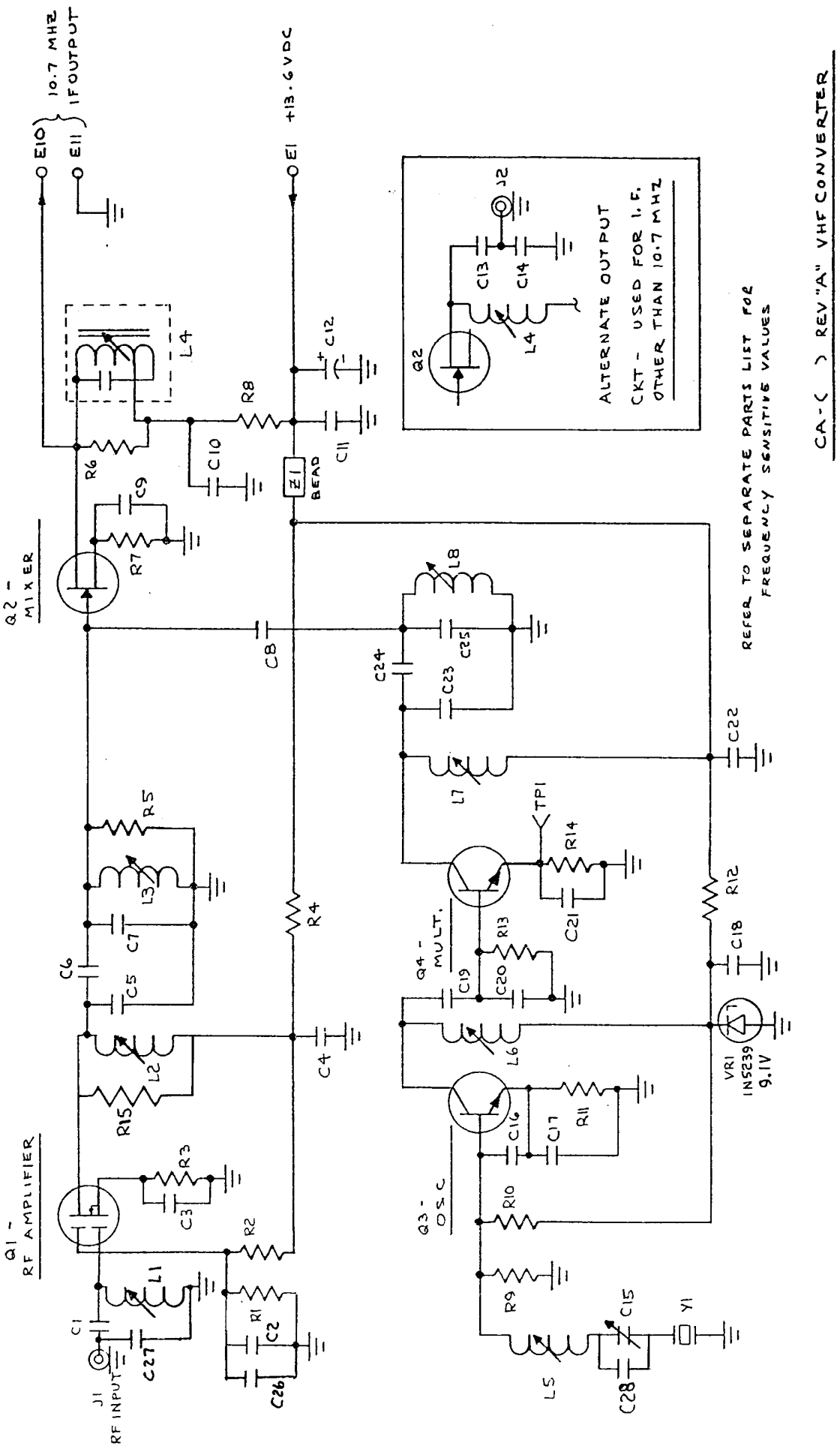

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