ATS-1 SSB TRANSCEIVER

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This construction article describes a single band all solid state SSB-CW Transceiver with dual purpose digital frequency counter. The complete transceiver is assembled on a single side Glass Epoxy PCB measuring 25.5 c.m. X 16.5 c.m.(10" X 6.5"). The intended output power is around 15 watts but many hams have managed to get around 30 watts RF output on 20 meter band.

The frequency counter is made on separate set of three Glass Epoxy PCBs, measuring 15.5 c.m. X 16.2 c.m. (6.1" X18.5 C.M.") totally.

All electronic components used in ATS-1 are available in Indian market.

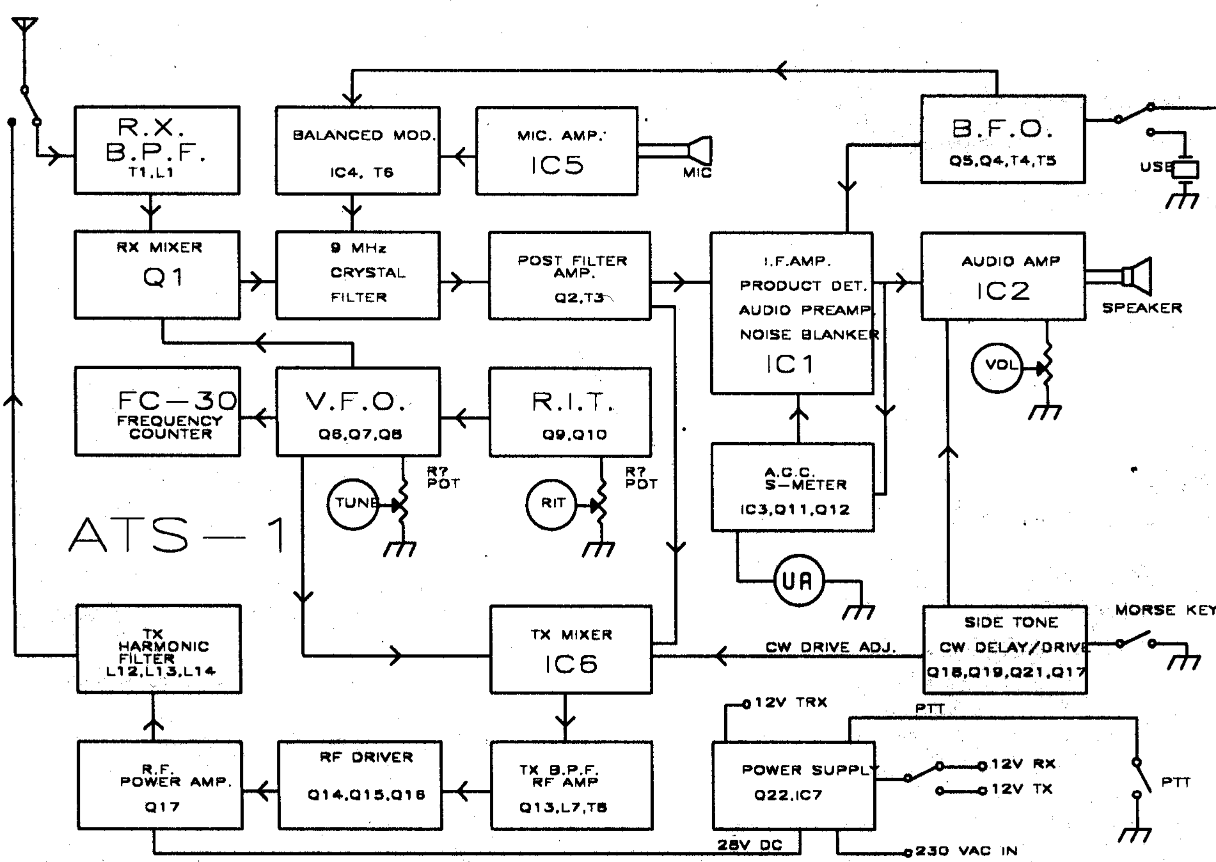
Several prototypes with some variation here and there were developed and one of them is described in this article. PCB for this version is available from Amateur Radio Association Delhi.

The PCB contains all the sections of the transceiver : RX mixer, 9 MHz crystal filter, post filter amplifier, IF amplifier, product detector, noise limiter, AGC, audio pre and power amplifier, variable frequency oscillator (VFO), Beat Frequency Oscillator (BFO), Mic amplifier, balanced modulator, Transmit mixer, driver and power MOSFET RF power amplifier, output power sampler and complete power supply.

Since the complete TRX is on a single PCB, it may look complicated at first sight but everything being on the same PCB makes it more compact and easy to assemble. On carefully checking the PCB you will find space for more number of components and more holes drilled than required. This is because the PCB is designed to accommodate different sizes of components with the idea " if this is not available you can use that".

The only thing unique in the circuit is the use of CA7611 (an IC primarily designed for the video section of colour TV receiver), as the receiver IF amplifier, product detector, noise blanker, and audio pre amplifier. Except the audio derived AGC and the use of 7611 , rest of the circuit blocks have been taken for various HAM publications and application notes.

The lack of switching of VFO and BFO signals during TX RX change over in ATS-1 is not, what an electronic engineer would recommend, but has been used nevertheless for simplifying and minimizing the number of components.



The ATS-1 is a single conversion transceiver with intermediate frequency of 9 MHz. A 9 MHz crystal filter manufactured by Bharat Electronics Limited (BEL) is used. The carrier generating crystals are also from BEL.

For 20 meter band a Variactor tuned VFO with a range of 5 to 5.35 MHz is used.

By simply tuning the receiver band pass filter, transmit band pass filter for 3.5 to 4 MHz and assembling the harmonic filter at the output of power stage for 80 meter band, ATS-1 can be made for 80 meter operation without any other change. The VFO will however tune the other way round.

For use on 40 meter with 9 MHz IF frequency, the VFO will have to tune from 1.9 to 2 MHz to cover the 7 to 7.1 MHz range, the RX and TX band pass filter and the harmonic filter at the output of the power stage will have to be made for 40 meter operation. The VFO will tune the other way round in this case also.

15 and 10 meter : With 9MHz IF this ATS-1 can not be directly used for 15 or higher band because it will require a higher frequency VFO which may not be stable. If you can make a stable VFO from 12 to 12.5 MHz (for 15 meter operation) or 19 to 20 MHz (for 10 meter operation) then you can make ATS1 for 15 or 10 meter operation. However a premixed VFO is recommended for these bands. It will require addition xtal oscillator, balanced mixer and a suitable band pass filter for the premixed VFO output. There is no provision for these additional stages on the PCB. But because of improving propagation condition on the higher bands as the sunspots climb the next solar cycle; we are soon going to offer an add-on board for premixed VFO. The board will fix vertically near the VFO and will have all the necessary stages.

The ready made coils available from ARA are for 20 meter operation with 9 MHz I.F.. The 9 MHz IF coils can however be tuned for 10.7 MHz I.F. by decreasing the value of the tuning capacitors. Therefor a 10.7 MHz SSB filters can also be used without much change.

Please Note

1. This project is recommended for hams who have previous experience of assembling and testing of Variable frequency oscillators, crystal controlled oscillators, etc.. and are otherwise familiar with testing and adjustments of RF circuits. It is recommended for those who have already made and operated on air at least a simple CW or AM transceiver.

2. Following equipment are required for proper alignment of ATS-1 :

   1. Multimeter.
   2. 2-30 MHz GDO (Grid or Gate Dip Oscillator).
   3. R.F. millivoltmeter.
   4. R.F. power meter ~30 Watt.
   5. High Frequency Cathode Ray Oscilloscope (optional)
   6. LCR or Inductance bridge (optional)

3. Other than the capacitor marked with + sign on one of their terminal i.e.electrolytic capacitors, capacitor C39, C40 and C37, and the trimmers; all other capacitors are ceramic disc type. **Do not use any other type of capacitors**.

Capacitor C39, C40 and C37 are Polystyrene capacitors. They are the capacitors which are transparent and you can clearly see the wound aluminium foil inside the capacitor. If you are unable to get Polystyrene capacitors, use NP0 (NP zero) type of ceramic disc capacitors instead. Ceramic disc capacitors with zero thermal coefficient are some time marked with black color strip on the top end of the capacitors.

4. Before attempting to make ATS-1, make yourself familiar with the functioning of the circuit. Consult some good book on Amateur Radio electronics.

5. First get the receiver portion working perfectly only then begin work on the transmitter section.

ASSEMBLING THE PCB :

1. First fix four 4mm X 25mm (or nearby size) screws in the four mounting holes in the four corners of the PCB so that when the PCB is placed on the flat table, its track and solder side is about 25mm (1") above the table surface. This is done so that when you apply power to the PCB for testing during assembling, there is no danger of any short circuit because of any lose wire pieces or components which might be lying on the table surface.

2. Fix all the wire links on the PCB using about 18 SWG good quality insulated copper wire. All wire links on the PCB are marked with thin white continuous lines. First cut a peace of wire about 2.5 c.m. longer than the link length, solder one end of the wire, then pass the wire through the hole at the other end of the link then lightly pull the wire tight with a nose plier and solder in place. Do not stretch the wire to much otherwise it may break, stretch just sufficient to remove slack and kinks if any.

3. Solder the four power rectifier diodes D29 to D32.
Be careful about the polarity of the diodes.

4. Solder all 1N4148 diodes.
Be careful about the polarity of the diodes.

5. Starting from R1 solder all the resistances but check all the resistance with a multimeter before soldering.

6. Solder all the variable preset resistances.
   Check all the variable presets with a multimeter before soldering.

7. Solder all the non polar capacitors starting form C1, i.e. all the disc ceramic and Polystyrene capacitors.

8. Solder all the trimmers .

9. Solder the two PCB Relays.

10. Solder PCB pins on all the terminal point on the PCB on which inter connecting wires or coaxial cables are to be soldered.

11. Solder all the electrolytic capacitors, be careful about polarity.
12. Solder all the IFTs, RF chocks, and inductors in the receiver portion.

Note: After soldering each components, carefully check the soldered joints for short circuits,solder bridges or dry solders. Correct if defective.

Before soldering any resistances on the PCB, first check it with a multimeter. Sometimes good looking resistances have breaks in the thin resistance film. Similarly check all the diodes and capacitors etc. before soldering.

The chocks and ferrite transformers of the TX section will be soldered after the receiver is functional.

Now the active components will be soldered section by section and each section will be made functional one by one.

POWER SUPPLY:

The first section to be completed is the power supply.

The ATS-1 circuits needs about 28 volt 2.5 ampere and 12 volt 250 mA DC source to operate. Except the power transformer, all other components needed for the power supply are on the ATS-1 PCB. The VFO and the BFO operates on regulated 9 Volt DC which is generated on the board itself by using a 9 volt three pin regulator IC7.

Circuit description :

The power transformer T12 supplies necessary ac voltages to the PCB. The primary of the transformer is wound for 220 volt operation and the secondary is a center tapped winding of about 12-0-12 AC voltage and capable of giving up to 3 ampere current without noticeable voltage drop. The overall power rating of the transformer is about 50 watts. Mains power is applied to the primary of the transformer is T12 through a front panel mounted double pole single throw switch S1 (DPST) and a backpanel mounted fuse of 0.5 ampere rating is fixed between the switch and the input socket mounted on the backpanel.

The two outer ends of the secondary are connected to terminal 1 and 2 of the power input point of the PCB (J11). Any end can be connected to terminal 1 or 2. The center tap of the secondary is connected to the point 3 of the power input point of the PCB (J11).

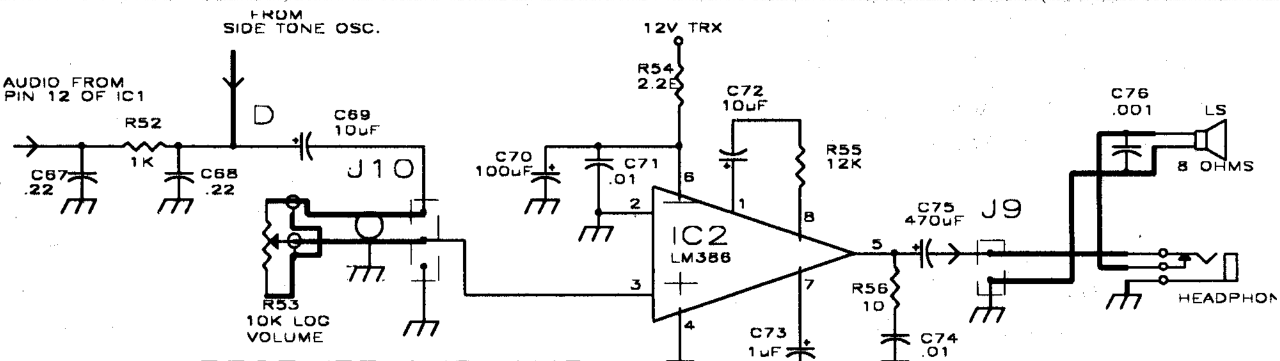
Please note that the center tap of the secondary of the power transformer T12 is not at the ground potential but is the +18 volt DC point. Make doubly sure that the center tap is connected to the point 3 of J11 .

The 24 volt AC from the secondary's outer ends and the 4 power diodes D29 to D32 (1N5402 or equivalent) forms a bridge rectifier and the resulting DC is filtered by the capacitor C143 which is mounted on the PCB itself. If required a second filter capacitor C144 can be mounted on the chassis and connected to terminal provided for it (J12). This rectified and filtered DC voltage of about 30 Volts is applied to the output power stage i.e. the power MOSFET Q17 and the driver transistor Q16 which is BD 139. (However in the version V2 of ASS-1 the driver Q16 is not connected to this 30 volt line, but is connected to 18 volt line.

The diodes D29 to D32 are 3 amp. 200 volt P.I.V. (peak inverse voltage) rectifier in plastic axial packing. Actually any diode of 3 amp. rating with 200 volt or more P.I.V. rating may be used.

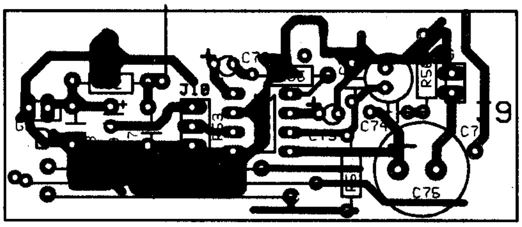
The filter capacitor C144 and C143 should be of minimum 65 volt rating while the capacitor C141 should be of minimum 35 volt rating.

The center tap of the transformer is at a DC voltage which is half of the voltage available after the bridge rectifier D29-D32. The DC voltage from the center tap is further filtered by the capacitor C141. The .1 uF ceramic disc capacitor C142 is for bypassing to ground any RF picked up by the transformer leads. This DC voltage is given to a zener regulated series pass transistor Q22. Q22 is TIP31 which is a silicon NPN transistor in T220 plastic packing. It is not necessary to use TIP31, actually any silicon transistor in TO220 packing having similar base connections, capable of withstanding more than 50 volts between collector and emitter, with a current rating of at least 1 amp can be used as Q22. The resistance R157 and the zener D34 regulates the base



RECEIVER AUDI AMP.

clockwise direction. If it is other way round then just interchange the connections on the outermost terminals of the volume control potentiometer.



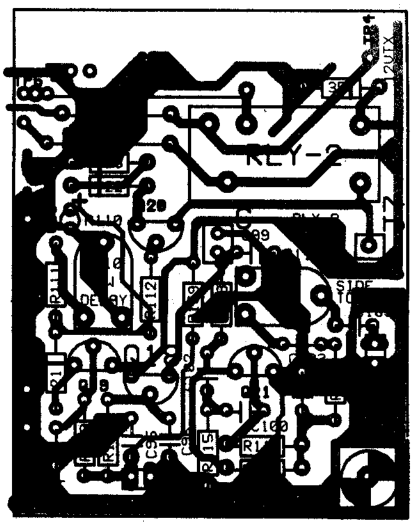
After checking and removing any solder bridges, short circuit or dry solders, insert the audio IC2 in the Base (be careful in inserting the IC in the base, check if by mistake you have not bend any lead and Verify whether the pin 1 of IC2 is in the pin marked 1 on the PCB i.e. make sure that the IC is not inserted the other way round) and switch on the power supply. The Audio stage remains powered in both TX and RX mode, if every thing is correct, then touching the point D with a live soldering iron will produce humming sound from the loudspeaker. The volume of this humming sound can be varied with the volume control.

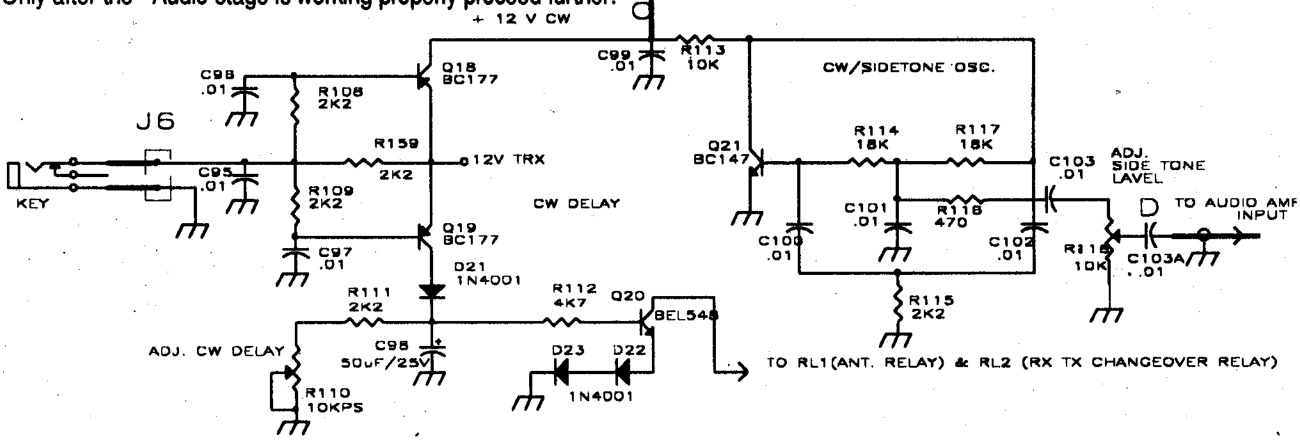
IF you do not hear anything then again check all the connections and components, their value, their polarity, all the solder points etc. and test again. If nothing is happening consult some friend who has experience in making electronic circuits work.

Only after the Audio stage is working properly proceed further.

SIDE TONE OSCILLATOR & CW KEYING CIRCUIT

After completing and checking the audio stage, assemble the CW keying stage comprising of Q18, Q19, Q20 with associated components and the sidetone oscillator stage comprising of Q21 with associated components. Q18 and Q19 are BC177 silicon PNP transistor, they can be replaced by any other equivalent general purpose silicon PNP transistors of similar rating and similar base connections. Similarly Q20 (BEL 548) and Q20 BC147 are silicon NPN transistor and can be replaced by any other general purpose low power silicon NPN transistors with same base connections.





When the Morse key is open the base of both Q18 and Q19 are pulled high by the resistance R108, R109 and R159. Since they are both PNP transistors they thus remain in cut off state when their base is at a higher potential as compared to their emitter. As soon as the Key is closed both the bases are pulled down to ground potential and both Q18 and Q19 starts conducting.

The Q19 now charges the capacitor C98 thorough D21 and pulls the base of Q20 high. The Q20 now conducts to short the PTT line to ground which in turn switch both the antenna relay RL1 and the power supply relay RL-2 (in version V1) or the base of similar but higher rating NPN-PNP combination which replaces the RL-2 in the Version V2 of ATS-1 PCB. Combination is (of Q? and Q? in V2 is similar to Q18 & Q19 combination).

When the Morse key is pressed the PTT line does not return to normal high stage (RX mode) immediately because of positive charge stored in the capacitor C98. The Charge at C98 slowly leaks to ground through resistance R11 and R110 thus producing a time delay in reverting the transceiver to RX mode. The time delay can be adjusted by the potentiometer R110 which is a preset mounted on the PCB. The diodes D22 and D23 increases the emitter potential by the voltage of two forward biased diodes, this is done to keep the transition form TX to RX mode sharp.

The Q17 which also starts conducting on Key close gives positive bias to the base of transistor Q17 (BC147 or any general purpose low power silicon NPN transistor), Q17 now starts conducting and unbalances the balance modulator stage to allow 9 MHz carrier to leak through . The level of unbalance and hence the strength of CW carrier is controlled by the potentiometer R93 which is a preset mounted on the PCB. Initially leave the slider of R93 towards the R39A side i.e. maximum CW level, final setting of R93 will be done when doing the final adjustments in the TX section. The Q18 on conducting also powers the Side Tone Oscillator Q21 (BC147 or equivalent) . The side tone oscillator gives an audio tone of about 800 Hz (with the present values of components) which is coupled to point D of the audio output stage. The volume ratio of side tone can be adjusted by the PCB mounted preset R118. Use a miniature coaxial cable to connect the variable point of pot R118 to the point D (input of the receiver audio amplifier) of the audio stage. The ground point of pot 118 is left floating so that you can either ground the point to a nearby ground point with a small piece of wire or can leave it floating. In the first case the pot. is in parallel to the volume control R53 and may interact with the main volume control; in the second case it is in series with the side tone output. You can, if you feel the need, increase or decrease the value of the pot R118 or omit the R118 altogether and adjust the side tone volume by varying the value of the coupling capacitor C103.

After checking and removing solder bridges, short circuits or dry solders, connect a Morse key to point J6 , power the PCB and press the Key close. On closing the key both the relay in V1 and the RL1 in V2 should close and on releasing the key should revert to open. If the relays are working properly , check the voltages with a multimeter at the following points:

Table of voltage points:

Test point	voltage in rx mode	voltage in tx mode
TP1(junction of LK1-C150)	28 Volt DC	28 Volt DC
TP2	15-18 V. DC	15-18 V. DC
TP3	12 V. DC	12 V. DC
TP4	0 V. DC	12 V. DC.
TP5	12 V. DC	0 V. DC.

Pressing the Key or the PTT both changeover the ATS-1 into TX mode.

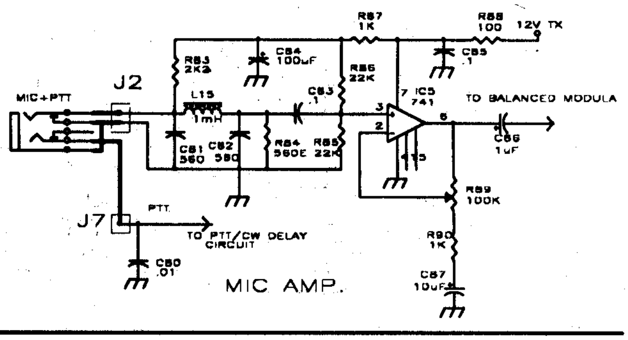
To check whether the side tone oscillator is working, power the ATS PCB and connect the Morse key to terminal J6. Now if everything is OK, on pressing the Key you would hear a Tone of about 800 Hz in the loudspeaker. Adjust the volume by varying R118. The final adjustments of R118 will be done after the receiver has started working.

MIC AMPLIFIER

The next stage to be assembled is the Mic Amplifier comprising of IC5 (op. amp. 741) and associated components.

The amplifier is for use with a condenser/electret type of microphone, though it can also be use with dynamic microphone by removing the biasing resistance R83 and after increasing the gain to compensate the low output of the dynamic microphone.

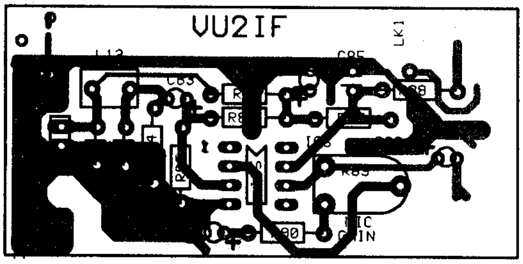
The R83 is for biasing the condenser./.electret Mic. The biasing



MIC AMP.

for different make of Mic is different and if the data is not available, then one can experiment with different values of the resistance R83 for distortion free natural sounding audio from the Mic amplifier.

The Mic and PTT switch are connected to the jacks J2 and J7. The Mic input from J2 passes through a low pass filter comprising of C81,C82 and inductance L15. This filter removes any RF picked up by the microphone leads. The resistance R84 decides the input impedance of the Microphone amplifier. For a dynamic Mic of 600 ohms impedance the R84 should be around 560 Ohms. For high impedance condenser microphone you can omit the R84 altogether. The overall gain is set by the PCB mounted preset resistance R89.



After you have soldered all the components check for any short circuit, solder bridge or dry solder etc.. For testing the Mic amplifier connect the output of the Mic amplifier i.e. the output side of the capacitor C86, to the input of the receiver audio amplifier i.e. point D on the PCB using a small piece of wire. Connect the Mic to the point J2. When connecting the condenser Mic observe the correct polarity, the connection common to the body of the Mic is the ground point. For connecting the Mic and the PTT line you will need about one and a half meter of 2 core shielded audio cable.

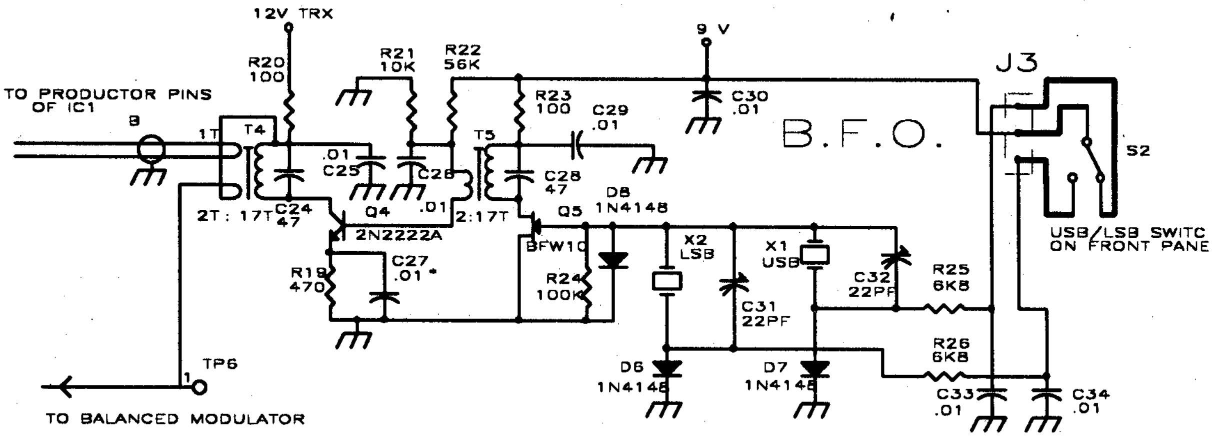
Now power the ATS-1 PCB. If everything is OK, if after pressing the PTT you speak in the Mic, you should be able to hear your amplified voice through the receiver Loudspeaker. You can increase or decrease the volume by the receiver volume control or the preset R89. If you increase the volume too much, the Mic amplifier and the audio amplifier will start oscillating giving a very loud high pitched tone. Leave the preset R89 half way and reduce the volume with the receiver volume control so that there are no oscillation. Now if the quality of audio is not good you can experiment with various values of biasing resistance R83 or different Mics till you get distortion free natural sounding voice from the loudspeaker.

After the testing is complete remove the wire link between the C86 to the point D.

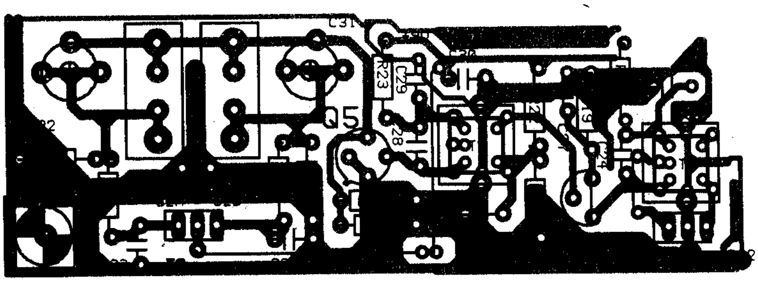
BEAT FREQUENCY OSCILLATOR (BFO)

The Beat Frequency Oscillator or the Carrier Oscillator is the crystal controlled oscillator which generates the carrier during the transmit mode and during recieve it feeds the carrier to the balanced product detector in the IC1 for recovering the audio from the received SSB signal.

The BFO has two crystals (Xtal) one for generating and demodu-



CARRIER / BEAT FREQUENCY OSCILLATOR



lating the Upper Sideband signal (USB) and the other for the lower side band signal (LSB).

You can purchase these crystals from Bharat Electronic Limited (BEL) with the 9 MHz crystal filter. The frequency of the Xtal for USB is 8.9985 MHz and for the LSB it is 9.0015 MHz.

Q5 which is BFW10 (JFET) is the oscillator with the two crystal connected to its gate. Q4 which is 2N2222A (a high frequency silicon transistor) is the buffer amplifier. The output of T4 is coupled to the RX and TX portion and both line are constantly on and no switching is used in the TX or RX changeover.

The crystals for USB or LSB are selected by diode switch. The diode D6 or D7 short the ground ends of the crystals to the ground when the diodes are switched on by applying DC through R25 or R26. The application of DC bias is applied by the Front panel mounted switch S2 connected to the pins J3 on the PCB.

Normally on 20 band only upper side band is used. So if you like you can solder only the crystal for USB i.e. 8.9985 MHz and solder a wire link in place of the diode D7. If you are doing that, you need not solder D6, D7, R25, R26, X2, C31, C33, and C34. The switch S2 is now not required.

C28 is used to tune the primary coil of T5 to 9 MHz and C24 is used to tune the primary of T4 to 9 MHz. First try 68 pF, then 47 or 56 pF if required. The T4 and T5 should peak at 9 MHz with the core about half way in between the two extreme ends.

After carefully checking and removing any short circuit, dry solder, solder bridge apply power to the PCB. Connect the probe of RF millivoltmeter to the drain of Q5, if the Q5 is already oscillating you will see some deflection in the RF millivoltmeter. If you see some deflection, then peak the T5 for maximum deflection.

You will find that oscillation stops when the T5 resonance is far away form 9 MHz. So if you do not see any deflection in the RF meter, try the next higher or lower capacitance.

Similarly peak the T4 by connecting the RF probe on the collector of Q4.

The Capacitor C27 connected between the emitter and ground controls the gain of the buffer stage. Initially solder two PCB pins inplace of C27. To adjust the gain, connect either RF millivoltmeter or CRO to the test point TP6 and measure the BFO voltage. Solder a .01 pF ceramic disc capacitor on the pins at C27 and again measure the RF voltage at TP6. Try the next lower or higher value for C27 till you get 200 mV at TP6. Increasing the value of C27 will give higher RF voltage at TP6.

Now for adjusting the frequency of the USB and LSB crystal, connect a digital frequency meter to TP6. Select the USB crystal (8.9985 MHz) with the switch S2, rotate the trimmer C32 till the frequency is 8.9985 MHz, similarly set the frequency of LSB crystal by rotating C31 to 9.0015 MHz.

The output of the BFO goes to the Balanced modulator IC4 and the product detector in IC1. For IC4 the connection is on the PCB but output to the IC1 is to be made by two small pieces of thin RF coaxial cables. Place for soldering three PCB pins is provided on the edge of the PCB in front of the coil T4. The center pin is the ground. Solder the outer shield of both the coaxial cables to this pin and solder the inner wire to either of the two outer pins. Again space is provided for soldering three PCB pins near the pin 8 & 9 of the IC1. Solder the center wires of the two coaxial cable to either of the two pins connected to pin 8 or 9 of IC1. Solder the outer shield of both the cable to the third (ground) pin. Keep the length of the cables as short as possible. In the final stage both the cable may be fixed to the PCB with rubber solution.

ASSEMBLING THE VARIABLE FREQUENCY OSCILLATOR - V.F.O.

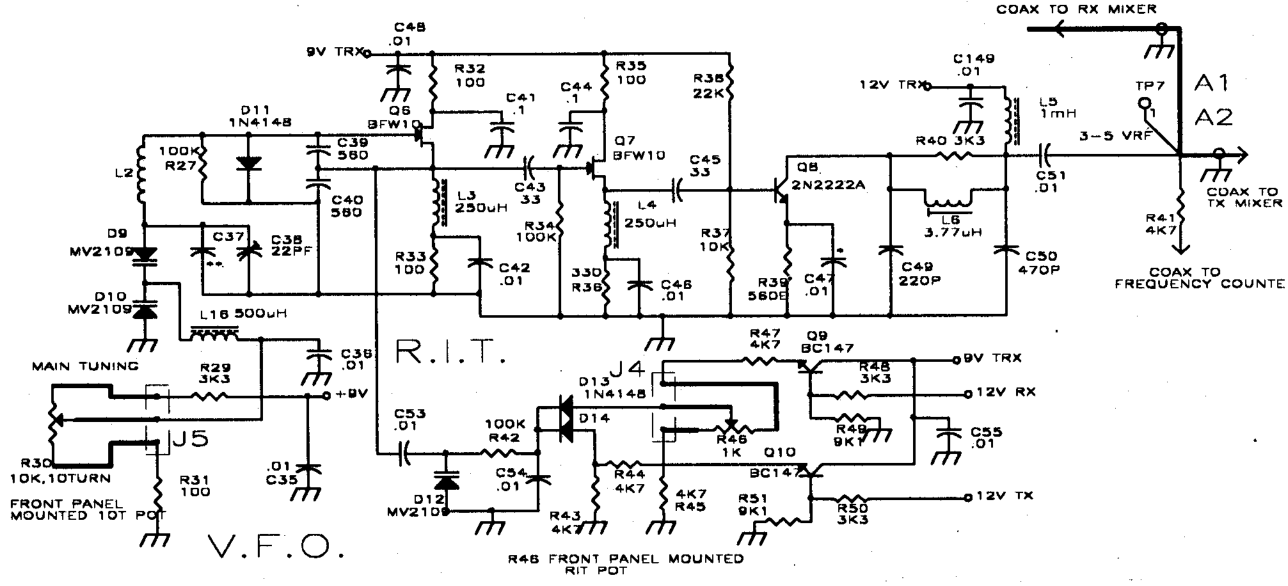
The variable Frequency Oscillator is the most critical section of the TRX because the frequency stability of you rig depends on the VFO.

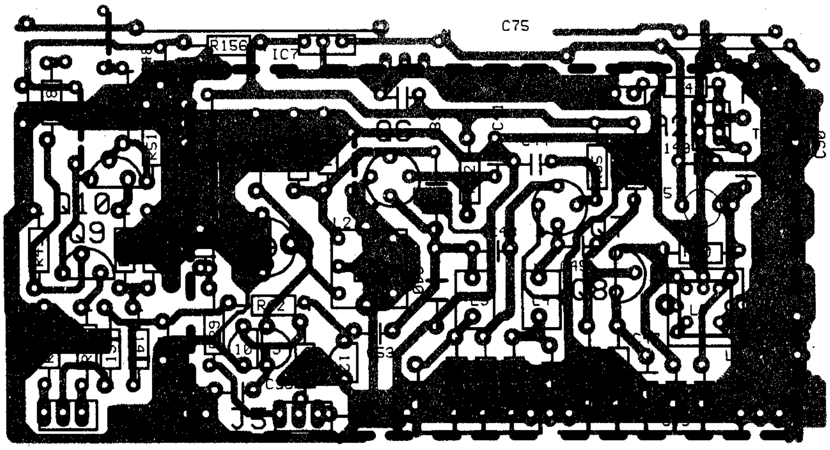
The JFET Q6 BFW10 with its associated circuit forms a standard Collpit oscillator. The frequency of oscillation is determined by the capacitors C37,C38,C39, C40, the capacitance of varicap diodes D9 & D10 and the inductance of the coil L2.

The frequency is varied by changing the DC bias fed to the junction of the two varicap diodes D9 and D10. For tuning across the band the DC bias is varied by using a 10 K Ohms ten or twenty turn wire wound variable resistance (potentiometer). The value 10 K Ohms is not critical, any pot. of nearby value can be used.

The cost of a good quality imported 10 turn pot. will be around Rs 250/-. Indian made multiturn pots are available for about Rs.80/-. However initially for testing you can use an ordinary single turn linear carbon variable resistance (potentiometer). You can solder the pot. directly on the three PCB pins soldered at J5. Once you have the VFO working properly then you can replace this pot. with a ten turn pot.

Use a 500 uH RFC (radio frequency choke) in place of resistance





R28. The value 500 uH is not critical any value between 500 uH and 1 mH can be used.

In case you do not want to use varicap diodes for tuning, you can use a good quality variable capacitor (preferably with miniature ball bearing at both ends) of about 5 to 50 pF variation with a good quality slow motion drive of minimum 1:36 ratio. The live end of the variable capacitor will be connected to the junction L2 - C37 and the body of the capacitor will be connected to ground.

In the circuit diagram no value is given for C37 and space is provided for it on the PCB. When trying to adjust the frequency rang of the VFO you might feel the need to add an additional capacitor in parallel to the trimmer C38. Initially solder two PCB pins in place of C37 and then you can solder additional polystyrene capacitor of suitable value on these pins.

When using an external variable capacitor in place of varicap diodes, folioing components are not required and should not be soldered on PCB : D9, D10, R31, R30, R35, and C36.

We have not given the number of turns for the coil L2. This coil should be wind on a low loss sturdy coil former which can fit on the space provided on the PCB for L2. the number of turns depends on the diameter of the former, gauge of the wire used, and value of the capacitors C39, C40, C37, C38, and the variation in the capacitance of the varicap diodes (or the external variable capacitor if used in place of the varicaps). First fix all the capacitors as shown in the diagram and temporarily wind a coil on a 1/4 inch dia 1 inch long former with thin enamel wire of about 26 swg. Before winding the coil drill two diametrically opposite small holes on one end of the coil former. Wind about 30 turns. pass the two ends of wire twice through two holes and solder the coil on the two PCB pins soldered in place of L2. Check the frequency range available with either a GDO or a frequency counter connected to the collector of Q8. A communication receiver can also be used to check the frequency range of the VFO. Now decrease or increase the number of turns on the L2 to get the required frequency range from 4.95 and 5.4 MHz. It is advisable to have some frequency overshoot on both the ends. The VFO range actually required is 5 to 5.35 MHz.

If you are unable to get the above range with any number of turns of L2, you may have to increase or decrease the value of the two capacitors which controls the feed back, i.e. C39 and C40. You can try any value between 220 to 620 pF, but keep the value of both feed back capacitors equal.

Q7 (BFW10) is the buffer amplifier and Q8 (2N2222A) is the VFO output amplifier. The output is taken from the collector of Q8 after passing through a low pass filter comprising of C49, L6 and C50. This low pass filter allows the VFO frequency to pass through but stops all the higher harmonics of the VFO.

After you have obtained the correct frequency range, the next step is to adjust the value of L6. Set the VFO on middle of its variable range (say 5.150 MHz) then listening to the VFO frequency on a communication receiver having S meter : adjust the L6 for maximum reading on S meter on the fundamental frequency of the VFO. Then tune the receiver on the second harmonic (say 10.30 MHz) and adjust the L6 for minimum reading on the second harmonic. Repeat similar adjustments on both the end frequencies of the VFO.

Repeat the adjustments of L6 and check the S meter reading for the VFO fundamental frequency . If the L6 is correctly adjusted the S meter will show almost constant reading throughout the VFO range. If it is not so repeat the adjustments of L6 till you get a flat response from the S meter.

If a communication receiver with S meter is not available then simply adjust the L6 for maximum output of VFO on the test pint TP7 by using a RF voltmeter or CRO. When the L6 is correctly adjusted the VFO output should remains almost same as you tune the VFO from minimum to maximum frequency.

The next step is to adjust the value of C47 so that you get between 3 to 5 volt RF on the test point TP7. Increasing the value of C47 will increase the output. Try values between .001 to .01 uF.

If you get low VFO output even with .01 uF capacitor at C47 then the collector RF choke L5 may be the culprit. The value of this RFCs should be about 1 mH but any value between 500 uH and 1mH will work. The main point is that the core used in winding this choke should have low loss at the VFO frequency. This RFC should be wound on low loss high frequency ferrite. a small dumbbell of MH81 or DL16 ferrite can be used. Fill the complete dumbbell with 40 swg enamel wire, this should work. You can try out various other ferrites or can use ready made RFC. Use which ever RFC gives the required RF voltage at the VFO output.

The feed through capacitor C52 is not used.

VFO SHIELD

Space is provided on the PCB for shielding the VFO. It is marked with thick dotted line. ON the dotted line there are holes for soldering PCB pins. On these pins you can solder small piece of copper clad laminate, copper foil or thin tin foil. Make sure that the shield is not shorting the pins of J5 .

After soldering the side plates cover the top with a piece of cooper clad laminate. Ground the top layer by soldering a small piece of wire from top to side plates.

This VFO shield will improve the long term frequency stability of the VFO and will prevent frequency jumping on transmit due to RF pick up. However care has been taken during layouting the PCB so that even without the shield, the VFO is capable of stable trouble free operation. Therefore initially you can operate the transceiver without the shield, and can fix it later on when applying finishing touches to the transceiver.

the 9 volt three pin regulator IC7 can be fixed to the shield with screw, no insulator is required because the body of the regulator is grounded. The regulator does not require any additional heat sink.

R.I.T. (Receiver Incremental Tuning) :

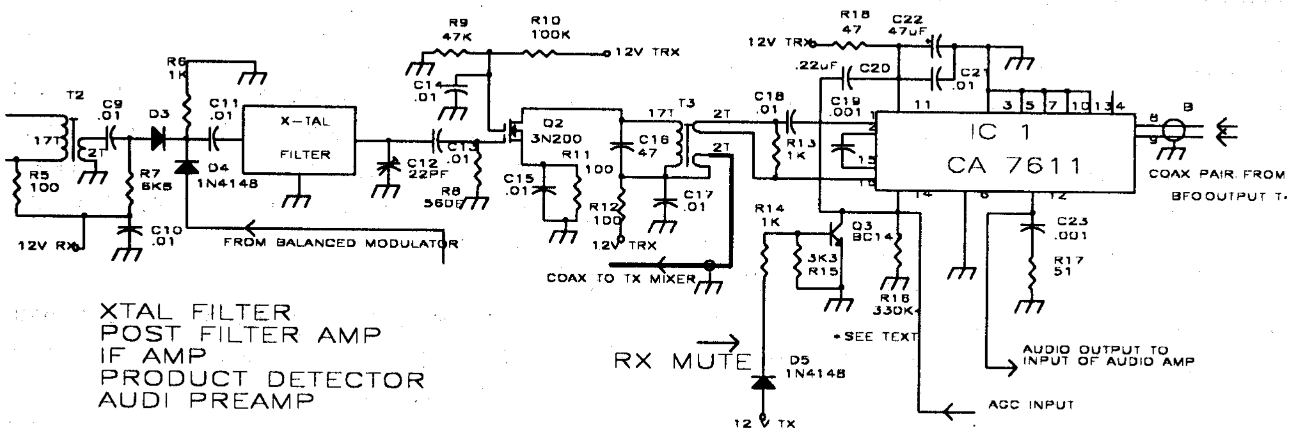
After the VFO is working properly, assemble the RIT portion and check the variation in the VFO frequency by varying the RIT pot R46. Normally 3 to 4 KHz variation is sufficient. If variation is very large, reduce the value of capacitor C53 till you get correct amount of variation.

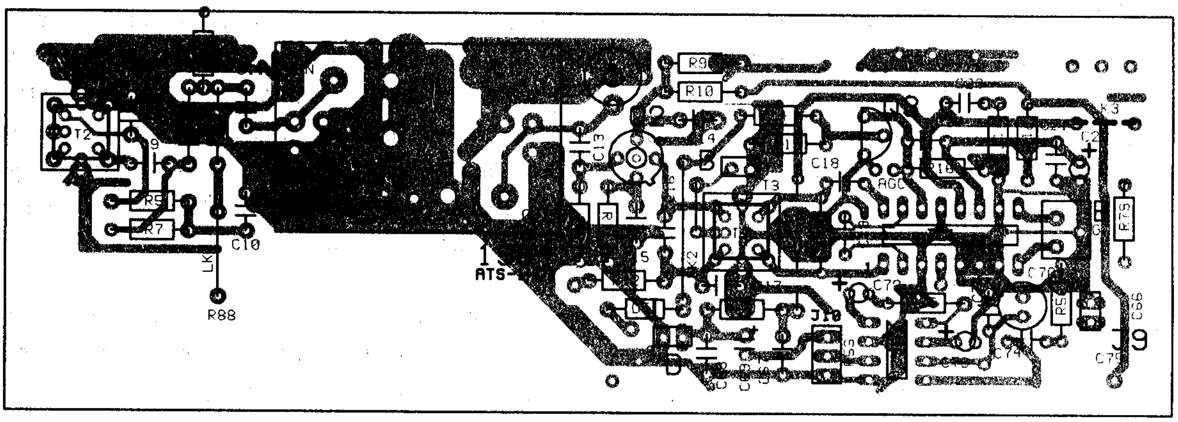
ASSEMBLING THE IF STAGE

After getting the VFO and BFO working properly, solder the components for the IF stage i.e. the components associated with the post filter amplifier Q2 and the IC1.

In the original version 3N200 was used but now a days it is becoming difficult to find and has also become very expensive. Dual gate MOSFET BF966 or similar can be used in its place. Though BF966 has different package (small round plastic body with four terminals in the same plane right angle to each other. If you bend the leg downward, it will fit nicely in place of 3N200. Remember the longest lead of BF966 is the Drain. After bending down both BF966 and 3N200 have same pin connections. Initially keep the trimmer C12 half meshed.

When soldering the components around the IC1 CA7611, solder





two PCB pins in place of resistance R16. The value of this resistance decides the gain of CA7611. Higher is the value of R16, higher is the gain. The maximum recommended value of R16 is 820 K Ohms. Initially solder 330 K resistance on the pins. Later on you can increase the gain by increasing the value of R16.

AT this stage also solder the BEL 9MHz crystal filter and other components associated with IC1. Secure the Filter on the PCB with the two screws and nuts provided with the filter and solder the central pin of the filter to ground.

Though normally it is recommended that IC used for RF work should be soldered directly without using an IC base but we have used IC base for CA7611 and have not faced any problem. Therefore if you prefer you may use IC base for CA7611. Use a new good quality base for IC1.

Check for any short circuit, dry solder or solder bridge. If all is OK, apply power. Now if you increase the audio volume you should be able to hear the mixer hiss from the product detector which is inside the IC1. If you remove the IC1 this hiss will disappear. This hiss at audio volume indicated that the BFO and the product detector stage are working.

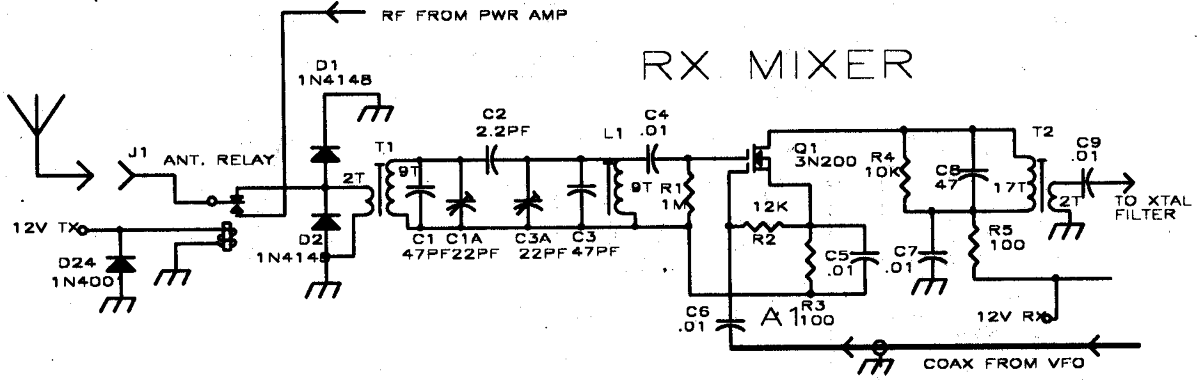
Connect a small piece of wire at the live connection of the output of a RF test oscillator to act as an antenna and then tune the oscillator around 9 MHz. You will hear a loud whistle as you vary the oscillator frequency across 9 MHz. Adjust the oscillator frequency at 9 MHz so that you hear a constant audio tone, then tune IFT T3 for maximum audio from the loudspeaker. You may have do decrease the RF level from the oscillator and the audio volume of the receiver for proper peaking of T3. The T3 should peak around the mid position of the core. You may have to increase or decrease the value of C16 to achieve correct tuning. The value of C16 may be between 47 to 68 pF. Try 68 pF first.

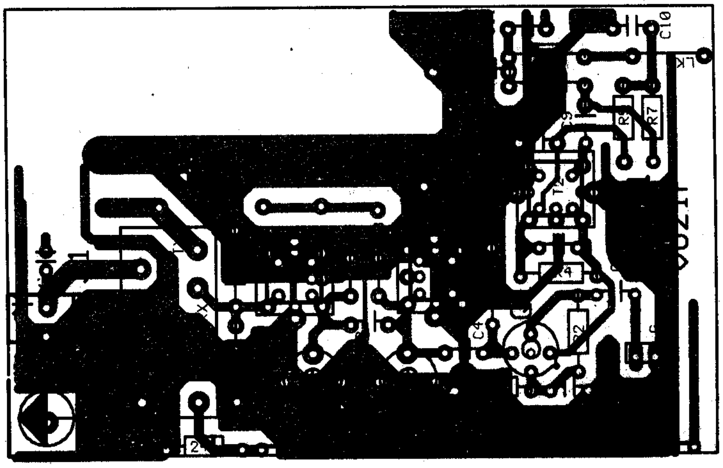
If you are able to adjust the test oscillator frequency exactly at Xtal filter's frequency (a rather difficult job with ordinary RF oscillators) then you can also peak the IFT T2 with capacitor C8 in a similar way. First try 68 pF for C8. If you can not tune the T2 at this stage do not worry, it can be tuned after assembling the first mixer stage. A GDO can also be used as a signal source in place of a RF test oscillator.

When tuning the IF stage if you encounter instability, first check if the two coaxial cable connecting the output of the BFO to the mixer input of IC7611 near the pin 8 and 9. If they are connected properly then high injection from the BFO might be the culprit. The BFO injection can be reduced by reducing or removing the capacitor C27 and also by slightly detuning the BFO output transformer T4. Dry solder or defective bypass or decoupling capacitors may also be the reason for instability. Check all the components carefully.

THE RECEIVER MIXER

If all the previous stages are working properly, solder all the components of the receiver mixer stage Q1. Here also you can use BF966 in place of 3N200.





The RFT T1, C1,C2, C3, and coil L1 forms a band pass filter to allow 20 meter signals (14 to 14.35 MHz) to pass through. In the PCB there is provision for fixing trimmer C1A in parallel to C1 and C3A in parallel to C3. If you are using slug tuned IFTs then these trimmers are not required, but if you wish to use RF toroids then for peaking the T1 and L1 these trimmer will be required. Even otherwise if you wish to experiment with different values for the band pass filter, you may find these trimmer useful. If you are using ready made coils available from **ARA** then do not solder these trimmers.

Connect the VFO output to the mixer input by using a miniature RF coaxial cable. This cable is connected between the PCB pins soldered on the VFO output point A1 near the capacitor C149 and the PCB pins solder on the point A1 marked VFO near the IFT T2. Take care to solder the shield of the coaxial cable to the ground pins on both end. do not interchange the live and ground connection, it will short the VFO output. Also take care not to short the coaxial inner and outer conductors while soldering . After soldering the coaxial cable check and confirm with a multimeter.

After soldering and checking for short or solder bridge, apply power. Adjust the RF test oscillator or GDO to 14.175 MHz i.e. around middle of the 20 meter band. Connect a small piece of wire to the oscillator out put to act as an antenna. Power the PCB and tune the oscillator signal with VFO (i.e. vary your VFO frequency till you here the oscillator signal), now if everything is proper and you have not made any mistake in the mixer stage, you should be able to hear an audio tone in the speaker when you tune to the test oscillator frequency. Now tune T1 , L1 and T2 for maximum audio for the speaker. Here also you may have to decrease the oscillator level and audio volume several times to peak all the coils properly. All the coils should peak around the middle position of the core. First try.68 pF capacitors for C1, C3 and C8. Increase or decrease as required. Repeat the adjustments two or three times.

The final adjustments for the band pass filter will be done after the AGC has started functioning.

After initial tuning with the test oscillator, connect external 20 meter aerial to the receiver input. Some time in the evening when the band is quite open and there are several ham stations on the band, switch on the ATS-1 receiver. You should be able to hear at least the strong ham signals though the audio at this stage may not be clear.

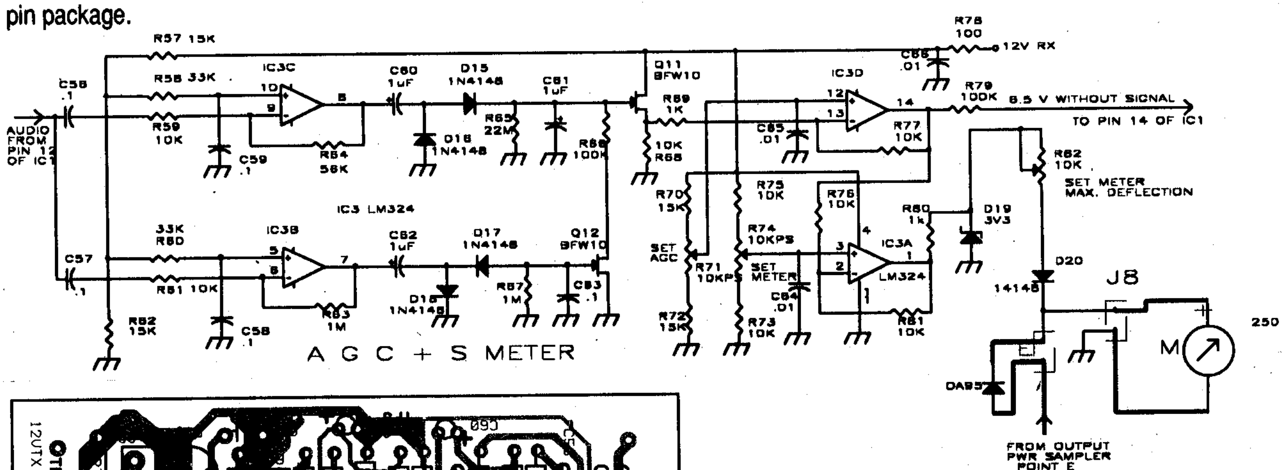
Tune in a strong SSB signal with VFO to get maximum audio. Now again peak the coils T2 and T3 for maximum audio.

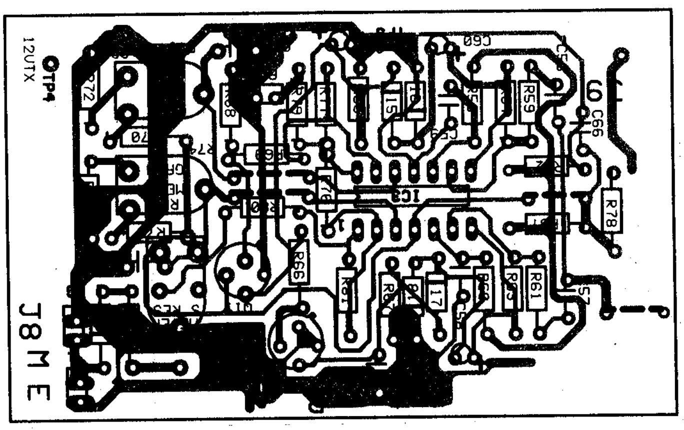
If the audio signal is strong but speech is not clear or natural, it may be due to your BFO not being on the correct frequency. For USB operation the BFO must be at 8.9985 MHz and for LSB operation it should be at 9.0015 MHz. Check and correct the BFO frequency as given in the BFO section.

If you do not have a frequency counter, you can adjust the BFO frequency by listening to a HAM USB signal on 20 meter. Tune in a strong SSB signal on 20 meter and rotate the trimmer C31 very slowly with a fiberglass or plastic tuning tool, till you hear clear and natural sounding audio at the center of the filter pass band. For checking the audio across the filter passband fine tune the VFO with the RIT control.

AGC

After the RX has started working, solder all the components in the AGC circuit. IC3 (LM324) has four operation amplifier in one 14 pin package.





Connect a 250 uA full scale deflection DC meter to the PCB pins soldered at J8. An ordinary small VU meter of the type used in Audio amplifier can be used. Connect the output AGC output from near C65 to the AGC pin of IC1 near PIN 14 of IC3.

Use a small piece of miniature coaxial cable, solder PCB pins at both ends . Check with multimeter, make sure that the ground connection is not interchanged thereby shorting the AGC output.

This is an audio derived AGC. The audio signal from the output of CA7611 (pin 12) is fed to two opamp via capacitor C56 and C57. The amplified signal from opamp IC3C is positively rectified by diodes D15 and D16 acting as voltage doubler. The rectified positive voltage charges the capacitor C61. The voltage at C61 is fed to the gate of Q11 (BFW10) source follower. The output is taken from the source resistance R69 and is then amplified and inverted by IC3D. This amplified and inverted AGC voltage is fed to the pin 14 of the IC1 CA7611. The voltage at pin 14 controls the gain of IC1. More is the voltage at pin 14 more is the gain. The gain saturates at about 8 volt at pin 14 when operating CA7611 from 12 volt supply.

The gain of the first opamp IC3C is decided by the ratio of R64 and R59 and the gain of the AGC amplifier IC3D is decided by the ratio of R77 and R69.

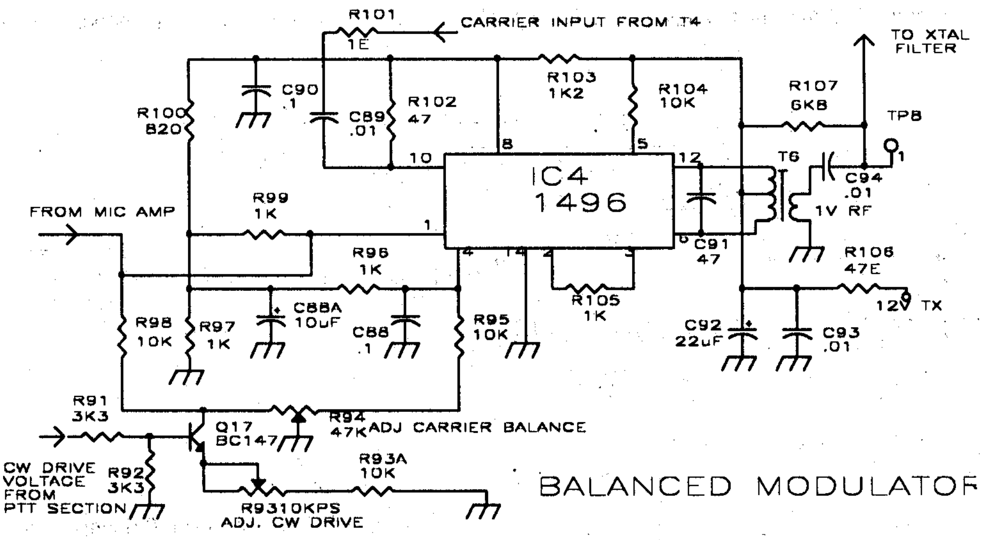
Variation in the level of input signal will very the DC voltage at the capacitor C61, which in turn will control the gain of the IF amplifier.

As soon as the input signal had decayed the charge stored in C61 will start slowly leaking to ground thorough R65 (22M) since this is the only path available to ground because on one side the diode becomes reverse biased and the other side is the high impedance gate of JFET Q11. The time constant of this decay and thus variation of AGC voltage depends on the value of C61 and R65, this is therefore quit large. This large time constant is necessary to have smooth AGC action during a QSO to take care of signal strength variation due to ionospheric fading. The disadvantage of this type of slow AGC is that after a strong noise pulse or strong signal has died down : the receiver remains desensitive for some time depending on the AGC time constant.

To overcome this annoying dely in receiver becoming fully sensitive after a strong signal, the IC3A, Q12 and associated circuit is used. The audio from CA7611 is amplified by IC3A and then rectified by D17 & D18 to negatively charge the capacitor C63 (0.1 uF). This negative charge at C63 keeps the gate of Q12 negatively biased and therefore whenever the receiver is receiving some signal, Q12 remains in cutoff stage (i.e. non-conducting stage). Now as soon as the incoming signal has died down, the negative voltage at C63 quickly decays to ground through R67 which is only 1 Meg Ohms. Since here we have kept the time constant small by choosing low value for C63 (0.1uF) and R67 (1 Meg), the negative bias from the gate of Q12 is removed very quickly (within few milliseconds) and as soon as the negative bias is removed form the gate of Q12 it starts conducting and quickly discharges the main AGC capacitor C61 to ground via R66 which is only 100 K Ohms. Because of this quick discharging of C61 the receiver now regains its sensitivity very quickly.

So now we have an AGC which has a slow time constant C61XR65 when a signal is present and which recovers very fast with a time constant of C61XR66 as soon as the signal disappears.

To adjust the AGC : remove the antenna from the receiver, switch on the receiver, adjust the preset R71 to get about 8 volt (some hams who are using ATS-1 recommend 6.5 volt) at pin 14 of IC1. Adjust R74 to set S meter to Zero. R82 is for adjusting meter deflection on strong signal. With antenna connected, when a very



BALANCED MODULATOR

strong signal is present the voltage at pint 14 of IC1 will vary about 4 to 5 volt.

IC3A is used as inverter to display the AGC voltage on S meter. R82 is used to adjust meter sensitivity.

The receiver AGC is only for operator's convenience and is not a necessary part of the receiver. If initially you want to keep thing simple, you can skip the AGC stage and after getting the receiver working you can start work on the TX section. The AGC can be added later on when complete transceiver has started to work properly.

If you do not want to use age at all, you can use a front panel mounted variable resistance of 470K (or 1 M) in place of PCB mounted R16. This will act as a manual IF gain control. In this case only two terminals of the variable resistance will be used. One end terminal and the central terminal. Use the end terminal which gives increase in gain for clockwise rotation of the knob.

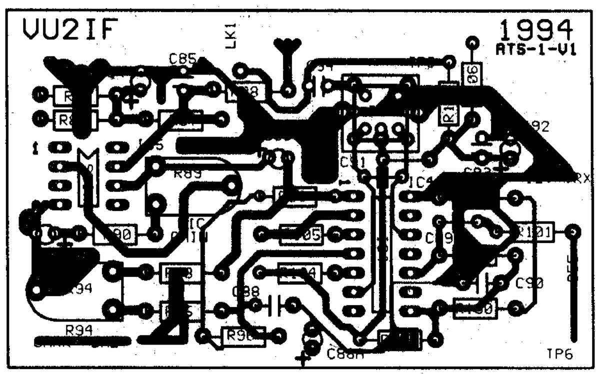
ATS-1 TRANSMITTER SECTION

After you have assembled and tested the receiver section : you can start assembling the transmitter section.

BLANCED MODULATOR

IC4 LM1496 with as associated components forms the balanced modulator. It is this stage where the audio form the Mic amplifier is modulated on the carrier frequency (8.9985 MHz for USB) to produce suppressed carrier Double Side Band (DSB) signal. The unwanted side band is then removed by the crystal filter. Power is supplied to the IC4 only during the transmit mode.

The audio form the Mic amplifier is fed to pin 1 of IC4 through capacitor C96. The Carrier frequency signal form BFO is fed to



pin no. 10 of IC4 through capacitor C89 . The 9 MHz DSB signal is available at the output side of T6. This DSB signal is fed to the input of crystal filter through diode switch D4. During transmit forward DC bias is applied to this diode through resistance R107 which allow passing of the DSB signal form T6 to the xtal filter.

The variable resistor R94 is used for balancing i.e. canceling out the carrier signal. For CW operation the balance is disturbed by shorting one end of R94 to ground through resistors R93 and R93A (marked as 39A on some earlier PCBs) by applying DC bias to the transistor Q17. The level of unbalance (thus the carrier level) can be adjusted by the variable resistance R93. Initially deep 94 in the mid position and R93 in minimum position (i.e. slider of R93 towards R93A).

The crystal filter will filter out the LSB signal and allow only USB signal to pass through (assuming that you are using 8.9985 MHz crystal in the BFO). This USB signal is amplified by the post filter amplifier Q2, which is active in both TX and RX mode. The amplified USB signal is then fed to the Transmit Mixer stage IC6.

After soldering and checking the components of the Balanced modulator section, apply power to the PCB and press the PTT switch. If everything is OK than you can hear the DSB signal in a communication receiver tuned to 9 MHz in USB or LSB mode. Tune the transformer T6 for maximum reading in the S meter of the communication receiver or you can use a RF voltmeter or CRO connected to one leg of D14. Do not disturb the RFT T3 as this stage was already tuned to 9 MHz during alining the RX stage.

Next measure the level of BFO injection at pin 10 of IC4 with RF millivoltmeter. This level should not be more than 220 mV. (see BFO section).

For adjusting the audio gain (R89), listen to your 9 MHz DSB signal in a communication receiver and speak in normal voice in to the microphone. Adjust the audio level by varying R89 so that clear audio without clipping and distortion is heard from the receiver.p

In case you don't have access to a communication receiver, this adjustment can be done after the next transmit mixer stage has started working.

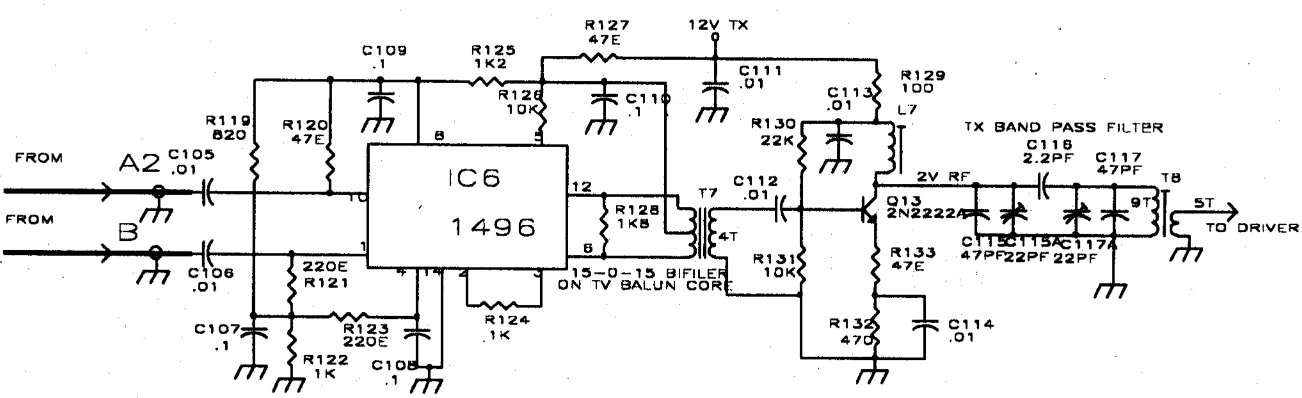
POST FILTER AMPLIFIER

Q2 and associated components forms the post filter amplifier. This stage is common to both Rx and Tx circuit and is already aligned during the receiver construction. The output of this amplifier is fed to the transmit mixer section through capacitor C106.

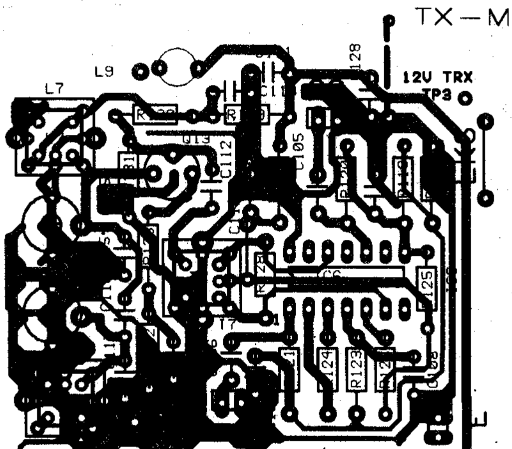
THE TRANSMIT MIXER

The IC6 and associated components forms the transmit mixer section. IC6 is also LM1496 double balanced mixer. The USB signal form the post filter amplifier is mixed with the 5 MHz VFO signal to give both 80 meter (4 MHz LSB) and 20 meter (14 MHz USB) signal at the output of the wideband transformer T7. This signal is amplified by the transistor Q13 (2N2222A) and then the 80 meter signal is filtered out by the band pass filter comprising of L7, T8, C115, C115A, C117 and C117A. The band pass filter allows only 20 meter signal to pass thorough. The output of the band pas filter is fed to the first stage of driver amplifier via capacitor C118.

The VFO signal at the input of the transmit mixer (pin 10 of IC6) should be around 300 mV. Check with a CRO or RF millivoltmeter. If it is more, then you can decrease it by decreasing the value of capacitor C51 and C105 till you get proper value. If you are using



TX—MIXER & TX B.P.F.

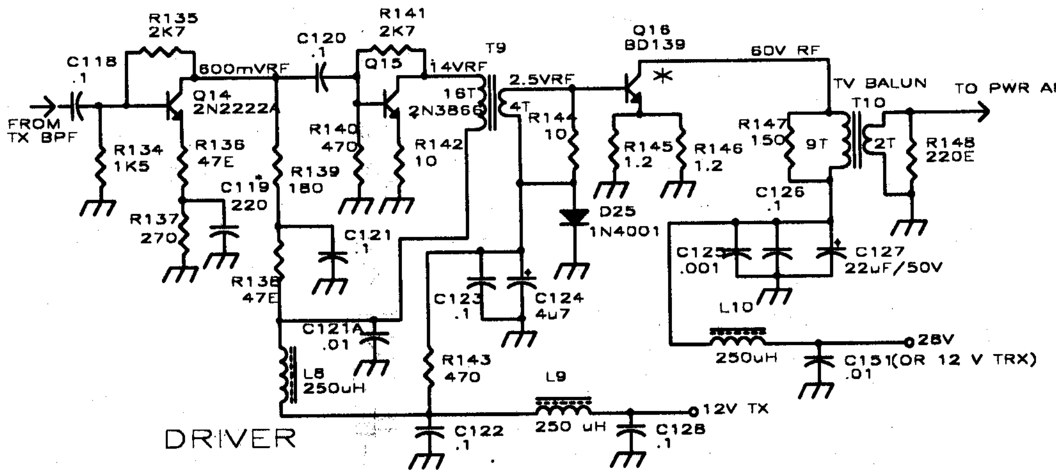


slug tuned coils then you do not need C115A and C117A. For C115 and C117 initially use 68 pF NP0 disc ceramic capacitors. For initial tuning of the bandpass filter : First solder Q14, Q15 and associated components (except C119), Adjust the VFO frequency around 5.175 MHz, adjust the CW carrier level pot R93 for maximum carrier leak thorough. Use a Morse Key for changeover to transmit mode. Connect the probe CRO at the collector of Q14. Tune L7 and T8 for maximum reading of RF volt at the collector of Q14, also check and verify from CRO that the frequency is of RF signal is 14.175 MHz, this is done to make sure that you are by mistake not peaking the coils for 80 meter signal. If you do not have a CRO then solder about 15 c.m. of insulated wire at the collector of Q14, tune a communication receiver around 14.175 MHz till you here the audio tone. Check and verify (by sending some Morse letters with Morse key) that it is the signal from your ATS-1 which you are hearing form receiver and not by chance any at 14.100 MHz and T8 at 14.25 MHz. Now very the frequency with VFO from 14.00 to 14.35 MHz, keep the Key pressed, if the response is flat the S meter reading will remain almost same as you very the frequency. If this is not so peak both the coils at slightly lower or higher frequency till you get the required response.

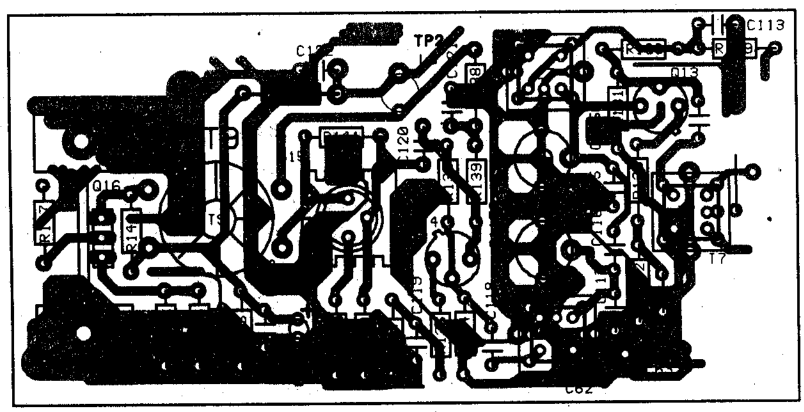
Remove the wire soldered to the collector of Q14.

THE DRIVER AMPLIFIER

The driver amplifier is a three stage wideband amplifier based on a circuit given in ARRL Hand Book (1984). It is capable of flat response from 80 to 10 meter. We have however used transistors and ferrites available in local market. The power output of the Driver amplifier is between 1 to 2 Watts.



DRIVER



external signal. After that peak L7 and T8 for maximum reading on S meter of communication receiver. You can also do this tuning by using a GDO in diode mode and tuned to 14.175 MHz. Couple the GDO coil to the small peace of insulated wire solder to Q14 collector.

This is only a rough tuning of the transmit band pass filter because the two coils are to be stager tune to get a flat response from the band filter from 14 to 14.35 MHz. For doing this now peak the L7

The three RFCs used in the driver: L8, L9 and L10 should have inductance of about 250 uH. They are wound on 6 mm (1/4") small two hole ferrite balun cores. You can use T12 toroids also. Wound about 35 to 40 turns copper enameled wire 26 swg (or nearby) gauge. The coils should be spread evenly around the two holes (or the toroid).

T9 is wound on large 12 mm (1/2") two hole ferrite balun core with 26 swg copper enameled wire. The primary has 16 turns and the secondary has 4 turns.

Be careful when soldering T9 or T10 and **do not solder the transformers the other way round** i.e. secondary and primary coil interchanged.

Solder remaining components of the driver stage. First solder two PCB pins in place of C119 and solder 1 K pf ceramic disc capacitor on these pins. Initially wind 9 turns in the primary and 5 turns in the secondary of the ferrite transformer T10. Use a two hole 12 mm long ferrite balun core and 26 swg copper enameled wire. Connect the output of T10 directly at the antenna point i.e. junction between C140 and C137 with a jumper wire. Fix heat sink on Q15 and Q16. The Q16 has to be insulated for the heat sink by using a mica washer. Use silicon grease on both side of the mica washer and fix the Q16 on the heat sink tightly with screw and nut.

Next solder the components C140, D28, C139, Pot R155, C152, diode OA95 or equivalent in place of R155, connect the wire link from C150 to the S meter connection point E on the PCB. Set the pot R155 for maximum sensitivity of S/Power meter, i.e. slider of R155 t towards the end connected to C138+.

Now connect either a 50 ohms dummy load capable of handling 5 watts power, or a 50 ohm external antenna to the RF output of ATS-1 PCB.

Switch on the ATS-1 on CW mode. Now if everything is soldered correctly, on pressing the Morse Key you should be able to see some deflection in the S/Power meter. If the meter is going beyond say half mark then decrease the deflection with pot R155, till it is about half scale.

Now by using the power meter reading as indication, systematically re-tune the transmitter stages for maximum output. Start from T6, then T3 then L7, and then T8.

Now check with RF millivoltmeter or CRO the RF voltage at the collector of Q14 it should be around 600 mV. If it is more or less, it can be adjusted by varying the value of the negative feedback capacitor C119. Use next higher or lower value till you get correct voltage at the collector of Q14.

The peak RF volt at the antenna input should be around 25 volt corresponding to about 2 watt output at the antenna.

INITIAL TESTING ON THE AIR IN 2 WATT QRP MODE

If you have successfully completed all the stage so far, then you ATS-1 is ready for initial testing on the AIR in the QRP 2 Watt mode.

But before testing on air mark the 0 position (mid point of rotation of RIT pot). In ATS-1 the RIT is always on. It is necessary to mark the zero point, i.e. the position of RIT pot where both TX and RX frequencies are same. You need either a Frequency counter or a communication receiver for this adjustment. Tune the communication at 5.100 MHz and press the Morse Key and vary the VFO frequency till you here the beat of the VFO signal in the communication receiver. Now revert to receiver mode and now vary the RIT pot till you hear the same beat note from the communication receiver. Mark the position of the RIT pot on the front panel as the zero position of RIT. Or if you are using a frequency counter then first measure the frequency of VFO at the test point TP7 (VFO output) in the TX mode then in the RX mode rotate the RIT pot till you get the same frequency. Mark the position of the RIT pot as the Zero position.

Whenever the RIT pot is set at the zero position, Both the Transmit and receive frequency are same. Whenever Calling CQ on ham band first keep the RIT at zero position and only after establishing a contact, then during the QSO you can adjust the receiver frequency with RIT for fine tuning of the received signal.

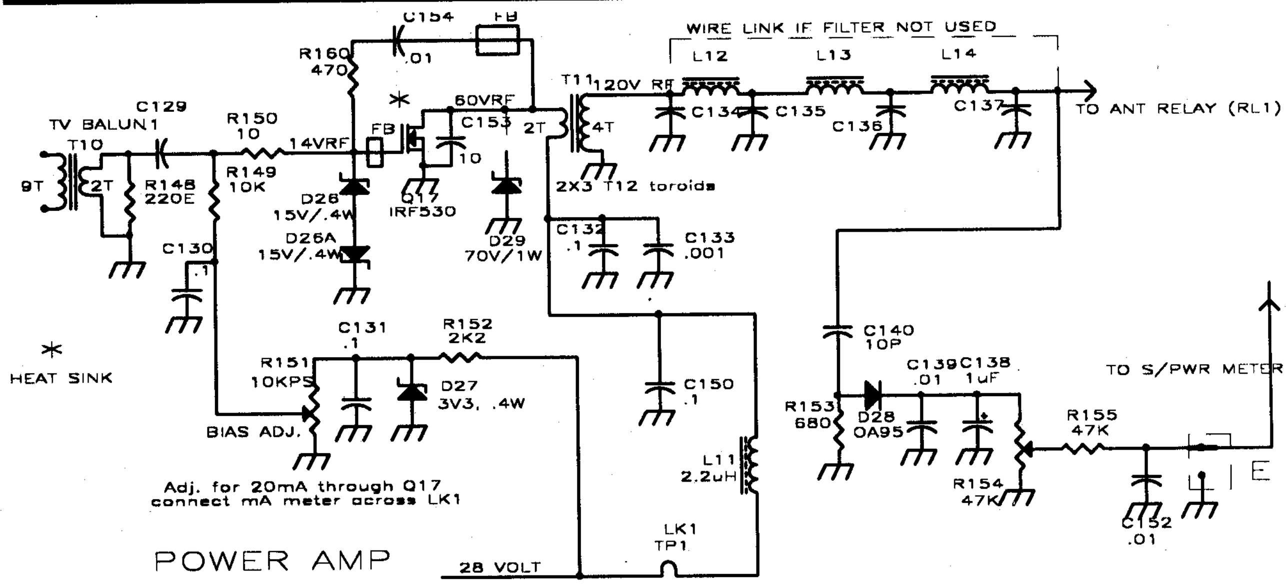
Now again minimise the carrier in the SSB mode with the balancing pot R94. Fix a schedule with another ham who is capable to copy your QRP signals and is friendly enough to help you, in your first on the air testing of ATS-1. It will be helpful if you also have a phone or VHF connection with him.

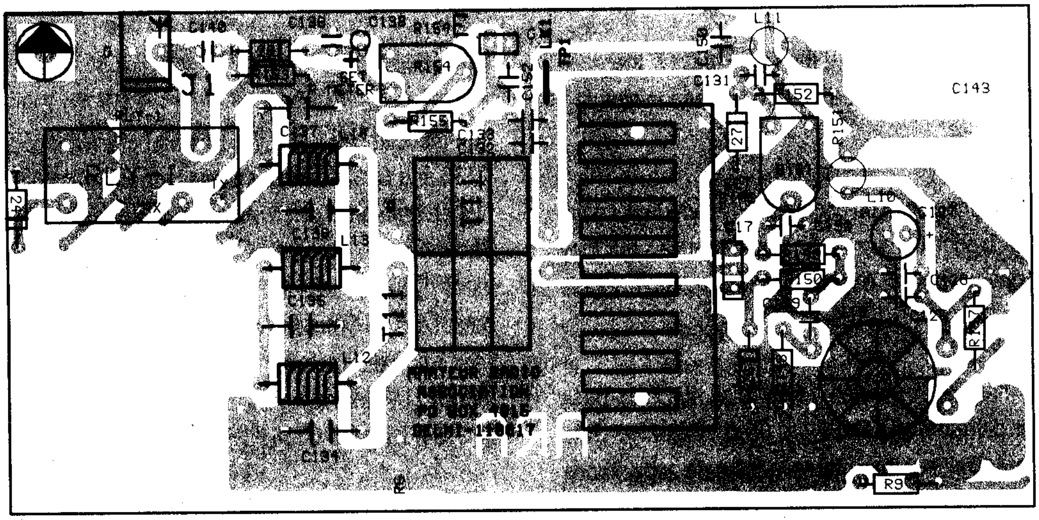
Transmit in the USB mode and adjust the MIC gain with R89 for distortion free audio and C12 for smooth natural sounding audio. AT this stage if necessary you can also experiment with DC bias given to the condenser Mic by trying out various values for R83. After adjustment in the USB mode, adjust the carrier level in the CW mode with the pot 93. Adjust R93 to get maximum S meter reading in your friends receiver, without distortion or overloading i.e. a clean pure sine wave tone in the receiver.

THE POWER AMPLIFIER

After you have tested the ATS-1 in 2 Watt mode, you can now solder all the components of the power amplifier stage except the power MOSFET. Remove the T10 transformer which was soldered when testing the driver stage and rewind it so that now the primary has 9 turns and secondary has 2 turns. Resolder T10 on PCB.

The RFC L11 carries all the DC current for the power stage





therefore the wire used should be capable of carring about 3 to 4 ampere and the ferrite used should not saturate even if duble the normal current flows through it. The inductance can be between 2.2 to 10 uH. You can use either a 25 mm dia 5mm thick toroid or two or three T12 toroid cores stuck together with ruber solution can be used. Wound about 10 turns of 22 or 24 gauge enameled copper wire with turns evenly spaced around the toroid.

For T11, the output transformer you can use a large 12 mm two hole balun core for up to 10 watt. For higher power you can make a bigger balun shape by sticking two or three T12 ferrite toroids together to form a longer tube of ferrite and then stick two similar tubes along side with rubber solution to form a big ferrite balun core. The primary has 2 turns and the secondary has three or four turns. Use insulated copper wire for secondary and primary. If you do not have thick gauge wire, you can twist two or three thin wires. Use such a gauge that the secondary and primary turns almost completely fill the holes of the balun.

Check the circuit and if every thing is OK power the PCB but do not press the key or PTT and measure the voltage ate the gate terminal of Q17 i.e. the point between R150 and D26. Adjust the biasing pot R151 such that you get about 2.2 volt at the gate of Q17. Now press the key and measure the RF voltage at the gate of Q17. It should be about 14 volt RF peak to peak. Adjust the CW drive level with the preset R93. The absolute maximum safe limit for gate RF voltage is +/- 20 volt. A single spike above this limit will puncher the gate of the power MOSFET. If you are getting much higher RF peak voltage at the gate, it may be due to reverse connection (i.e. secondary and primary interchanged) of T10. Verify the connection of T10 very carefully. Similarly carefully check and Verify the connections of the output ferrite transformer T11.

If all connections are OK, solder the power MOSFET Q17 and fix a heavy heat sink. Q17 is also to be isolated from the heat sink with a mica washer and plastic spacer for the screw. Use silicon grease on both side of the mica washer and fix Q17 tightly on the heat sink with nut and screw.

Install a heavy heat sink on Q17. You can use a 6mm thick 7.5 or 10 cm aluminium angle about 7.5 cm long as heat sink and screw additional additional fined heat sink on this aluminium angle.

Connect a DC milliampere meter (or a multimeter in the current measuring mode) across the link LK1 and switch on the on the ATS-1 but do not press the key or PTT i.e. remain in the receiver mode. Now adjust the biasing pot R151 slowly so that it shows a bias current of about 20 mA through the power MOSFET Q17. Switch off the ATS-1 and remove the DC ammeter. Short the LK1 with a fuse wire capable of caring about 3 ampere maximum.

Several different power MOSFETs can be used for Q17.(IRF630, IRF430 etc.)

Since we are using about 28 volt at the Drain of Q17, the POWER MOSFET should be rated for 100 volt and minimum 3 ampere rating.

FETs of still higher voltage can be used but they show lower gain. Similarly FETs of higher current rating could be used but they require higher driving power because of higher Gate-Sourse capacitance.

You can experiment with various FETs. The back to back connected zener pair D26 and D26a are used to limit the Gate voltage under safer limit but they increase the gate capacitance and once you have finalised the gate RF voltage, output power and the type of MOSFET to use, you can remove them if you prefer. Similarly the resistance R150 could also be reduced or removed to get increase output power.

To stop VHF parasitic oscillations you can use a small ferrite bead on the gate of the MOSFET and solder a 10 to 56 ceramic disc capacitor between the drain and ground.

Power MOSFETS can be quickly destroyed by momentary voltage higher that the maximum Drain voltage. When operating at maximum power level the voltage at Drain will swing to about Double the DC voltage at the Drain. Therefore during initial testing solder a 1 watt 60 volt zener between the Drain and ground of the Power MOSFET. The cathode of the zener is soldered to the Drain. If you are unable to get a zener of 60 volt rating you can solder two or more one watt zener in series to get a total 60 volt rating. This zener is shown connected to the Drain with dashed line . After you completed the testing of the power stage and are sure that the Drain voltage even in worse case will not go higher than the Drain voltage rating you can remove the zener or if you like you can the zener connected. Remember no pcb space is provided for this zener and this has to be solder on the drain terminal of Q17 and some nearby ground point.

For further improving the stability of the PWR stage you can use negative feedback from Drain to Gate by connecting the Drain to gate through a .01 capacitor C154 in series with R160 with one or two ferrite bead on the connecting wire.

All these components connected to increase stability will decrease the overall gain of the PWR stage, and some of them may not be required but initially it will be safer to use them and later on you can remove them one by one .

Hams who have made ATS-1 have obtained output power in 10 to 30 watts range.

Output filter

The inductances L12, L13, L14 and capacitances C134, C135, C136 and C137 forms a multisection low pass filter to attenuate higher harmonic of 20 meter signal which could cause TVI. Though space is provided for all these components on the PCB, initially you can feed the antenna without any filter. Connect the output of T11 directly to antenna output point on the PCB with a wire link. Later on you can experiment with various filters to reduced TVI. Initially try a simple pie type low pass filter consisting of C134, L12 and C135.

Given below is a table for the values of the components used in the output filter for various ham bands. Though ATS-1 is primarily intended for 20 meter operation some hams has made it for different bands. These component values have been taken form a article by Dug DeMaw W1FB : Power-Fet Switches as RF amplifiers, QST April 989, 30-33 pp.

Band	C134/C135	C135/C136	L12/L14	L13
	pF	pF	uH	uH
75/80 M	560	1200	2.46	2.89
40 m	470	820	1.4	1.56
30 m	220	470	0.96	1.13
20 m	110	300	0.6	0.65
17 m	100	250	0.52	0.65
15	110	240	0.48	0.56
12 m	120	270	0.54	0.63
10 m	56	150	0.3	0.38

The capacitors are silver mica or polystyrene, 100 volt or greater Use 24 swg or nearby by gauge of copper enameled wire for the coils wound on torrid cores. air core coils can also be used. When using air core coils fix them in such a way that each coil is at right angel to the nearby coil.

If you have access to a inductance meter / bridge or a LCR bridge you can make the coils by measuring the inductance or you can estimate the inductance by paralleling the coil with a known value of capacitance and then measuring the resonance frequency. From the resonance frequency you can calculate the value of inductance since you already know the value of the capacitor.

NOISE REDUCTION IN RX

The receiver IC1 CA7611 from some manufacturers are of higher gain and require very less BFO injection. With normal level of BFO injection of ATS-1 these ic produce excessive mixer noise. This mixer noise can be reduced by further decreasing the BFO injection to the pin 8 and 9 of IC1. You can omit the C27 and use a low gain translator (say BC147) in place of 2N2222A at Q4.

In the worst case, three additional resistance are used i.e. R161, R162 and R163 for BFO injection. There is no space for these resistances on the pcb. Solder R163 below the pcb pins near pin 8 & 9 of the IC1. Solder R161 and R162 in place of pcb pins near RFT T4 and solder the central conductors of the two miniature coaxial cable to the other end of these resistances. This will reduce the mixer noise to large extent. Try this only after the complete TRX is working OK.

For further reduction of mixer hiss a very simple low pass filter is made of R52, C67 and C68. For further reduction of mixer hiss you can replace R52 by a 33mH audio choke. You can experiment with different value of AFC, C67 and C68 to decrease the mixer hiss.

ATS-1 PARTLIST

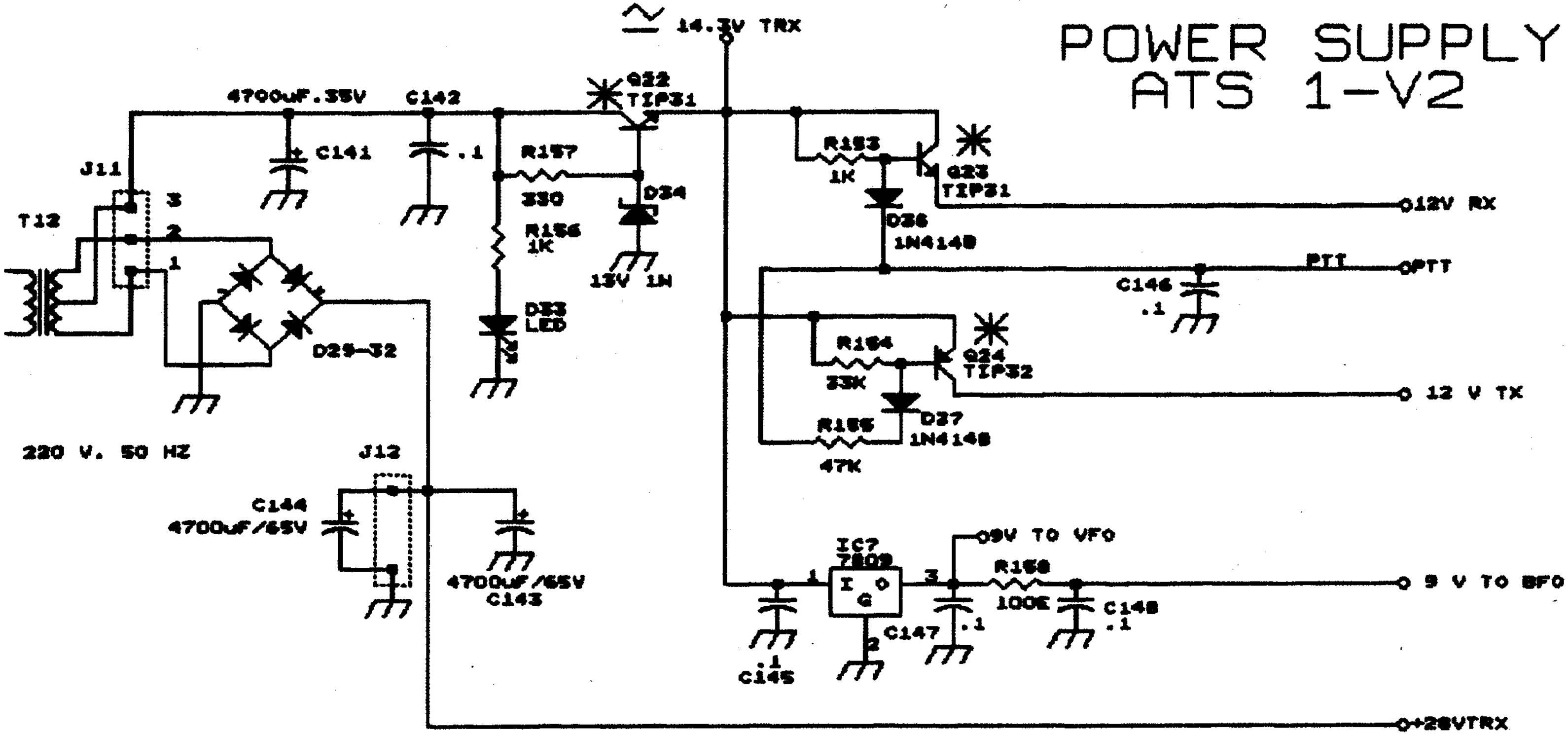
S.No.	Item	Quantity	Reference
1	2.2PF	2	C2,C116
2	10PF	2	C140,C153
3	22PF	1	C12
4	22PF TRIMMER	7	C1A,C3A,C31,C32,C38, C115A,C117A
5	33PF	2	C43,C45
6	47PF	1	C37
7	68PF	9	C1,C3,C8,C16,C24,C28,C91, C115,C117
8	100PF	1	C89
9	220PF	2	C27,C119
10	330PF	1	C105
11	470PF	4	C39,C40,C49,C50
12	560PF	2	C81,C82
13	0.001uF	5	C19,C23,C76,C125,C133
14	0.01uF	57	C4,C5,C6,C7,C9,C10,C11, C13,C14,C15,C17,C18,C21, C25,C26,C29,C30,C33,C34, C35,C36,C42,C46,C47,C48, C51,C53,C54,C55,C64,C65, C66,C71,C74,C80,C93,C94, C95,C96,C97,C99,C100, C101,C102,C103,C103A, C106,C111,C112,C113,C114, C121A,C139,C149,C151, C152,C154
15	0.1uF	31	C41,C44,C56,C57,C58,C59, C63,C83,C85,C90,C107, C108,C109,C110,C118,C120, C121,C122,C123,C126,C128, C129,C130,C131,C132,C142, C145,C146,C147,C148,C150
16	0.22uF	2	C20,C67,C68
17	4		C134,C135,C136,C137 SEE TX LPF TABLE
18	1uF electrolytic	6	C60,C61,C62,C73,C86,C138
19	4u7 electrolytic	1	C124
20	10uF electrolytic	4	C69,C72,C87,C88
21	22uF electrolytic	1	C92
22	22uf/50V electrolytic	1	C127
23	47uF electrolytic	1	C22,C98
24	100uF electrolytic	2	C70,C84
25	470uF electrolytic	1	C75
26	4700uF electrolytic	1	C141
27	4700uF/50V electrolytic	2	C143,C144
28	1.2E	2	R145,R146
29	2.2E	1	R54
30	10E	4	R56,R142,R144,R150
31	22E	2	R101,R163
32	47E	6	R18,R106,R127,R133,R136, R138
33	51E	3	R17,R102,R120
34	100E	15	R3,R5,R11,R12,R20,R23, R29,R31,R32,R33,R35,R78, R88,R129,R158
35	150E	1	R147
36	180E	1	R139
37	220E	3	R121,R123,R148
38	270E	1	R137

39	330E	2	R36,R52
40	470E	6	R19,R116,R132,R140,R143, R160
41	560E	3	R8,R39,R84
42	680E	1	R153
43	820E	2	R100,R119
44	1K	17	R6,R13,R14,R21,R69,R80, R87,R90,R96,R97,R99,R105, R122,R124,R156,R161,R162
45	1K2	2	R103,R125
46	1K5	1	R134
47	1K8	1	R128
48	2K2	7	R83,R108,R109,R111,R115, R152,R159
49	2K7	2	R135,R141
50	3K3	6	R15,R40,R48,R50,R91,R92
51	4K7	7	R9,R41,R43,R44,R45,R47, R112
52	5K6	1	R22
53	6K8	4	R7,R25,R26,R107
54	9K1	2	R49,R51
55	10K	19	R4,R10,R37,R59,R61,R68, R73,R75,R76,R77,R81,R93A, R95,R98,R104,R113,R126, R131,R149
56	12K	2	R2,R55
57	15K	4	R57,R62,R70,R72
58	18K	2	R114,R117
59	22K	4	R38,R85,R86,R130
60	33K	2	R58,R60
61	47K	1	R155
62	56K	1	R64
63	100K	6	R24,R27,R34,R42,R66,R79
64	330K	1	R16
65	1M	3	R1,R63,R671
66	22M	1	R65
67	1K LIN POT	1	R46
68	10K,10TURN POT	1	R30
69	10K LOG POT	1	R53
70	10K PS Horizontal	7	R71,R74,R82,R93,R110, R118,R151
71	47K PS Horizontal	2	R94,R154
72	100K PS Horizontal	1	R89
73	330E/1W	1	R157
74	COIL-SET FROM ARA	1	L1-L14,T1-T11
75	1N4148	16	D1,D2,D3,D4,D5,D6,D7,D8, D11,D13,D14,D15,D16,D17, D18,D20

76	1N4001	6	D21,D22,D23,D24,D25,D35
77	1N5408	4	D29-32
78	OA95	2	D28,D29
79	MV2109 VARICAP	3	D9,D10,D12
80	3V3 ZENER	2	D19,D27
81	13V/1W Zener	1	D34
82	15V/.4W Zener	2	D26,D26A
83	70V/1W Zener	1	D29
84	LED	1	D33
85	LM324	1	IC3
86	741	1	IC5
87	7809	1	IC7
88	LM386	1	IC2
89	LM1496	2	IC4,IC6
90	CA7611	1	IC1
91	3N200	2	Q1,Q2
92	BC147	5	Q3,Q9,Q10,Q17,Q21
93	2N2222A	4	Q4,Q8,Q13,Q14
94	BFW10	5	Q5,Q6,Q7,Q11,Q12
95	2N3866	1	Q15
96	BD139	1	Q16
97	IRF530	1	Q17
98	BC177	2	Q18,Q19
99	BEL548	1	Q20
100	TIP31	1	Q22
101	8.9985 MHz CRYSTAL (USB)		1 X1
102	9.0015 MHZ CRYSTAL (LSB)		1 X2
103	9MHz BEL CRYSTAL FILTER		1 X-FIL.
104	SPEAKER 4 Ohms 1W	1	LS
105	0.5AMP FUSE WITH HOLDER		1 F1
106	CONDENSER MIC WITH PTT		1 J2
107	RELAY SPDT PCB MOUNTING		1 RLY-1&2
108	3 PIN POWER CORD AC		1
109	UHF CONNECTOR	1	J1
110	SWITCH DPST 2A	1	S1
112	SWITCH SPDT 2A	2	S2,S3
113	MORSE KEY	1	J6
114	PCB PINS	25	-
115	POWER TRANSFORMER 12-0-12 VOLT 3A SECONDARY		1 T12
116	HEAT SINKS FOR Q15,Q16,Q17,Q22		-
117	ATS-1 PCB	1	FROM ARA
118	S-METER	1	250uA VU METER
119	PCB PINS	15	BURG STRIPS
120	CHASSIS	1	-

Note =All resistances are .25 watts except R157 which is 1W.
All capacitors are disc ceramic unless stated otherwise.
C37,C39,C40 are polystyrene.
All electrolytic capacitors are of 16 volt unless stated otherwise.

POWER SUPPLY
ATS 1-V2



IN ATS1-V2 THE RELAY RLY-2 IS NOT USED

Q23 & Q24 ARE USED INSTEAD, FOR TX RX SWITCHING

Q22 & Q23 USED IN PLACE OF RELAY RLY2
SEE COMPONENT LAYOUT ON ATS1-V2 PCB