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10/99

# OPERATION AND MAINTENANCE MANUAL
# KACHINA MODEL KC-ATU
# AUTOMATIC ANTENNA TUNER

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# CHAPTER 1 - GENERAL INFORMATION

## 1-1 OVERALL DESCRIPTION

The Kachina KC-ATU is a fully automatic antenna tuner, designed for a wide range of applications. This product features an advanced microprocessor based tuning algorithm which allows this antenna tuner to tune up on normal voice signals from the transmitter, and also contains a *learning* algorithm which allows the control computer to remember which network constants are required for a given operating frequency. This feature permits the antenna tuner, once the *learning* operation is completed, to retune a given frequency in approximately 20 milliseconds. This is less than the time required to say *hello.* The tuner operation is completely automatic and requires no operator intervention. If the antenna system is altered or replaced, the tuner will automatically *relearn* the required constants. During the learning period, operation is somewhat slower and, depending on the particular frequency/antenna combination, up to 5 seconds may be required to achieve a matched condition. Once the antenna is properly matched, the tuner signals this condition by pulling a control line low. This control signal may be used to operate an *all tuned* indicator of some kind at the operators' T-R position.

The Kachina KC-ATU also includes a DEMAND TUNE function and a TUNE LOCKOUT capability.

The DEMAND TUNE function allows the user to force the antenna tuner to retune on demand. This permits *overwriting* previously stored tuneup information when desired.

The TUNE LOCKOUT feature is useful when two or more transmitters are co-located, or when it is desirable to inhibit the auto tune function for any reason. EXAMPLE: When two antennas are in close proximity, it is possible that transmitting on one antenna may cause considerable RF to be coupled into the adjacent antenna. This can cause the tuner to reset, disturbing the operation of the radiotelephone. In such cases, the TUNE LOCKOUT feature can be used to prevent the KC-ATU from entering the tune mode until the radiotelephone transceiver it is associated with is actually transmitting.

## 1-2 ELECTRICAL CONFIGURATION

The tuner matches the antenna by selecting the proper network from a possible combination of 64 values of input capacitance (input C), 32 values of output capacitance (output C) and 256 values of series inductance (L). Network configuration is automatically determined during the tune cycle and may be either a Pi network or either of two type of L networks selected for maximum efficiency. Tuneup is entirely automatic and is accomplished on voice signals, making it unnecessary to provide a *low power tune* mode in the transmitter. The use of a -20 dB coupler in the VSWR sensors allows the error detectors to function down to power levels of 5 to 10 watts. This allows the use of radio equipment which has *high VSWR shutdown* circuitry.

## 1-3 MECHANICAL CONFIGURATION

All of the circuitry of the Kachina KC-ATU is contained on one printed circuit board. This printed circuit board is mounted on an aluminum shield plate with six 6/32 stainless steel screws. The shield plate is held in the waterproof housing with four 10/24 stainless steel screws.

The printed circuit board is solder masked which helps to prevent corrosion and moisture problems. Both the SO-239 R.F. connector and the six terminal interface connector strip are mounted on the printed circuit board itself. This interface connector accepts wire ends directly, eliminating any requirement for special lugs or lugging tools however, a PL-259 type R.F. plug must be fitted to the coaxial feed line.

## 1-4 WEATHER HOUSING

The Kachina KC-ATU antenna tuner is housed in a weatherproof fiberglass case designed to withstand the environmental conditions encountered when mounted in an open vehicle or on the weather decks of ships. The internal construction is designed to withstand the shock and vibration of commercial or marine service. Corrosion-resistant hardware and passivated alloys are employed throughout.

Stuffing glands for the RF and DC cables are provided on the lower edge of the weather housing, along with a 1/4-20 stainless steel ground stud. The antenna connects to a terminal located on the top of the weather housing.

## 1-5 SPECIFICATIONS

| | |
|---|---|
| **Frequency Range:** | 1.6 to 30.0 MHz |
| **RF Power Capability:** | 150 watts peak envelope power (PEP) |
| **Input Impedance:** | 50 ohms |
| **VSWR:** | <2:1 |
| **Power Requirements:** | 13.6 VDC negative ground |
| **Operating Currents:** | 2 Amps max. |
| **Tuning time:** | Learn Mode, typically less than 5 seconds<br>Educated Mode approximately 20 milliseconds |
| **Useable Antenna Length:** | 23-75 feet (7-23 meters) 2-25 MHz<br>9 Foot (2.7 meter) whip 3.5-30 MHz |
| **Mounting:** | Any position |
| **Environmental Temp. Range:** | -30 C to +60 C |
| **Size:** | 15 in. X 12 in. X 5.5 in. (381 mm x 304.8 mm x 99mm) |
| **Weight:** | 10 Lbs./4.5 kgs. |
| **Case Construction:** | Weatherproof fiberglass |
| **Control Cable:** | No. 18 Gauge, 2 conductor, shielded<br>(3 to 5 conductor for tune indication, DEMAND TUNE and TUNE LOCKOUT options) |

# CHAPTER 2 - PRINCIPLE OF OPERATION

## 2-1 NETWORKS

Figure 1 shows the schematic diagram for the two basic network configurations. Note that the L network as viewed from the generator may be configured as either C in or C out, whichever is required by the load. In either case, the end of the network containing the shunt C element will be the *higher* impedance end of the network.

## 2-2 SCHEMATIC DIAGRAMS

Figure 2 is the schematic diagram of the antenna tuner. RF input is applied to UHF fitting J1, 13.6 VDC is connected to the terminals marked GND and + on P1 (pins 1 and 2 respectively), and an appropriate antenna and ground system are connected to feedthrough insulator and stainless steel stud respectively. The TND flag line (pin 4 on P1) is connected to the remote indicator device if used.

## 2-3 AUTO TUNE OPERATION

When RF power is applied to the Kachina KC-ATU it is first passed through an array of detectors which determine the frequency, load VSWR and the reactance sign. Forward power is continuously monitored, since the control computer requires an indication of both forward and reflected power in order to allow tuning to proceed. In practice, the forward power detector is used by the computer as a truth check to insure that the measurements made are indeed a result of applied RF and not spurious levels from the data conversion system. Tuneup will *only* proceed when sufficient forward power is present to provide this truth check. After passing through the detector system, the RF is applied to the tuner array. This consists of 6 capacitors in shunt on the input arm of the network, arranged in binary increments, 9 inductors in the series arm, arranged in binary increments, and 5 more capacitors in shunt on the output arm, also arranged in binary increments. Relays are provided in conjunction with each lumped constant which allow removal or entry as desired. Thus, it is possible through the manipulation of 26 relays to build a network having 64 values of input shunt C, 32 values of output shunt C, and up to 512 values of series L.

## 2-4 VSWR DETECTOR

Current transformer Tl and voltage transformer T2, in conjunction with termination resistors Rl and R5 make up a dual directional coupler. This directional coupler is inserted in the 50 ohm transmission line between the input connector, Jl, and the tuning network. A sample of *forward* power appears across termination Rl, while a sample of *reflected* power appears across termination R5. The *forward* and *reflected* power RF samples from the directional coupler are detected by diodes CR1 and CR3. R/C filter networks are provided on both the *forward* power and *reflected* power signals and both are clamped to the +5 Volt rail through diodes CR2 and CR4 to prevent overdriving the A/D converter inputs of CPU chip, U5.

With voltages representing both *forward* and *reflected* power available to the CPU, it is possible to compute the VSWR continuously during the tuning process.

## 2-5 FREQUENCY COUNTER

The memory storage system in the Kachina KC-ATU is based on the fact that the control computer senses what frequency is in use. This is accomplished by applying a prescaled sample of the RF signal to the the CPU timer input. The prescaler consists of UlA, U2 and U3. A sample of the RF signal is applied through a biased clamping network consisting of CR9, CR10, R17, R18, R19 and R20, to the input of CMOS schmitt trigger UlA. The shaped output signal is then divided by 2048 through cascaded counters U2 and U3.

The output from the counter train also serves as an interrupt generator for the CPU, acting as an *RF present* indicator.

## 2-6 PHASE DETECTOR

T3, CR5, 6, 7 and 8 and the associated components form a phase detector which indicates the sign of any reactance associated with the antenna tuner system as seen from the generator. Operationally, a line current sample is compared in phase with a voltage sample in a double balanced diode ring. Output polarity is *negative* for a net *capacitive* reactance. The output of the phase detector is connected to an A/D input on the system CPU chip.

## 2-7 THE CONTROL COMPUTER

Actual antenna matching is implemented through a tuneup algorithm contained in the memory provided in the controller-computer system. The computer itself is designed around the HCMOS 68HC705P9P single chip CPU. This device was chosen for it's versatile instruction set and on-chip ROM, RAM and A/D converter. Control of the antenna tuner relays is done through U8, U9 and U10, together with relay drivers Ull, U12 and U13. U8, U9 and U10 form a serial to parallel interface port. *Clock* and *data* signals are provided from CPU ports PB7 and PB5, respectively. In operation, data is transferred into the CPU under program control from the array of sensors. Essentially, the program monitors the status of the input sensors and starting from a preset condition, manipulates the RF elements through it's control algorithm to achieve a correctly tuned condition. At the completion of the tuning algorithm, the computer generates a table in non-volatile memory which correlates the status of the various network relays with the applied RF frequency. This table is stored in EEPROM U4 and is used to provide the *learning* feature in the Kachina KC-ATU. After storing and latching the network status, the CPU returns to the *stop* mode and waits for another *TUNE REQUEST* condition.

## 2-8 INITIALIZATION AND FIREUP

Since any microcomputer generates RF noise while running, U5 is normally held in the *stop* mode and requires an interrupt signal to start program implementation. The CPU IRQ signal consists of a logic *low* signal on pin 2 of U5 and may be derived from any of several sources.

1. The output from the frequency counter chain (U2, U3) is AC coupled to the gate of MOSFET amplifier Q2. The drain of Q2 is connected to pin 2 of U5. Thus, whenever the frequency counter is generating an output, an interrupt signal is present on the CPU IRQ pin.

2. The DEMAND TUNE input (p1, pin 3) is connected through a pair of cascaded inverters U1C and U1B and steering diode CR12 to the CPU IRQ pin. The inverters are biased in such a manner as to cause the output of U1B to remain *high* unless the DEMAND TUNE line is grounded. When the DEMAND TUNE input is grounded, U1B will pull the CPU IRQ pin low through CR12, generating an input signal.

3. Beginning with PC board revision C, an additional IRQ option has been added. It is possible to generate and interrupt via the PTT input line (p1, pin 5). The output of PTT inverter U1F can be diode ORed into the input of U1B by putting a shorting bar on the pins of JU4. With JU4 thus jumpered, an interrupt signal is generated whenever the PTT input line goes low. Note that if this option is selected, the PTT line must be connected to the system radiotelephone transceiver in order to sense the *key up* voltage on the transceiver PTT line. It is this open circuit voltage which prevents U1F from generating a continuous interrupt signal.

## 2-9 INFORMATION READ

The data sensors (previously described) are interfaced with the CPU through the A/D input ports, PC3, PC4 and PC5. Once the tune algorithm is running (following an interrupt request as outlined above and lacking any applicable prestored data) the program can access any desired variable by merely *looking* at the desired input port.

## 2-10 INFORMATION WRITE

When the CPU requires a change in the lumped RF tuner parameters, it writes the desired data into the series to parallel buffer. This is done by outputting the desired status of the network relays in a serial data stream from PB5 (SDO) on the CPU. Clocking is derived from PB7 (SCK). For example, it is desired at some point in the tuneup sequence to *increase* the inductance by one binary increment. To accomplish this, the CPU examines the binary number representing the status of the L control relays, decrements that number by one and clocks that number one bit at a time into the series to parallel buffer.

## 2-11 THE PROGRAM

The control algorithm is contained in CPU ROM. The actual program consists of many subroutines and branch statements in *machine language* for the 68HC705P9P. This program is complex, proprietary and protected by Copyright. For these reasons, no detailed treatment of the program will be given here. A general understanding of the process may be had by examination of the key steps the program makes in determining the lumped constants required to tune a 25 foot antenna (for example) at a frequency of first 4 MHz and then 1.6 MHz. In the 4 MHz case, immediately after startup the program will first examine the EEPROM table for applicable data. In the event that no previously stored data is found, or that any such data is tested and found incorrect, the program will initiate a tuneup sequence. By examination of the phase detector the determination is made that the antenna is short (capacitive) at the drive frequency, and so series L is inserted until the phase detector indicates that the load is no longer capacitive. At this point the program measures the VSWR. It will generally be greater than 2:1 and if so, the program increments the input C while manipulating series L to simultaneously raise the input impedance and maintain a resistive match. This process is continued until a satisfactory VSWR is obtained. Following tuneup, the network data is stored against an address determined by the frequency measurement already made and stored. The program is then terminated. If, in the previous example, it is not possible to normalize the reactance of the antenna with the available supply of L (possible at 1.6 MHz), the program will increment the output C and search the L again, continuing in this fashion until the phase detector indicates that the load is resistive. It will then measure the VSWR and proceed as before. The difference is that now the network will be a PI network instead of the original L network. Additional subroutines are included in the program which set various *breakpoints* in the allowable constants as a complex function of frequency. In fact, the overall *program* actually consists of a program SET which is designed to allow maximum flexibility while still maintaining high operating speed.

Another unique feature of the Kachina KC-ATU is the *duplex* operating mode. This mode is provided in order to allow the operator to eliminate the large loss in receiving sensitivity which can occur when the KC-ATU (or any antenna tuner for that matter) is used in the 2-3 MHz spectrum. The sensitivity loss occurs as a result of the relatively narrow bandwidth of the matching network when used with short antennas. Remember that the tuner responds to *transmitter* frequencies on tuneup and so acts as a narrowband preselector filter at the transmitter frequency. Normally, this creates no problem, but in special cases, particularly when the antenna system is short, the ground system good, and the receiver frequency is far removed from the transmitter frequency, considerable loss in receiver sensitivity can result. The problem is especially acute when the wide split puts the receiver frequency on the *high side*, since the tuning network is generally configured as a low pass filter. The *duplex* mode makes use of a special control algorithm which, when energized, senses the *receive* mode and switches out all tuning elements. This connects the antenna directly to the input of the receiver and, while the receiver input will not be *matched* to the antenna, a substantial increase in overall sensitivity will generally result. When transmitter operation resumes, the KC-ATU will revert to the previously stored tune data.

If it is desired to utilize the duplex operating mode, contact the factory for information regarding the control requirements.

# CHAPTER 3 - INSTALLATION PROCEDURE

## 3-1 MECHANICAL CONSIDERATIONS

The Kachina KC-ATU requires only that a source of 13.6 VDC, an RF transmission line (RG-58/U up to 30 feet, RG-213/U over 30 feet) and a suitable antenna/ground system be attached. No bandswitch information, low power tune, or *handshake* is required to the RF generator since the coupler tunes on voice signals. Power consumption is nominally less than 1 amp, allowing the use of light 2 to 5 conductor shielded cable for reasonable run lengths. (NOTE: The extra conductors in the power cable are to provide for an ALL TUNED indicator flag and/or the TUNE LOCKOUT and DEMAND TUNE feature(s) when desired. The power terminal of the Kachina KC-ATU, P1, is clearly marked for polarity and the entire tuner is protected against reverse polarity connection by series diode CR15. Weatherdeck mounting is permitted but years of marine experience indicate that inside mounting or even just splash-protected mounting is to be preferred , particularly in cold, damp environments.

The base of the antenna should be connected to the high voltage feed-through terminal on the top of the Kachina KC-ATU weather housing. Note that this insulator is not designed to support heavy mechanical loads. If such loading is encountered, the use of a strain insulator is desireable.

The ground system should be connected to the 1/4 inch stainless steel stud protruding from the bottom of the weather housing. Ground runs of over a few inches should be made from 4 inch wide copper strap or better. The actual ground system should be as good as possible and may consist of screening embedded in decks or roofs, coamings, rails, stack shrouds, water and/or fuel tanks, etc. Ships with a non-conducting structure such as fiberglass require careful attention to detail to provide an adequate ground system. Please note that this attention to ground integrity is *not* unique to the Kachina KC-ATU, *all* shipboard installations have the same requirements. The Kachina KC-ATU autotune algorithm is capable of providing an adequate impedance match for an extremely wide variety of antenna/ground systems. This capability will insure proper operation of the system transceiver. It can *not* however insure that the antenna/ground system will radiate RF energy effectively. Such radiation efficiency is solely a function of the antenna and ground installation. ***A PROPER ANTENNA/GROUND INSTALLATION IS OF PARAMOUNT IMPORTANCE!***

## 3-2 ELECTRICAL CONSIDERATIONS

Connector Pl on the antenna tuner printed circuit board provides the cable interconnect for power, shield ground, the ALL TUNED flag and when desired, the DEMAND TUNE and/or TUNE LOCKOUT features.

DC Power is connected to terminals 1 and 2 of Pl. pin 1 is the negative terminal and pin 2 is the positive terminal. The coupler runs off a nominal 13.6 volt source and the entire tuner is protected against reversed polarity connection by series diode CR15.

A remote ALL TUNED indicator can be connected to pin 4 of Pl. This terminal is pulled to ground when the tuner has completed the antenna tuneup cycle.

The KC-ATU DEMAND TUNE feature allows the operator to override the channel storage memory when desired. This is accomplished by momentarily grounding Pl, pin 3. If this feature is to be used at the transceiver, connect a wire from Pl, pin 3 through a momentary switch to ground.

When two or more transceiver systems are co-located, it is commonplace for a transmission on one system to upset the antenna tuner setup on the other. This happens when energy from one antenna is absorbed by the other in sufficient quantity to *fool* the other antenna tuner into resetting. This condition can be alleviated by using the TUNE LOCKOUT feature.

To invoke the TUNE LOCKOUT feature of the KC-ATU, connect Pl, pin 5 (PTT) to the PTT line in the associated transceiver through the interconnect cable. This connection will allow the KC-ATU to sense the open circuit (key up) voltage from the transceiver PTT line. This voltage is used to inhibit tuner operation. When the voltage is absent (key down condition), the tuner operates normally. The TUNE LOCKOUT port circuitry is compatible with open circuit voltages between +5 and +15 volts, DC. Port impedance is approximately 100K ohms.

## 3-3 ELECTRICAL CHECKOUT

After mechanical installation is completed, the SSB transmitter should be adjusted to the *highest* frequency desired, a directional wattmeter such as the BIRDtm Model 43 inserted into the transmission line, and the transmitter energized. Upon application of RF energy, the Kachina KC-ATU should begin to tune, indicated by a general *clattering* of the PC mounted relays. If the antenna length and ground parameters are within range, a few syllables of speech should immediately cause the relay noise to cease, reflected power on the wattmeter to drop to a value consistent with a better than 2:1 VSWR and the PC mounted tuned led, CR14, to light.

The SSB transmitter should now be adjusted to the *lowest* desired frequency, and the speech test repeated. Again, the Kachina KC-ATU should immediately sense the mismatch, enter the tune mode and retune the antenna system. The tune cycle will take somewhat longer at the lower frequencies, since the algorithm must search through more possible values of L and C to find an appropriate combination. A few seconds of speech should result in an *all tuned* indication. If the antenna parameters are within the specified range, and the above tests have been performed succesfully, the Kachina KC-ATU installation and tuneup may be considered complete.

Note that, as received, the memory system in the Kachina KC-ATU will most likely not contain prestored data appropriate to your installation. For this reason, the memory feature will likely *not* be impressive at first. To allow the Kachina KC-ATU to *learn* your antennas' requirements, simply proceed from frequency to frequency, allowing the normal tuneup to take place. As more and more frequencies are *memorized* by the computer, it should be possible to return to a previously used frequency and discover that the computer immediately flashes the ALL TUNED flag, usually before the first syllable is completed. It should be further noted that the EEPROM memory system is capable of storing hundreds of individual frequency/relay combinations but that most of these combinations are actually used in the first 4 or 5 MHz of operating frequencies. This is done in order to provide better memory resolution at the lower frequencies where antenna systems are inherently narrowband. Very often, one or two memory positions will give adequate band coverage at frequencies in the higher marine bands.

# CHAPTER 4 - TROUBLESHOOTING

## 4-1 COUPLER WILL NOT TUNE - NO RELAY ACTION

1. Apply +12 VDC to the antenna tuner and measure the DC voltages needed for operation:

   A.) +12 VDC on left hand side of U7. (NOTE: PC board is oriented with coaxial connector (Jl) at the lower right hand corner.)

   B.) +5 VDC on right hand side of U7, pins 1 and 28 of U5 and pin 2 of Ul.

2. The relays should initialize in the following way:
   KO thru K5 - open
   K6 thru K15 closed
   Kl6 thru K25 open

This will indicate that the CPU and the associated circuitry is probably working correctly. (Unless intermittent)

3. Individual relays may be tested by simply grounding the appropriate relay driver pin with a short jumper wire. (eg: To test KO, ground pin 16 of U11. The jumper simulates the operation of the open-collector driver transistor between pins 1 and 16 of U11.)

Individual relay drivers may be tested by using the jumper to connect the appropriate relay driver INPUT pin to +5 VDC. (eg: To test the relay driver associated with KO, connect the jumper between U11, pin 1 and +5 VDC.)
» *NOTE: Integrated circuits U8, U9 and U10 should be removed when this test is performed. Otherwise, they may be damaged.*

The serial-to-parallel shift register (U8, U9 and U10) I.C.s may be tested as follows:

Remove U5 from its socket. Jumper pins 1 and 16 of U8. Also connect a jumper from pin 2 of U8 and ground. When DC voltage is applied to the board, the relays will energize in a random pattern. To sequentially operate the relays, it is possible to manually *clock* the relay driver circuitry. This is accomplished by applying a +5 volt pulse to Pin 13 of the U5 socket. (Using a short jumper connected to Pin 13 of U5, momentarily connect the jumper to the +5 volt rail and then to ground.) Each pulse will clock a DATA 0 into the serial-to-parallel relay driver, opening one relay per clock pulse. To reset the relays simply connect the jumper from Pin 2 of U8 to +5 VDC instead of ground. Once again, *clocking* pin 13 of the U5 socket will sequentially close one relay per clock pulse. Note that the relays are always clocked sequentially, starting at KO and proceeding through K25.

4. If step 3 indicates that the relay driver circuitry is functioning properly, the problem may be a defective CPU (U5). This must be tested by substitution. Replace the suspected part with a known good CPU.

5. In the event that a substitute I.C. does not solve the problem, check for bent pins on the socketed I.C.s.

6. Using a suitable oscilloscope, check the RF level present at pin 13 of U1. (A level of approximately 8 V p-p should appear when an RF signal of 150 watts is connected to J1.)

7. The signal present on pin 10 of U3 under the conditions described in Step 6 should be a 5 V p-p signal with a frequency 1/4 of that seen on pin 13 of U1. (eg: Input frequency = 2048 KHz, Pin 10 of U3 = 512 KHz.)

8. The signal present on pin 12 of U3 under the conditions described in Step 6 should be a 5 V p-p signal with a frequency 1/2048 of that seen on pin 13 of Ul. (eg: Input frequency = 2048 KHz, pin 12 of U3 = 1 KHz.) Note that this same signal should be present at pin 25 of U5

## 4-2 RELAYS OPERATE BUT NO TUNE

1. Check the sensor diodes (CR1, CR3) for correct operation by using the diode test scale of a digital multimeter. Typical forward voltage drop will be approximately 0.57 VDC. Reverse direction reading varies with the meter used and which diode is under test. This is a function of in-circuit testing. If you have *ANY* concern about the reverse direction reading, unsolder one lead of the diode under test. The reverse reading should then be open.

2. Connect a DC voltmeter between R15 and the ground rail. With no RF signal present, the voltmeter should read approximately +2.5 VDC.

Connect the RF output terminal to an appropriate antenna simulator and apply RF power to the coaxial input connector (J1). The relays should begin to operate by increasing the inductance (Relays K6 through K15 will open sequentially). The voltmeter connected to R15 should read less than +2.5 VDC when the antenna is capacitive (ie: Shorter than 1/4 wavelength) and greater than +2.5 VDC when the antenna is inductive (ie: longer than 1/4 wavelength).

3. Check that pin 2 of U5 is pulsed low when RF power is applied to J1. (You must have forward power present which will cause pin 12 of U3 to output a square wave).

4. The most common problems encountered under *no tune* conditions have been: bad diodes, defective (burned contacts) relays and broken or burnt wires on Tl and T2. The voltage winding on T2 may be checked by using an ohmmeter between the antenna terminal and the ground rail. A short circuit to ground indicates that the winding is good. The other transformer windings should also be tested between ground and the appropriate point in the circuit. NOTE: These components may be damaged by near-by lighting strikes.

## 4-3 COUPLER TUNES BUT NO MEMORY

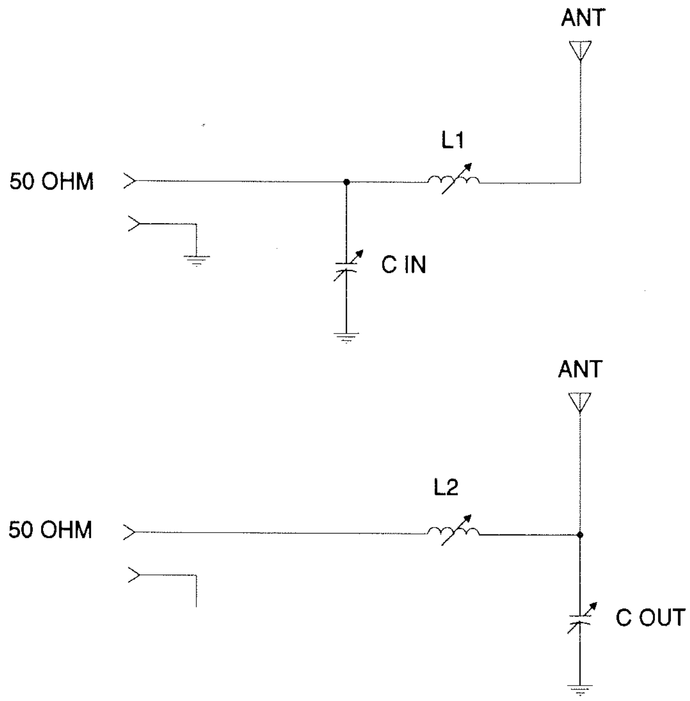
1. Check for +5 VDC on pin 8 of U4.

2. If normal voltage is present, suspect U4 or U5 as possibly damaged. Test by substitution.

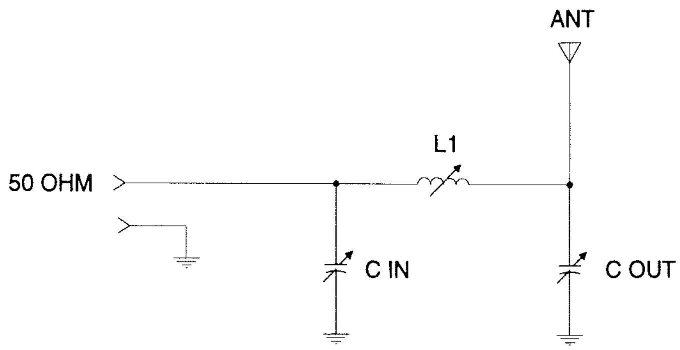
## 4-4 TUNER WILL NOT DEMAND TUNE

1. Check that the DEMAND TUNE (DTN) line (P1, pin 3) is at +5 VDC.

2. Wait approximately 1 second before pulling the DEMAND TUNE line low. The tuner must turn off the clock before it can acknowledge a second DEMAND TUNE signal. (This condition will occur 1 second after loss of forward power with the DEMAND TUNE line high.)




THE "L" NETWORK




THE "TT" NETWORK

FIGURE 1 - NETWORK CONFIGURATIONS

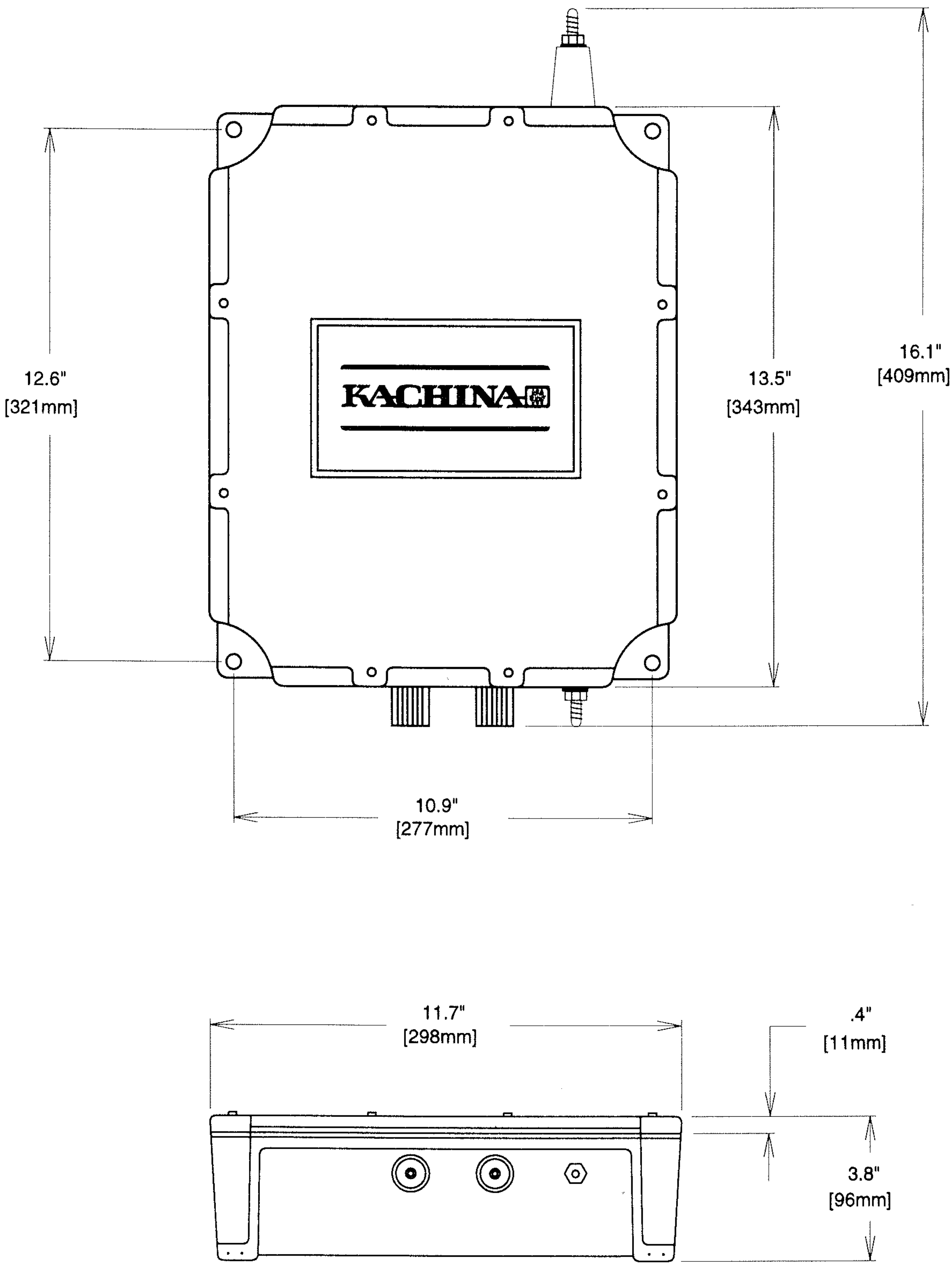



**FIGURE 4 - OUTLINE AND MOUNTING DIMENSIONS**

# APPENDIX A - PARTS LIST

| SYMBOL | PART # | DESCRIPTION |
|---|---|---|
| C1 | CAP-0013-003 | CAPACITOR, MONOLYTHIC, .01UF, 100V |
| C2 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C3 | CAP-0013-003 | CAPACITOR, MONOLYTHIC, .01UF, 100V |
| C4 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C5 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C6 | CAP-0013-003 | CAPACITOR, MONOLYTHIC, .01UF, 100V |
| C7 | CP-0007-003-10B | CAPACITOR, 25LS, 15PF, DM15 |
| C8 | 105002 | CAPACITOR, MONOLYTHIC, 1UF |
| C9 | 105002 | CAPACITOR, MONOLYTHIC, 1UF |
| C10 | 105002 | CAPACITOR, MONOLYTHIC, 1UF |
| C11 | 105002 | CAPACITOR, MONOLYTHIC, 1UF |
| C12 | 105002 | CAPACITOR, MONOLYTHIC, 1UF |
| C13 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C14 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C15 | 105002 | CAPACITOR, MONOLYTHIC, 1UF |
| C16 | 115059 | CAPACITOR, .1LS, 22PF |
| C17 | 115059 | CAPACITOR, .1LS, 22PF |
| C18 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C19 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C20 | 105002 | CAPACITOR, MONOLYTHIC, 1UF |
| C21 | 150000 | CAPACITOR, TANTALUM, 2.2UF, 16-25V |
| C22 | 140011 | CAPACITOR, TANTALUM, 10UF, 16V |
| C23 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C24 | CAP-0037-102 | CAPACITOR, ELECTROLYTHIC, 1000UF, RAD, .2LS |
| C25 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C26 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C27 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C28 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C29 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C30 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C31 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C32 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C33 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C34 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C35 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C36 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C37 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C38 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C39 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C40 | CAP-0003-001 | CAPACITOR, DM19, 100PF |
| C41 | CAP-0003-001 | CAPACITOR, DM19, 100PF |
| C42 | CAP-0003-001 | CAPACITOR, DM19, 100PF |
| C43 | CAP-0003-021 | CAPACITOR, DM19, 200PF |
| C44 | CAP-0003-021 | CAPACITOR, DM19, 200PF |

| SYMBOL | PART # | DESCRIPTION |
| --- | --- | --- |
| C43 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C44 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C45 | 135471 | CAPACITOR, DM19, 470PF |
| C46 | 135331 | CAPACITOR, DM19, 330PF |
| C47 | 135102 | CAPACITOR, DM19, 1000PF |
| C48 | 135621 | CAPACITOR, DM19, 620PF |
| C49 | 135222 | CAPACITOR, DM19, 2200PF |
| C50 | 135102 | CAPACITOR, DM19, 1000PF |
| C51 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C52 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C53 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C54 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C55 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C56 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C57 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C58 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C59 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C60 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C61 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C62 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C63 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C64 | CAP-0050-050 | CAPACITOR, 50PF, 5KV, RMC |
| C65 | CAP-0050-050 | CAPACITOR, 50PF, 5KV, RMC |
| C66 | CAP-0050-100 | CAPACITOR, 100PF, 5KV, .5LS |
| C67 | CAP-0050-100 | CAPACITOR, 100PF, 5KV, .5LS |
| C68 | CAP-0050-200 | CAPACITOR, 200PF, 5KV, RMC, .5LS |
| C69 | CAP-0050-200 | CAPACITOR, 200PF, 5KV, RMC, .5LS |
| C70 | CAP-0050-100 | CAPACITOR, 100PF, 5KV, .5LS |
| C71 | CAP-0050-100 | CAPACITOR, 100PF, 5KV, .5LS |
| C72 | CAP-0050-200 | CAPACITOR, 200PF, 5KV, RMC, .5LS |
| C73 | CAP-0050-200 | CAPACITOR, 200PF, 5KV, RMC, .5LS |
| C74 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C75 | CAP-0013-003 | CAPACITOR, MONOLYTHIC, .01UF, 100V |
| C76 | 105002 | CAPACITOR, MONOLYTHIC, .1UF |
| C77 | 115001 | CAPACITOR, .45LS, 10PF |
| CR1 | SEM-0098-002 | DIODE, 1N5282, ULTRA FAST |
| CR2 | 410000 | DIODE, .45LS, 1N4148 |
| CR3 | SEM-0098-002 | DIODE, 1N5282, ULTRA FAST |
| CR4 | 410000 | DIODE, .45LS, 1N4148 |
| CR5 | 410000 | DIODE, .45LS, 1N4148 |
| CR6 | 410000 | DIODE, .45LS, 1N4148 |
| CR7 | 410000 | DIODE, .45LS, 1N4148 |
| CR8 | 410000 | DIODE, .45LS, 1N4148 |
| CR9 | 410000 | DIODE, .45LS, 1N4148 |
| CR10 | 410000 | DIODE, .45LS, 1N4148 |
| CR11 | 410000 | DIODE, .45LS, 1N4148 |
| CR12 | 410000 | DIODE, .45LS, 1N4148 |
| CR13 | 410000 | DIODE, .45LS, 1N4148 |
| CR14 | 400007 | DIODE, LED, RED, T1 |
| CR15 | SEM-0089-001 | DIODE, 1N5402, 3A, RECTIFIER |
| CR16 | 410000 | DIODE, .45LS, 1N4148 |
| CR17 | 410000 | DIODE, .45LS, 1N4148 |
| F1 | 530005 | FUSE, 2A, 125V |
| J1 | 610000 | CONNECTOR, ASSEMBLY, UHF |

| SYMBOL | PART # | DESCRIPTION |
|---|---|---|
| JU1 | CON-0240-020 | 2 PIN, SINGLE ROW HEADER |
| JU2 | CON-0240-020 | 2 PIN, SINGLE ROW HEADER |
| JU3 | CON-0240-020 | 2 PIN, SINGLE ROW HEADER |
| JU4 | CON-0240-020 | 2 PIN, SINGLE ROW HEADER |
| K0 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K1 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K2 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K3 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K4 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K5 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K6 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K7 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K8 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K9 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K10 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K11 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K12 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K13 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K14 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K15 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K16 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K17 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K18 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K19 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K20 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K21 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K22 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K23 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K24 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| K25 | REL-0007-007 | RELAY, D/P BASE, W/CLEAR COVER |
| L1 | ASY-1630-L1 | INDUCTOR, AIR, .125UH, 3 TURNS |
| L2 | ASY-1630-L2 | INDUCTOR, AIR, .250UH, 5 TURNS |
| L3 | ASY-1630-L3 | INDUCTOR, AIR, .50UH, 8 TURNS |
| L4 | ASY-1061-L2 | INDUCTOR, 1.0 UH |
| L5 | ASY-1061-L3 | INDUCTOR, 2.0 UH |
| L6 | ASY-1061-L4 | INDUCTOR, 4.0 UH |
| L7 | ASY-1061-L5 | INDUCTOR, 8 UH |
| L8 | ASY-1612-L6 | INDUCTOR, 16 UH |
| L9 | ASY-1061-L7 | INDUCTOR, 32 UH |
| P1 | TER-0026-002 | TERMINAL, 3 POSITION |
| Q1 | 450008 | SWITCH, MOSFET, 2N7000 |
| Q2 | 450008 | SWITCH, MOSFET, 2N7000 |
| R1 | RES-0006-510 | RESISTOR, 51 OHM, 1W |
| R2 | RES-0001-301 | RESISTOR, 300, 1/4W |
| R3 | 215100 | RESISTOR, 10, 1/4W |
| R4 | RES-0001-202 | RESISTOR, 2K OHM, 1/4W |
| R5 | RES-0002-510 | RESISTOR, 51 OHM, 1/4W, 5% |
| R6 | RES-0001-301 | RESISTOR, 300, 1/4W |
| R7 | 215100 | RESISTOR, 10, 1/4W |
| R8 | RES-0001-202 | RESISTOR, 2K OHM, 1/4W |
| R9 | 215150 | RESISTOR, 15, 1/4W |
| R10 | 215150 | RESISTOR, 15, 1/4W |
| R11 | 215150 | RESISTOR, 15, 1/4W |
| R12 | 215150 | RESISTOR, 15, 1/4W |

| SYMBOL | PART # | DESCRIPTION |
|---|---|---|
| R13 | 215470 | RESISTOR, 47,1/4W |
| R14 | 215470 | RESISTOR, 47, 1/4W |
| R15 | 215102 | RESISTOR, 1K, 1/4W |
| R16 | 215102 | RESISTOR, 1K, 1/4W |
| R17 | 215562 | RESISTOR, 5.6K, 1/4W |
| R18 | 215152 | RESISTOR, 1.5K, 1/4W |
| R19 | 215152 | RESISTOR, 1.5K, 1/4W |
| R20 | 215102 | RESISTOR, 1K, 1/4W |
| R21 | 215103 | RESISTOR, 10K, 1/4W |
| R22 | 215103 | RESISTOR, 10K, 1/4W |
| R23 | 215472 | RESISTOR, 4.7K, 1/4W |
| R24 | 215106 | RESISTOR, 10MEG OHM |
| R25 | 215103 | RESISTOR, 10K, 1/4W |
| R26 | 215103 | RESISTOR, 10K, 1/4W |
| R27 | 215103 | RESISTOR, 10K, 1/4W |
| R28 | 215101 | RESISTOR, 100, 1/4W |
| R29 | 215103 | RESISTOR, 10K, 1/4W |
| R30 | 215104 | RESISTOR, 100K, 1/4W |
| R31 | 215103 | RESISTOR, 10K, 1/4W |
| R32 | 215102 | RESISTOR, 1K, 1/4W |
| R33 | 215152 | RESISTOR, 1.5K, 1/4W |
| R34 | 215101 | RESISTOR, 100, 1/4W |
| R35 | 215100 | RESISTOR, 10, 1/4W |
| R36 | 215100 | RESISTOR, 10, 1/4W |
| R37 | 215100 | RESISTOR, 10, 1/4W |
| R38 | 215100 | RESISTOR, 10, 1/4W |
| R39 | 215100 | RESISTOR, 10, 1/4W |
| R40 | 215100 | RESISTOR, 10, 1/4W |
| R41 | 215100 | RESISTOR, 10, 1/4W |
| R42 | 215100 | RESISTOR, 10, 1/4W |
| R43 | 215100 | RESISTOR, 10, 1/4W |
| R44 | 215100 | RESISTOR, 10, 1/4W |
| R45 | 215100 | RESISTOR, 10, 1/4W |
| R46 | 215100 | RESISTOR, 10, 1/4W |
| R47 | 215100 | RESISTOR, 10, 1/4W |
| R48 | 215100 | RESISTOR, 10, 1/4W |
| R49 | 215100 | RESISTOR, 10, 1/4W |
| R50 | 215100 | RESISTOR, 10, 1/4W |
| R51 | 215100 | RESISTOR, 10, 1/4W |
| R52 | 215100 | RESISTOR, 10, 1/4W |
| R53 | 215100 | RESISTOR, 10, 1/4W |
| R54 | 215100 | RESISTOR, 10, 1/4W |
| R55 | 215103 | RESISTOR, 10K, 1/4W |
| R56 | 215222 | RESISTOR, 2.2K, 1/4W |
| R57 | 215222 | RESISTOR, 2.2K, 1/4W |
| R58 | 215102 | RESISTOR, 1K, 1/4W |
| R59 | 215123 | RESISTOR, 12K, 1/4W |
| R60 | 215102 | RESISTOR, 1K, 1W |
| R61 | 215104 | RESISTOR, 100K, 1/4W |
| R62 | 215103 | RESISTOR, 10K, 1/4W |
| T1 | ASY-1630-T1 | TRANSFORMER, 1630/330, POWER DE |
| T2 | ASY-1630-T1 | TRANSFORMER, 1630/330, POWER DE |
| T3 | ASY-1612-T3 | TRANSFORMER, PHASE |

| SYMBOL | PART # | DESCRIPTION |
|---|---|---|
| U1 | SEM-0144-014 | 74HC74, HEX, SCHMIT, TRIG |
| U2 | SEM-0143-074 | 74HC74, CMOS, DUAL D, FLIP-F |
| U3 | SEM-0143-402 | 74HC402, CMOS, BINARY, RIPP |
| U4 | 460065 | 16K-BIT, SERIAL, E2, PROM |
| U4SOC | 640012 | IC SOCKET, 8 PIN, DIP |
| U5SOC | 640010 | IC SOCKET, 28 PIN, DIP |
| U6 | SEM-0193-001 | MC34064P-5, TO-92, RESET, GE |
| U7 | SEM-0109-001 | REGULATOR, VOLTAGE, 7805, 5V |
| U8 | SEM-0140-094 | REGULATOR, SHIFT/STORE, 4094, CMOS |
| U9 | SEM-0140-094 | REGULATOR, SHIFT/STORE, 4094, CMOS |
| U10 | SEM-0140-094 | REGULATOR, SHIFT/STORE, 4094, CMOS |
| U10SO | 640011 | IC SOCKET, 16 PIN, DIP |
| U11 | SEM-0151-003 | 1413P, CMOS, DARL, TRANS, ARR |
| U12 | SEM-0151-003 | 1413P, CMOS, DARL, TRANS, ARR |
| U13 | SEM-0151-003 | 1413P, CMOS, DARL, TRANS, ARR |
| Y1 | 951027 | CRYSTAL, COLOR BURST, 3.579545, HC/18 |

# WARNING

**Observe the following procedures when installing and operating your KC-ATU Automatic Antenna Coupler:**

1. Do not use coaxial cable between the antenna coupler and the antenna unless the outer shielding has been removed. Keep this cable as short as possible (preferably 1m length or less).

2. Ensure that the coupler is well grounded using the grounding terminal provided. This is especially critical with automatic antenna couplers or erratic operation will result. In mobile operation ground directly to the automobile chassis (making sure <u>all</u> paint is scraped away first). In base station use ground directly to a waterpipe, if available. DO NOT GROUND TO NATURAL GAS LINES OR EXPLOSION MAY RESULT.

3. Do not transmit below 3.5 MHz when using antennas of less than 7 m (23 feet) in length. Doing so will result in serious damage to the antenna coupler.

4. Do not use antennas shorter than 2.7m (9 feet) in length or longer than 23m (75 feet).

5. Very high voltages are developed where the antenna connects to the coupler and at the antenna. Keep clear of these areas when transmitting.

6. Read the Installation and Operation Manual provided with each antenna coupler before proceeding with installation.

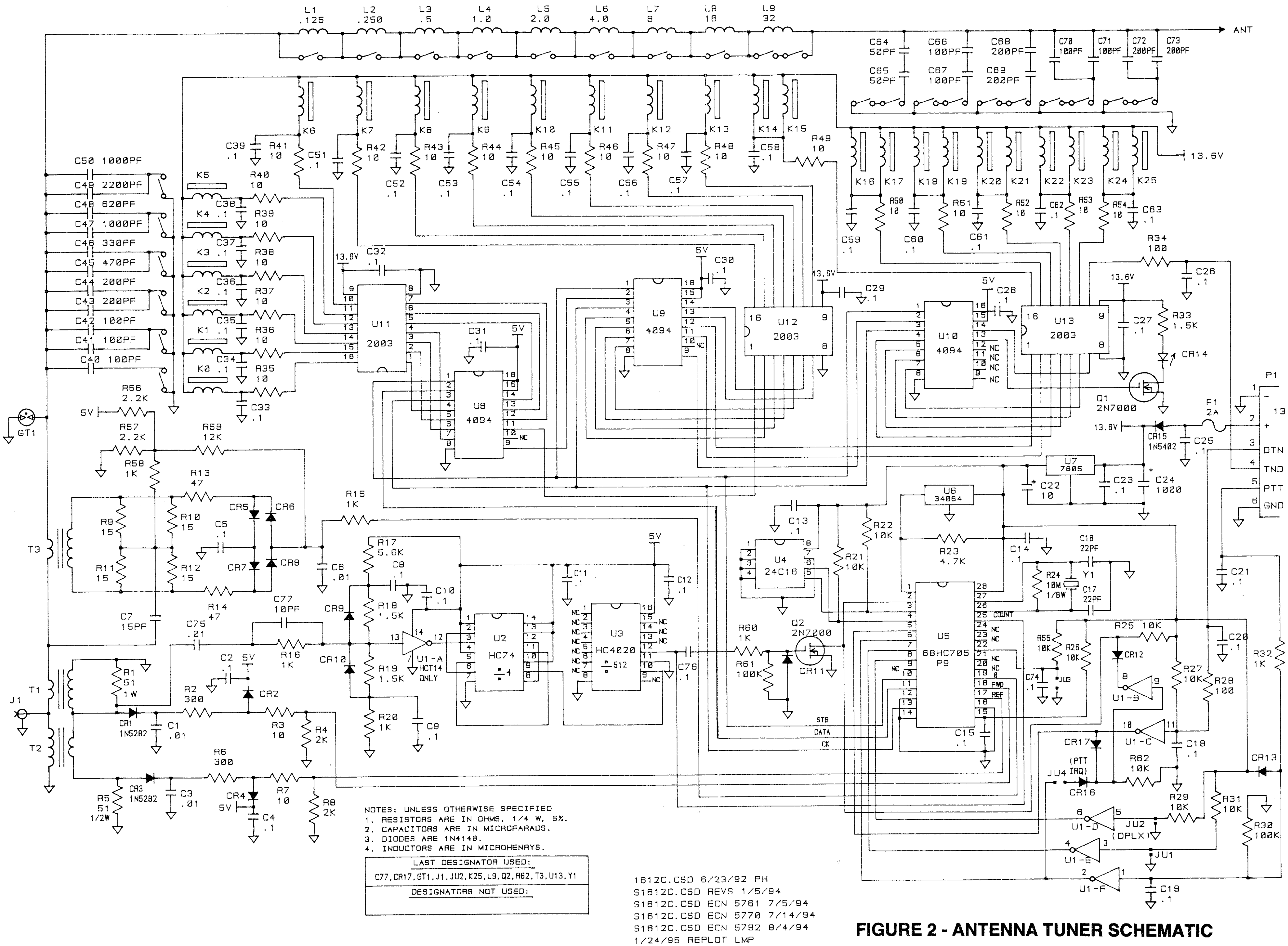



**FIGURE 2 - ANTENNA TUNER SCHEMATIC**

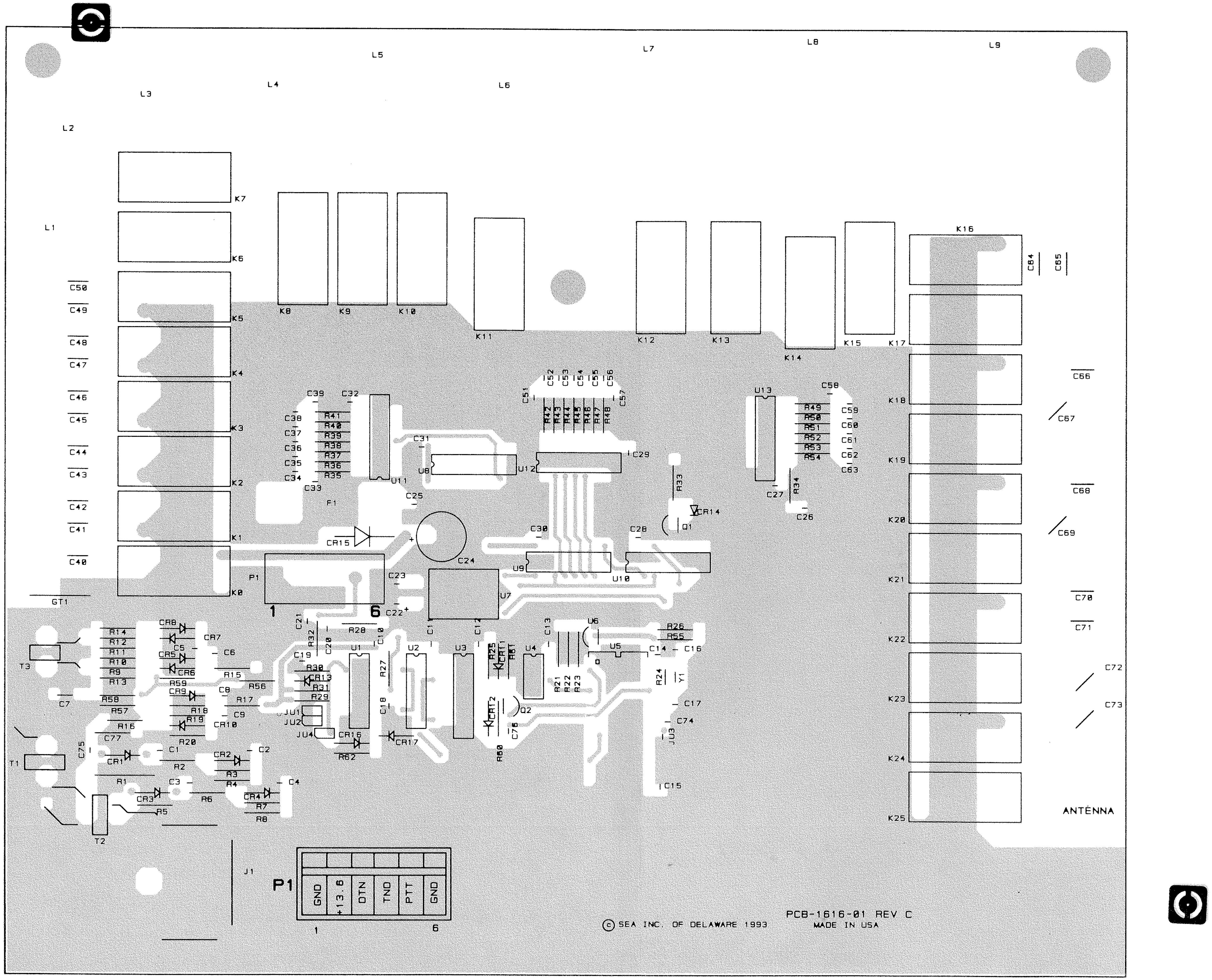



**FIGURE 3 - COMPONENT PLACEMENT GUIDE**