RM-96 A COST EFFECTIVE 7 MHz SSB TRANSCEIVER

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THE IDEA

It has been quite some time since I thought of building a solid state 7 MHz SSB transceiver, especially to work on 12 V battery. However, the project took quite a few years to materialize due to involvement in satellite work like building special antenna systems, cavity type linear power amplifiers etc. Finally since three of my sons got their licenses, I thought of building the equipment for them and sat with the project seriously.

The following are the criteria, which I considered as important in the proposed circuit arrangement of a simple SSB transceiver.

1. To make use of Low priced components available in Indian market.
2. To use simple and Low cost mechanical devices for the Tuning system, dial etc.
3. Simple circuitry with acceptable performance.
4. Minimum controls on the front panel.
5. To work on 12 V battery and mains power pack.

Keeping the above points in mind, I have made the following circuit arrangement to the best of my knowledge to suit my requirements.

THE EVOLUTION

I built this circuit for the first time in **March 1995** using three PCB's (**RM-95 version**). The first PCB consisted of complete Rx and TX up to mixer and first amplifier stage. The second PCB lodged the broad band linear driver and the third contained the PA. Initially I had used bipolar power amplifiers - **2N3632** and then **2N5070** both of which could not give more than **5 watts** output. Later I switched over to the power FET **IRF830**. In RM-95, I have used BEL BCF 100/1, 9 MHz crystal filter. The performance was reasonably good and reports received on band were encouraging. Slowly queries started coming in for my circuit and PCB layout. Impressed with the performance of RM-95 I thought of designing a new PCB, which would incorporate all the circuitry in one single board. My good friend FROM Socky VU2N]S joined hands with me in bringing about this modified second version. We sat together and fabricated a single PCB and Socky took up the artwork. The result is the RH-96 Board.

All the discussions between VU2NJS and me about the PCB layout were going on daily on 7088 kHz. Having heard my signal on the version (RM-95) quite a few amateurs who heard us on the band discussing about RM-96 expressed their desire for the PCB for themselves. Thus, we ended up making 37-numbers of the PCB in the first batch itself and all of them were whisked away from us.

THE CIRCUITRY

The circuit it self is very straightforward and quite simple. A zip file with all relevant circuits is downloadable by clicking here.

Rx

On the receiver side, it starts with cascade RF amplifier followed by a bipolar BF194/494 mixer feeding into a crystal filter. It is followed by a two stage IF amplifier and a product detector. The audio amplifier is LM 380. Since we have built a number of 2M VHF rigs where LM 380s were used, I have special liking for this IC as it requires minimum external components and gives an output of 1 watt.

TX

On the Transmitter side is pA741 microphone amplifier, a carrier oscillator plus buffer amplifier, a simple two diode balanced modulator, a BF194/494 TX mixer and a chain of linear amplifiers ending with BD139 driver. The PA is a power FET and you can choose from IRF510 to IRF840 series. I have tried and used successfully 510, 511, 530, 830, and 840 from the IRF series and VN66AFD with appropriate supply voltage suitable for that particular device.

VFO

The VFO is a Colpitts oscillator followed by a direct coupled emitter follower. Since I used a 10 MHz ladder filter in my RM-96, I had some trouble with its harmonic 6 MHz, both on the receiving and transmitting side (like the SWR/Power meter showing a residual power, very critical TX mixer tuning etc.). However, after introducing a tuned circuit the output of the emitter follower all evils have disappeared.

POWER SUPPLY

The power supply (Fig-2) is an economy type circuit with 18 to 20v center-tapped transformer rated for about 3 Amps continuous duty cycle. A bridge rectifier of 3 A rating is used. Half voltage is taken from the center tap and fed to a 7812 regulator IC giving 12V supply for the Rx and TX exciter stages.

CHANGE OVER

The antenna cum Rx/TX change over (fig.4) is a 12v - 300 ohms DPTP type relay. In one set I have used the garden variety (the type used is voltage stabilizers) and in the other the OEN sealed type relays.

AGC OPTION

You will observe in this circuit there is no AGC in the Rx. It was purposely omitted to keep the circuit simple. [did not find any difficulty in listening to strong signals as a RF gain control is provided. However, on local signals there is dome distortion. For those of you who would like to have an AGC, here is a circuit, which]: have, used (Fig. 3).

THE PRINCIPLE OF THIS CIRCUIT IS:

The AF voltage from top end of the volume control is fed to a 741 operational amp and/ts output/s rectified and fed to the base of a 2N2222A. The collector voltage is taken and is fed to the bases of the first £F amp and the 1st IF amp. The emitter voltage is fed to an ' meter, which is a 250, uA meter with an appropriate resistor.

THE CONSTRUCTION

It is presumed that the builder of this circuit is having the required basic knowledge of SSB generation, good soldering practice etc. with a little bit of general construction abilities. However, here are a few tips to keep in mind while constructing this rig.

1. Use a l0-watt soldering iron.
2. A good quality 60/40 lead with a resin core must be used.
3. All RF inter connection are made by RG 174 coax cable.
4. A two core shielded cable must be used for volume control.
5. A good quality two core shielded cable must be used for the microphone.
6. All chassis to ground connections may be made with barbed wire.
7. Use shortest length of coaxial cable possible to connect TX output to re/ay and relay to antenna socket.

The PCB diagram (actual size) and the component layout are given in the Fig.:[1 and Fig.12 respectively. This PCB consists of the entire TRX circuit including the VFO, which is on left side bottom corner of the board. The VFO section is to be cut out from the main board in old version but now in the new version it is designed in a separate small PCB. This is mounted on the 'L' bracket behind the front panel.

After constructing the power supply first go about winding all the coils and the RFC's according the data given in table-l. Then solder all the components on the PCB and make all inter connections including the +12v continuous supply to the VFO, IF amp, Carrier Oscillator and the Audio amp. Do not connect the VR and VT supplies until you are ready to align.

TUNING MECHANISM

Since my aim was to make this stage mechanically simple and easy to construct with readily available parts (without having to use a reduction/ slow motion drive) a PVC 2x tuning condenser was used with a plastic drum 2" or 2.5" diameter and a nylon dial cord with metal spindle, Both the VFO PCB and the PVC 2x-gang condenser are mounted side by side on the 'L' bracket as shown in the Fig-5. I have been using this setup for the past six months and did not find any difficulty in tuning and neither did I face any backlash problems so far.

POWER FET STAGE

Since we are feeding nearly 50 watts DC input to the [RF 830 with 45 volts on the drain and drawing about 1 amp current, a good 3.5" x 3.5" x 1.0" heat sink must be used to mount the power FET. What ever the FET you use (with a TO 220 case) it is to be fitted on the heat sink with a mica insulator in between, coated with silicon compound on either side with a nylon feed through bush etc., as shown in the figure-6. A window of 1 inch square is cut in the back panel of the cabinet after positioning the FET (fitted with heat sink) closest to the point on the PCB where the leads are to be connected. The shortest possible flexible wire leads must be used for connecting the FET pins to the PCB.

DO NOT CONNECT TIIE FET TO TIIE CIRCUIT INITIALLY UNTIL ALL THE STAGES ARE ALIGNED.

CAUTION

A ferrite bead is inserted on the gate lead to the FET to suppress any spurious oscillations etc. Since most of the ferrite beads available in the market are a bit thick/n diameter be careful when you d/de it on the gate lead, as there is a strong likelihood of a contact with the drain lead. Therefore the high voltage supply of the drain will be fed to the gate and the FET would go (2£T. Hence, the fo/lowing precautions are to be taken. (As shown/n Fig. 7)

1. Bend the gate and the source leads away from the drain and slightly forward.

2. Slide short plastic or PVC sleeves on the gate lead, one before and ne after the ferrite bead preventing its free movement.

A DC current meter is mounted on the front panel to indicate the idling current and the voice peak current. This will enable 'o to observe any drift in the idling current or an q, ease in the current on voice peaks. Due to ,n number of unknown reasons like mismatch . A 1.5 Amp fuse is introduced into the .- supply circuit as a protection for the pow(F i' and the power supply.

THE ALIGNMENT

Generally, most of the amateurs do not have access to test equipments, which makes the alignment a bit difficult. One should have lots of patience and procee owly and carefully. It is easier if two sets ar : It at a time since one set will act as a signal source for the other. In addition, look for local ham who has a commercial transceiver with a digital frequency read out.

Before proceeding with the alignment, check the PCB for any possible short circuit in the tracks due to an over flow of lead while soldering and for any other snags and lapses in the construction.

ALIGNING THE Rx

Start by aligning the receiver of the first set. Connect the +12v DC supply to the Rx stages only i.e. V connections, touch the top terminal of the volume control, and listen for a hum in the speaker. (]:t is presumed that you have connected the loud speaker. Hi! When you hear the hum it means that the LM 380 stage is OK.

CARRIER OSCILLATOR

For LSB when you use a **BEL 9 MHz crystal filter** the carrier, oscillator crystal's frequency is 9001.5 kHz First check whether the stage is oscillating or not. By using commercial TRx (FT-757 GX etc.,) remove the antenna of the commercial TRx and connect a piece of wire about one meter long to its antenna socket and bring the PCB near the set. Bring the wire nearer to the 9001,5 kHz crystal, You should be able to hear a strong carrier anywhere between 8995 kHz to 9010 kHz, Having heard it make sure that it is from your oscillator only by disconnecting the +12v supply to PCB, :If the tone stops then the test is ok. Now bring the frequency of the crystal oscillator to 900.5 kHz by varying the 220 PF trimmer capacitor in series. if 220 PF trimmers are not available use a 22 PF Philips green trimmer along with a fixed disc capacitor parallel to it, the value of which as required to bring the oscillator to the desired frequency.

Now the oscillator of the second PCB also is tuned in the same way (remember it was suggested that two of you start the project at the same time).

Bring the carrier frequency of the second oscillator to 9001.0 kHz and use this second set as a signal source for the alignment of the IF stages of the first set.

ALIGNMENT STAGES

Take a piece of hookup wire about one foot long and connect it to the base of the **Q-8** (product detector). Keep the other ends of the hook up wire closer to the oscillator of the second set which is being used as a signal source. Advance the volume control and you will hear a tone in the speaker. By turning the trimmer of the second set's carrier oscillator, the pitch of the sound will vary. This is because the carrier of one oscillator is beating with the carrier of the other and produces a beat note, which is the tone you hear. After hearing the tone remove the hookup wire from the base of (-8 and connect it to the base of Q-7. You may not hear the tone in the speaker. Turn the slug of L7 up and down until you hear the tone and then peak it for maximum sound. Now shift the hookup wire to the base of (-6 and peak the slug of L-6 the same way for a maximum sound in the speaker. Again shift the hookup wire to the base of Q-5 and carefully listen for the tone in the speaker and peak slug of L-5. Since the signal is now passing through the SSB filter, the tone heard will be weak. Now in the same position again peak up the slugs of L-6 and L-7 by varying them finely for maximum sound. This completes the alignment of the 9 MHz IF stages. Alternatively if you have a signal generator with a 9 MHz signal you simply connect it in place of the hookup wire and align all the stages step by step as explained above.

ADJUSTING VFO

If you are using a 9 MHz BEL filter for 7 Mhz band the VFO is to tune between 2000-1900 kHz. If you are using a 10 MHz ladder filters then your VFO will have to tune between 3000-2900 kHz. So depending on the filter you use the frequency of the VFO must be set. Adjusting the slug of L-! and increasing or decreasing the value of the series capacitor i.e. 25 PF can vary the frequency of the VFO. These checks are carried out with the help of the commercial TRx's digital frequency read out.

ALIGNING THE FRONT END OF Rx

Connect the antenna to the base Q-5 and tune the VFO for some signal and keep it there. Now shift the antenna to the base q-3 and adjust the slug of L-4 for maximum audio. Finally shift the antenna to the antenna terminal at L-2 and peak the slugs of L-2 and L-3 for maximum signal. Having come up this far re-align all the stages in the Rx again with the help'of a weak signal. This completes the alignment of Po<. Now peak the slug of L-14 for maximum back ground noise and leave it at that for the time being.

ALIGNMENT OF TX

First disconnect the V, supply and connect the **+12v** supply to VT line and check all the DC voltages present on the collector, emitter and the bases of the transistors and the pins of [C's in the transmitter circuit. If all the voltages are ok only then proceed as follows.

Disconnect the secondary line winding of L-.2 going to the gate of Q-16. Then connect a 6 volts 0.2 Amp dial lamp bulb between the secondary end of L-:I. 2 and the ground. For tuning the exciter upto, the driver stage this bulb will serve as a dummy load and a visual indicator for the power output. Also for unwanted outputs like self-oscillations, parasitic oscillations etc., keep the VFO frequency at about 1950 kHz (the TX carrier output frequency will be about 7050 kHz). Tune the commercial TRx to about 7050 kHz with only a one-meter hookup wire for an antenna and bringing it closer to the BD139 stage until you hear the carrier. Make sure that the carrier is from your TX only by switching it off. Then peak the L-9 slug for maximum carrier output either by the help of the reading in the 'S' meter of the commercial TRx or simply by the maximum audio level heard in the speaker. Proceed to peak the L-10 slug also the same way. By now, the bulb in the output of BD139 should be glowing at least slightly. Now peak both the slugs of L-9 and L-10 again for maximum brilliance of the bulb. As you do this take the piece of antenna wire on the Rx farther away from the transmitter or reduce the RF gain control of the Rx so that it does not over load and misguide you while adjusting the slug of L-9 and L-10. Finally again go back and adjust the L-8 slug for maximum brilliance of the bulb

BALANCING THE CARRIER

This part needs a lot of patience. First, turn the i K ohm balancing preset from one side to the other. Some where around the center there should be some reduction in the carrier level seen as a reduction in the brilliance of the glowing bulb or as heard in the receiver. Keep the preset at the setting where carrier level is minimum. Now take a 22 PF disc capacitor and connect it first at point A as shown in figure-9, on the bottom side of the PCB and see if the glow in the bulb has become dim or bright. Remove the 22 PF disc from point A, connect it at point B, and observe the bulb.

The effect should be the opposite of point Connect the 22 PF disc capacitor either at A or B where ever the carrier level is reduced. Then again adjust the L- 8 slug and the 1K preset to balance and nullifies the carrier completely. If the carrier persists then try using a 10 PF or 33 PF disc capacitor instead of the 22 PF used. By altering the value of the capacitor and simultaneously varying the L-8 slug and the I K preset you can null the carrier. Now connect the microphone and the 1 Meg preset in the lC circuit for maximum gain first (i.e. maximum clockwise). [f you talk into the microphone you should be able to hear it in the receiver and the bulb should glow and flicker. When you stop talking then the bulb should not glow. lf the bulb is glowing slightly all the time that means there is a spurious signal out put.

Leak the carrier a little by turning the I K preset to one side and you can see the bulb glowing slightly. Then adjust the L-14 slug at the VFO out put for maximum brilliance of the bulb. Now again balance carrier by turning back the 1k preset to its original position where the carrier disappears. Now if you talk into the microphone the bulb should glow, flicker, and stop glowing when you stop talking. This completes the balanced modulator stage alignment.

ALIGNING THE P.A. STAGE:

Connect a perfectly matched 7 MHz antenna to the output of the P.A. Set the !0K bias preset to minimum by tuning it completely clockwise to give zero bias to the gate of the FET. Now connect the leads of the FET to the circuit board..Se carefu/ wh//e $olderinq the¢e /ead$.]t is adv/$ab/e tO d/¢ Corln't the ¢o/derinq /rQn from the ma/ns while soldering the FET to the circuit board. Now apply voltage to the drain of the FET via a DC current meter. The drain current meter should show only a flick of the needle, which is due to the charging of the electrolytic capacitor in the de-coupling circuit, Then onwards the device should not draw any current and the meter should not show any reading. Now very slowly and carefully turn the :[Ok bias preset anti-clockwise (while pressing the P'I-I' and with out talking into the microphone) to give positive bias to the gate. Until about +2.5, volts to the gate there may not be any increase in the drain current. When the bias is about +3.5 volts the drain current will rise to about 20 to 30 ma, depending upon the device used and the drain voltage, Anyhow adjust the standing current / idling current to about 20-30 ma and leave it at that, This gives the best linearity when these power FET's are used as linear amplifiers.

Now remove the dummy load (bulb) and connect the RF output from the **BD139** i.e. the secondary of L-!2 to the P.A. stage. Now switch on the TX, there may be Only a slight in the drain current to say about 40-50 mA depending on the residual carrier or hum etc. Now if you can speak into the microphone with single tone the drain current should increase to about 0.8 to 1.0 Ampere depending upon the device used etc. Do not speak too long into the microphone at this stage, as the P.A. tank is not tuned. Now connect a SWR/Power meter between the output of the P.A. and the antenna.

While whistling into the microphone, adjust the 70 PF trimmer for maximum power output i.e. for maximum forward reading in the SWR meter. Also after a few minutes, check the heat generated at the heat sink it should be warm and not hot.

Finally listening on the commercial TRX adjust the I Meg microphone gain control while speaking into microphone for maximum and good quality audio without any distortions. Now make a call and you are on the air. :It is up to you to make any other adjustments or add any refinements to the circuit.

ABOUT CRYSTAL LADDER FILTER (FIG. 10)

For those of you who want to build filter, it is suggested that crystals of 8 to 10 MHz ranges be used for best results. According to the original article of F6BQP, for a 4 crystal ladder filter one has to select all the four crystals having same frequency, within !00 Hz of each other on series resonant frequency. The termination impedance of 800 to 1000 ohms is chosen for SSB filter. The values of the capacitors in the circuit given in Fig. !0 are calculated by the formula.

C= 1/(2(r)
Where
'f' is the crystal frequency in Hz
'R' is the termination impedance in ohms
'c' is the capacitance in farads,
(c is latter converted to Pico farads by multiplying farads by 1000000000000).

For a 4-crystal ladder filter the formula is:
Co = Cx 0.4142
C = Cx '1.82
C2 = CX 2.828.

Make a small PCB for mounting the crystals. Use as little copper foil as possible and cut away the remaining part of the PCB after construction of the filter. Make a small metal box and fit the PCB in it, Ground the box with a short lead. For 10 MHz

NOTE:

This circuit is basically made for use on 40M band. However for 20 M use every thing is same, only point stated here is that IRF830 is not very ladder filter the value of the capacitors work out approximately as given in the figure.

ACKNOWLEDGEMENTS

I would like to thank the following Hams VU2DDX, VU2TVR, VU2AD, VU3VKS VU2TSF VU2S3V, and many Hams for supplying the literature, other materials etc., and assisting in this project. effective on 20-M band. During experiment, it is found that IRF830 at 30-40 volts gives 5-6 watts output only. Therefore on 14 MHz IRF510 T- MOS FET is used.

RM - 96 Coil and RFC Data for 7 Mhz.

Coil No.	Pri. turns	Sec. turns	SWG	Remarks
L1	80		36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L2	2	32	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L3	32	5	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L4	32	5	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L5	25	4	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L6	25	7	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L7	25	7	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L8	25	10 at the center on primary	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L9	20	5	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L10	20 (tap at 10 turns from ground end	5 (at center of the primary)	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L11	30	4	28	On T - 05 HFA
L12	6	4	28	Looped through an 1/2" TV balun core
L13	7	10	18-22	T - 10 HFA

RFC's 250 micro Henry 20 turns of 28 SWG wire on T-05 HFA toroid cores.

Winding Coils:

Start winding the primary first from the bottom to the top end of the former beginning from the cold end (i.e. DC supply or ground end). Then the secondary is wound over the primary starting again from the bottom with the cold end. The coils are close wound without any gap in between.

RM - 96 Coil and RFC Data for 14 Mhz.

Coil No.	Primary. turns	Condenser	Secondary turns	SWG	Remarks
L1	38	100 pf		36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L2	2	60 pf	32	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L3	17	60 pf	4	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L4	17	60 pf	4	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L5	25	100 pf	4	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L6	25	100 pf	7	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L7	25	100 pf	7	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L8	25	100 pf	10	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L9	16	100 pf	5	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L10	16 (tap at 8 turns from ground end	100 pf	5	36	On 5 mm coil former with 10mm Sq. base & 5 pins, with ferrite slug & can
L11	30	-	4	28	On T - 05 HFA
L12	6		4	28	Looped through an 1/2" TV balun core
L13	7		10	18-22	T - 10 HFA

RFC's 250 micro Henry 20 turns of 28 SWG wire on T-05 HFA toroid cores.

Sourcing

1. The above cabinet (with the frequency counter and S- Meter) is available from OM Pratap in Bangalore. He can also supply fully assembled kits.

2. Good Quality Glass Epoxy PCBs and Circuit diagram for the project are available from Mr. Rao himself . His QSL info is Mr. R. M. Rao, 66-10-29 /4, South Auchutapuram, Kakinada, ANDHRA PRADESH - 533004, INDIA.

3. Coil set for the project is available from Mr. P. Mohan Rao of Ruby Electronics. His QSL info is Ruby Electronics, Wahaib Road, Tenali, Guntoor District, Andhra Pradesh, INDIA

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4. Torrid for projects are available from Ferrita Enterprises, C-4, Industrial Estate, Udyambag, Belgaum - 590008.

RM - 96 II - 14Mhz Version

By: S. Rama Mohan Rao , VU2RM

RM 96 - 7 MHz transceiver was introduced to the fellow Hams in year 1996. Ever since listening on the band, many Hams have built and are working satisfactorily, if not excellent, keeping in view that the aim was and is to keep the cost Low.

From the year **2000,** many builders are swinging to build it for 14 MHz. Some got the coil data, some do not have. Therefore, in this article data is given for 14 MHz. Constant experimentation, to improve the performance of the set quite a changes, have been made. It is that during experimentation for higher output of TX, compared to **IRF830** etc,. I found that the device IRF510 is best suited by virtue of its Low CISS & COSS value. With 30 volts, it is giving about 20 to 25 watts output. However, any self-oscillator or over drive etc. it is easy to burn it. 5o, get a proper circuit to make the device withstand the beating. I have now used IRF840. !t is standing the beating and with 50 V on drain, gives 20 to 22 watts output. A measurement on spurious output was made and it is found the spurious output is 27 dB below the peak power output.

I have also experimented on the balanced modulator. Many of my fellow Ham friends asked me why I have not thought of MC1496 or NE602 IC's etc. So, I have wired up two circuits on general-purpose boards using MC1496 and NE602. I have simply replaced by giving external connections and used for 3 days each PCB in place of the two diodes balanced modulator. None of them have reported any change in the modulation quality etc. So I have removed and restored back the two diodes balanced modulator.

Then I have used these boards in the TX mixer circuit. Yes, there is a difference in the quality of the signal. So, now I wired one MC1496 circuit on the general purpose PCB and removed all the components that are used for BF194 TX mixer. The new PCB size about 1"x1" is standing up near the edge by the side of L 9. If I make a new version, of RM 96 PCB. I intend incorporate ME 1496 circuit in Transmit mixer stage. Therefore, that is all, for now.

Data			
COIL AND TRANSFORMERS			
14 Mhz	Pri.	Sec.	SWG
L 2	2	17	36
L 3	17	-	36
L4	17	4	36
L9	16	5	36
L 10	16 T CT at 8T	4	36

Data			
COIL AND TRANSFORMERS for 9 Mhz			
9 Mhz	Pri.	Sec.	SWG
L 5	25	4	36
L 6	25	7	36
L7	25	7	36
L 8	25	10	36
L 1	75		36
L 14	45		36

Data			
For 10 Mhz. Filter			
10 Mhz	Pri.	Sec.	SWG
L 5	20	4	36
L 6	20	7	36
L 7	20	7	36
L 8	20	10	36
L 1	35		36
L 14	40	8	36
Wind seconday at center for L 8 & L 10. The rest at, bottom cold end.			

Data			
TOROIDS			
	Pri.	Sec.	SWG
L 11	16	4	O.5" toroid 26 SWG
L 12	6	4	1 cm balun core 26 SWG
L 13	4 (18 SWG)	6 (Hookup wire single strand)	4 Nos of 1/2" toroid
L 12 and L 13 are to be wound similar way.			

NOTES ON RM 96 FINAL PA TANK COIL

By: S, Rama Mohan Rao, VU2RM

After several qso's on the7 Mhz band with new hams who have built RM 96 upto BD139 driver and not able to get power from IRF stages, the often asked question is "how many turns should I use on a very good imported toroid. I have used but it is not giving more than 2 to 3 watts. What should I do? Well, it is a very pertinent question. Yes, so let us go a bit deep to get an answer.

The theory part of it tells us that there are certain Parameters, which are required to calculate this data. Having a very good-looking imported toroid alone will not help us. We need to know either the permeability or the AL value of the core and its maximum frequency it can be used. Next, it is to be known weather it is iron core or ferrite core. As per little knowledge about these cores, my idea is that iron dust core toroids are light in weight and ferrite cores are a bit heavy. To calculate the number of primary turns & secondary turns the following formulae are used at this end.

Firstly: we should calculate the drain load resistance into which it has to deliver power output. Let us assume that our PA stage employs IRF 830 TMOS FET. Say we are applying about 36 Volts DC to the drain and it draws about 1 to 1.5 Amps of current. (This assumption is based on the practical experience on these sets and BD139 drive is capable of giving that much gate voltage.). We measured up to 8 V with RF diode probe.

Therefore, power input is P=:I_D x V_D i.e. 1.5 A X 36 V = 54 watts DC input. Let us take the efficiency of this stage with all sorts of cheap components as 50%. Therefore the power RF output at the drain is 54/2=27 watts or say 25 watts.

The remaining 29 watts (54-25) is to be dissipated as heat, so use a reasonable heat sink with vertical fins.

Now the drain load R_D=VCC^2/2 P_O. Where Vcc is the drain supply voltage. Here it is 36 V. P_O is the Power output (25 watts).

Therefore R_O=(36X36)/(2X25)=25.9 or 26 q.

These 26 ohms is the load resistance into which the IRF 830 will deliver these 25 watts of RF output power. Now to proceed further we should know the AL value of the core, and weather it is a ferrite or a dust core, which is necessary.

Here we have taken the cores manufactured by Ferrita Enterprise, Belgaum, Nickel Zinc Ferrite meant for RF use. They manufacture cores with material HF-A group going up to 40 MHz and HF-B group going upto 80 MHz. For our PA tank choice was made for T20-HFA core, considering cost...etc. This HFA, T20 core is having an AL value of 60.

Now further calculations are as follows:

- Known the RD here it is 26 . We have, to calculate the primary inductance required.
- L (lh)=5 Ro/(2f) where f is the frequency in MHz. For f=7 MHz.
- Therefore L (Lh)= (5X26)/(2 X (22/7) X7)
  =130/(6.28 X 7
  = 2.95 Ih

Therefore the primary inductance of our tank coil should have an inductance of 2.95 uh or say 3 uh. Now, with our Belgaum HFA.T-20 core we have to calculate the turns required on the toroid.

The number of turns as follows:
N=1000 x sq. root of (L mh)/AL) for ferrite core,
N=..00 x sq. root of (L mh)/AL) for dust core.

Here note the inductance value in milli Henries where as we had the answer for L in micro Henries. So, convert pH to mil. Now we have to wind 7 turns on this core in the primary. However, remember the PA tank coil is an impedance matching transformer i.e. your antenna feeder cables impedance of 75 or 50 g are to be transformed into the required drain load of 25 .

If all goes on like this, We have to calculate the secondary turns, for inverted V antenna where we use 50 cable. The turn's ratio between the primary and the secondary is all as far as winding is concerned. Use a gauge of wire which carries that current in the primary i.e. about :!.8 SWG is OK, for secondary it can be around 22 SWG. First wind the secondary turns as it contains more turns, then wind primary turns over the secondary.

Here P_1 goes to drain and P_2 goes to (+) supply. Then S_1 goes to ground and S_2 goes to antenna change over relay. This sequence is to be followed for proper coupling.

Further Note: If the primary inductance is more, let it be due to more primary turns or due to more AL value of the toroid core. The drain current will decrease and will not give the estimated power output. In such cases reduce primary turns maintaining the same turn ratio between primary and secondary.

I think this much gossip is enough for our PA tank.

Wish you good luck.
73 de VU2RM

PUSH-PULL AMPLIFIER FOR 14 MHz

By: S. Rama Mohan Rao, VU2RM

After working many years on my RM-96 with IRF830...etc. in the final PA, I have tried the sàme tried the same circuit for 14 MHz transceiver. The same broad band is used with IRF830. It has given an output of 4watts or so. Then, I have gone deep into the subject of VMOS & TMOS power FET's. I have decided to use these devices with Low CISS & COSS (input & output capacitance) values. I have finally chosen to use IRF510 devices. This has a maximum Voltage (V_{DS}) of 110 V.

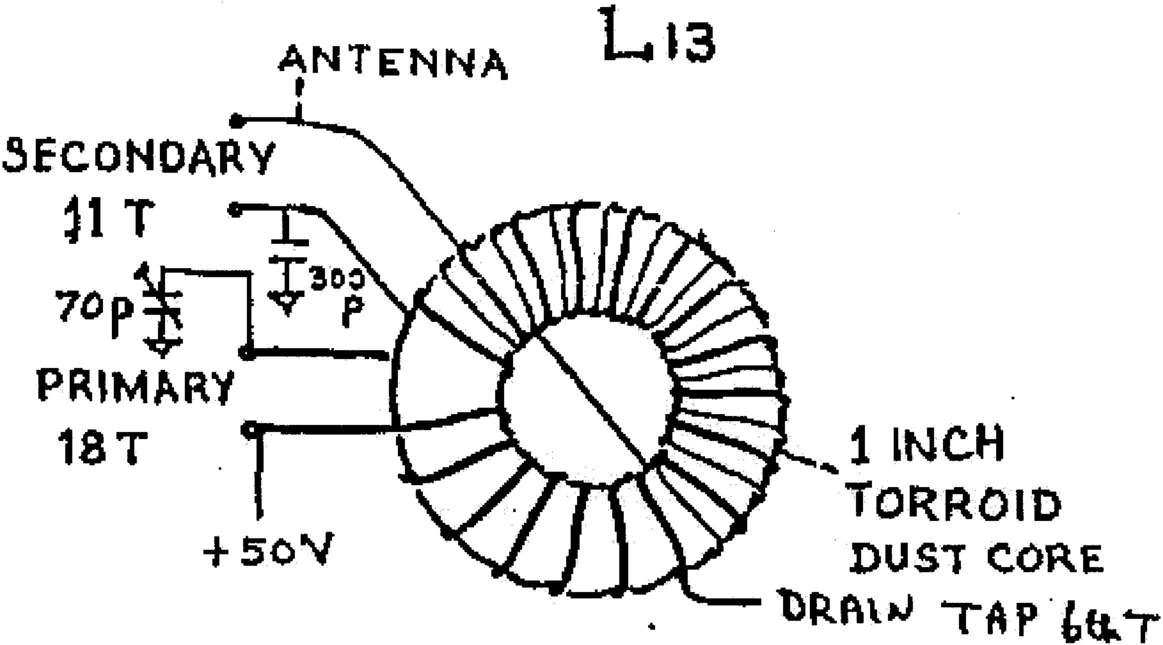
I have built a push-pull stage because of the following reasons:

- When a tuned circuit is used in the final tank circuit with a single stage amplifier, the quah/ of the signal sounds good.
- Nevertheless, with a single stage broad band/t is not the same quality.
- I felt that this difference is due to the flywheel effect of the tuned circuit.
- During the technical discussions with some of the home brewers, it is learnt that the)/also found the same when the wave shape was seen on the oscilloscope.
- The pos/five and the negative half cycles are not the same
- Therefore, I have decided to make a push-pull amplifier.
- Also for the reason that as we are using broad band amplifier, there are bound to be some harmonic generations, due core saturation of the final toroid and various reasons.
- In push-pull these can be avoided largely and therefore less spurious outputs and better quality.
- Keeping in view al/these points the following circuit is evolved and it is working satisfactorily.

Experimentation made on this circuit:

After building this circuit, I found, one IRF is getting hotter than the other. I made all checks I know, but it is observed that one gate is getting more voltage than the other. Then I reversed the secondary windings. Now, the other gets more heated. So evidently, IRF has nothing to do with this unequal drive voltages to the gate. I tried T with an imported toroid. No luck got fed up and thought of introducing negative feedback to equalizes the gain of each FET. So, tried combination of RC network, which is a general practice. About 100 Kilo ohms in series with 150pf capacitance from drain to gate. Now both the positive hail cycles and negative half cycles are equaled and the defect of one FET getting hotter than the other vanished. The quality also improved. Even I operated for one or two hours the heat sink is not getting heated up. i am using 22 Volts supply on the drain and it draws about 2 Amps. (i.e. 44 watt DC input). It is giving a power output of 25 watts into a 50 ohms antenna as measured on a Daiwa power/SWR meter. Further, there is no reflected power from the PA stage. So, RF filters are not used.

I have not built a 21 MHz RM-96, but looking at CISS value of IRF510, I have a strong belief that it can work on 21 MHz also. So this will be a good choice for 7/14/21 MHz power amplifier. When one Ham from North India told me that he is using IRF840 in 14 MHz and is getting about 20 watts output, I immediately got hold of IRF840 and replaced the IRF510 with IRF840. The power output is just 4 watts. I have increased the voltage from 22 V to 40 V, the output power went upto 10 watts. However, the heat sink is getting hot indicating that the efficiency is Low. Therefore, I left the PA like that, settling with IRF510 only. Happy, go lucky, now that is all my experimentation on the push-pull power amplifier.



TUNED CIRCUIT

Fig-9. BAL.MOD.

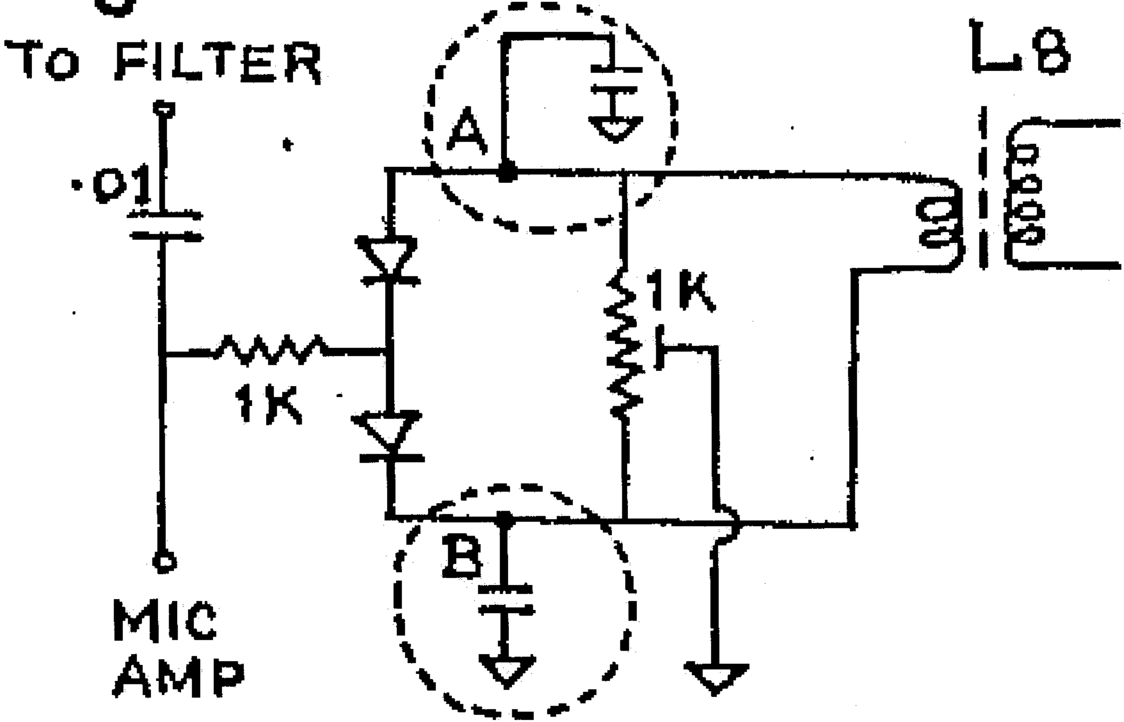


Fig-10. LADDER FILTER

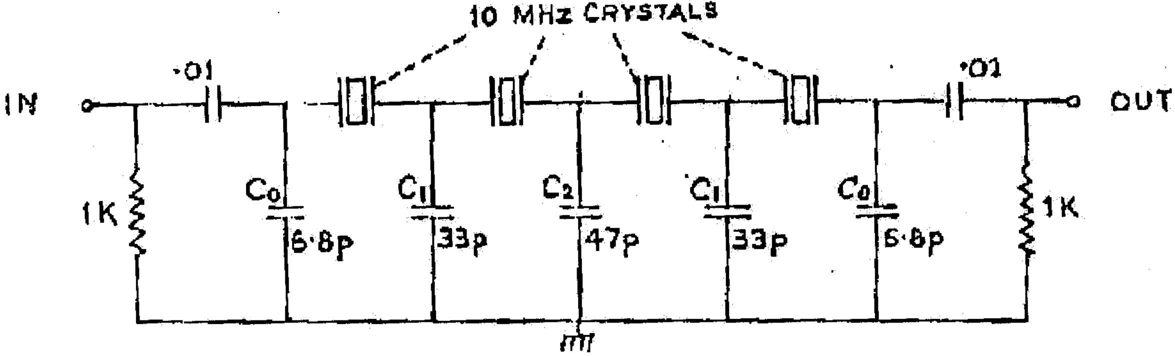


Fig-6.
MOUNTING FET

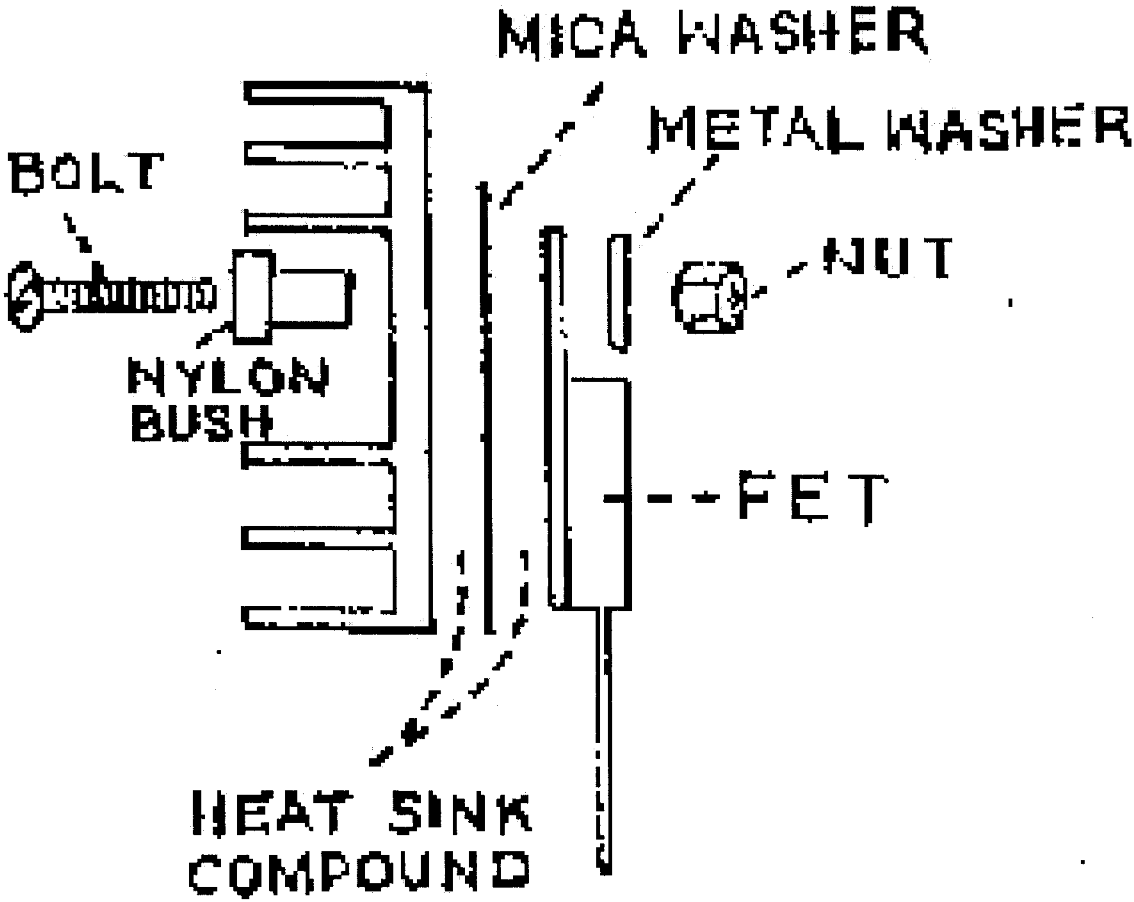


Fig-7. FERRITE BEAD ON FET

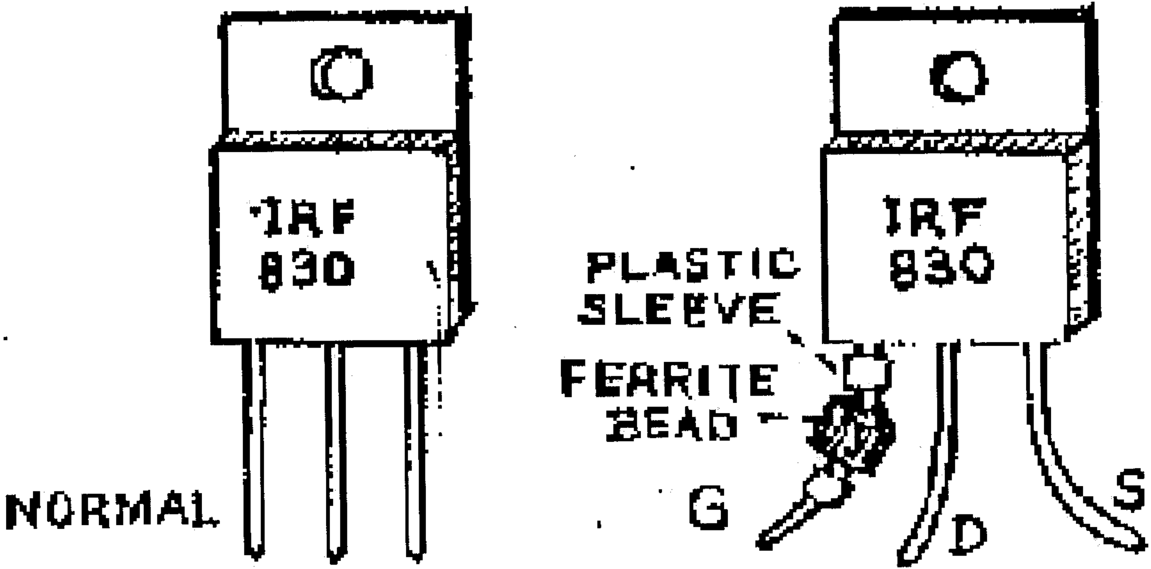
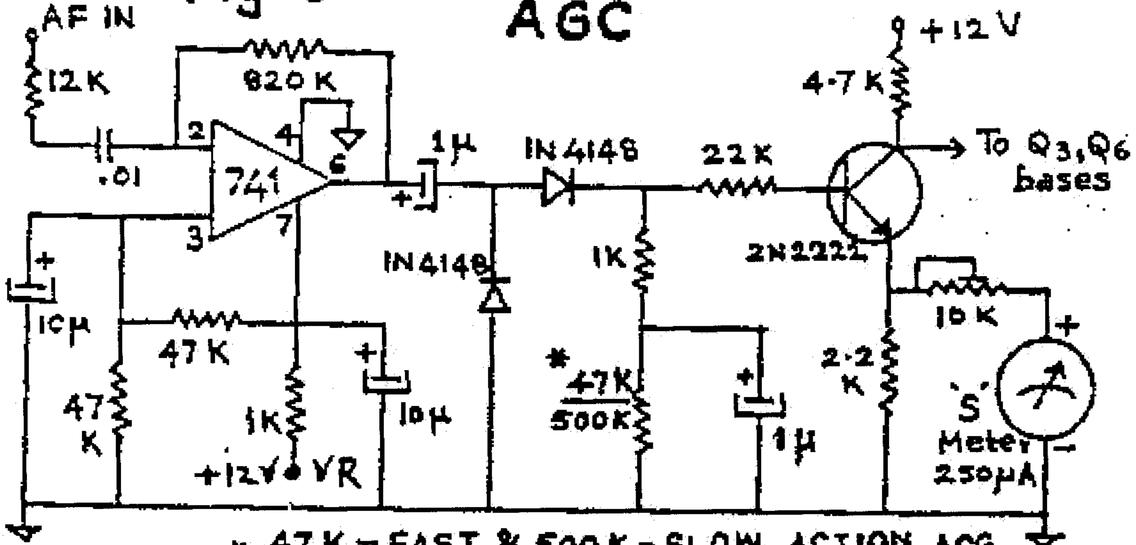
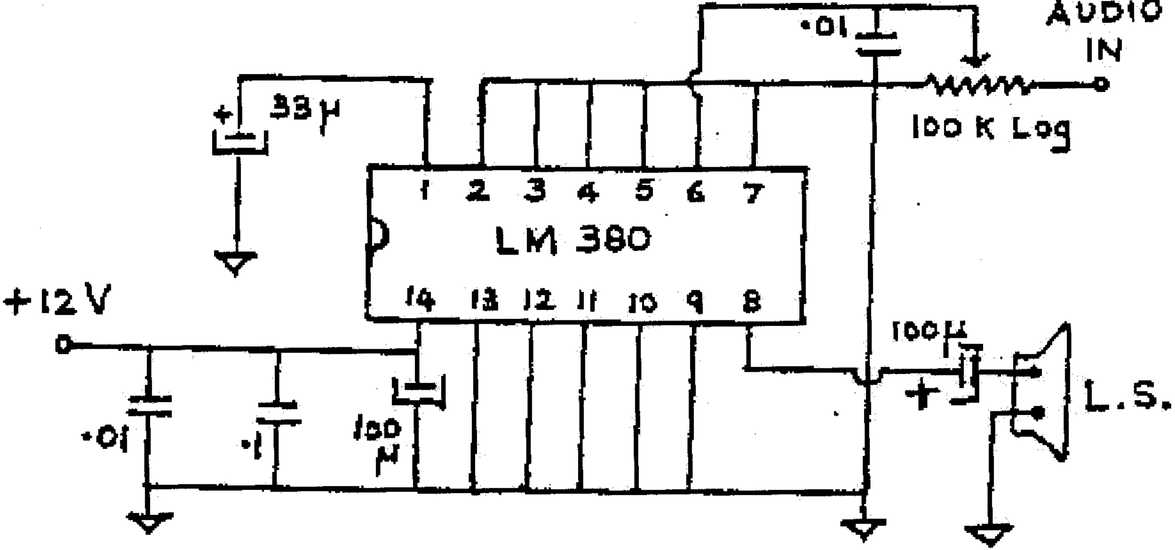


Fig-3



* 47 K – FAST & 500 K – SLOW ACTION ACG.

AUDIO AMP.



AUDIO IN
·01
100 K Log
33 μ
+
1 2 3 4 5 6 7
LM 380
14 13 12 11 10 9 8
+12 V
·01
·1
100 μ
100 μ
+
L.S.

MIC. AMP.

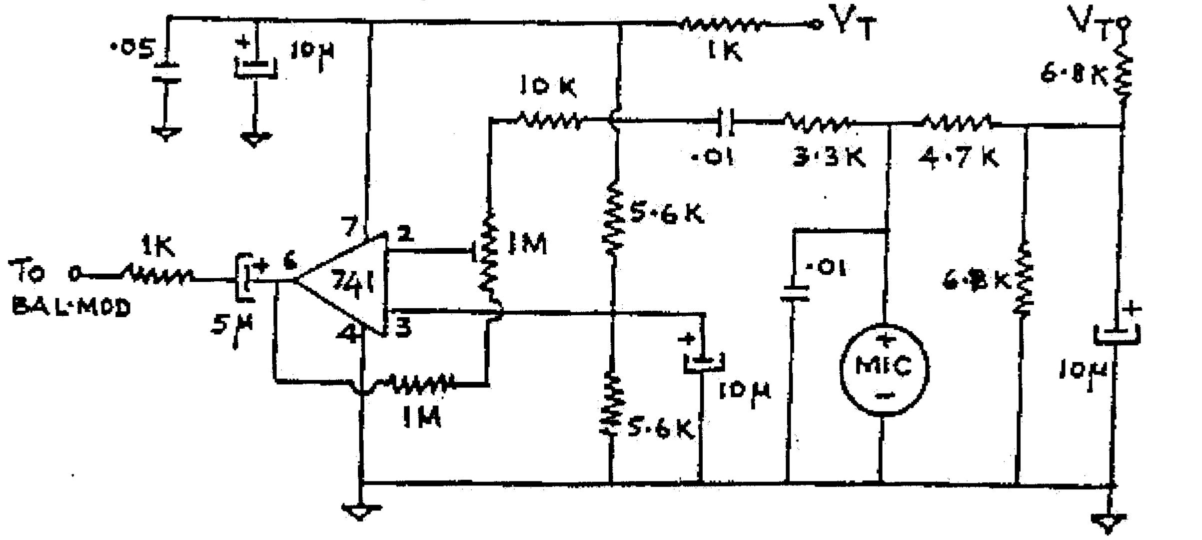


Fig-1. P.A.

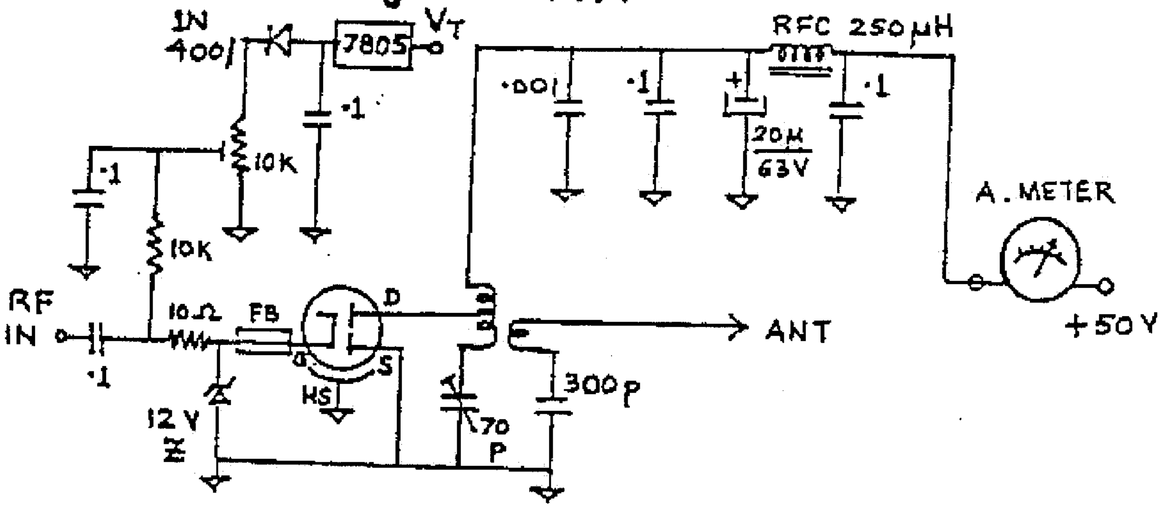


Fig-2. POWER SUPPLY

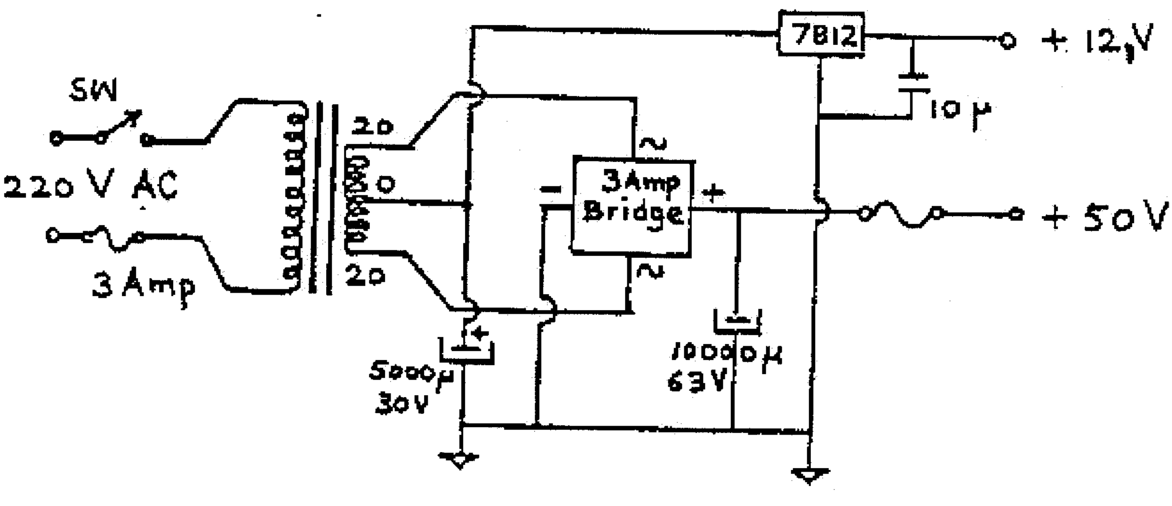


Fig-5 TUNING MECHANISM

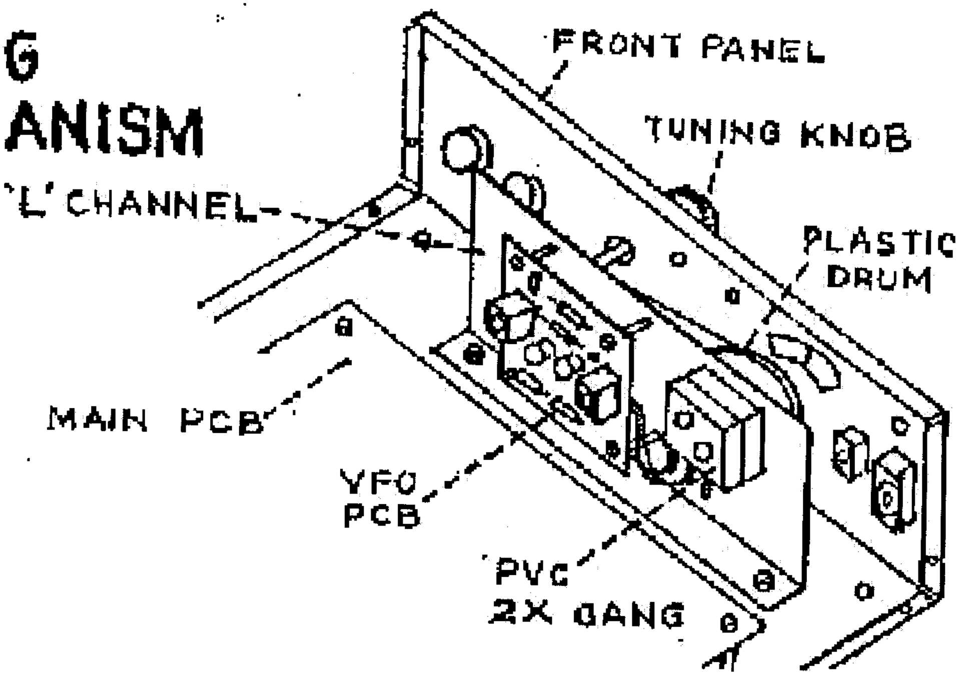
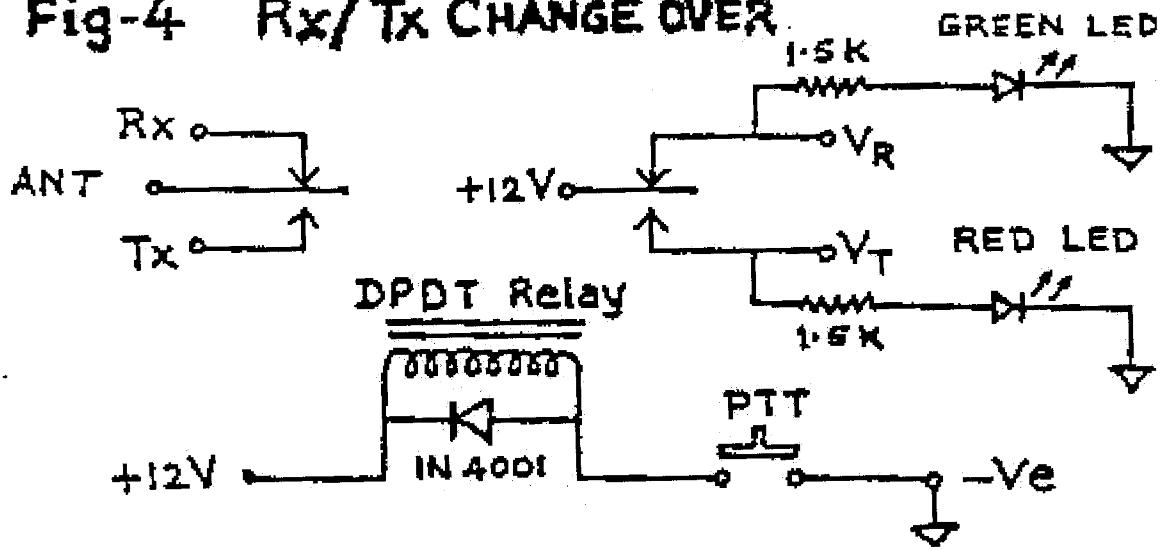
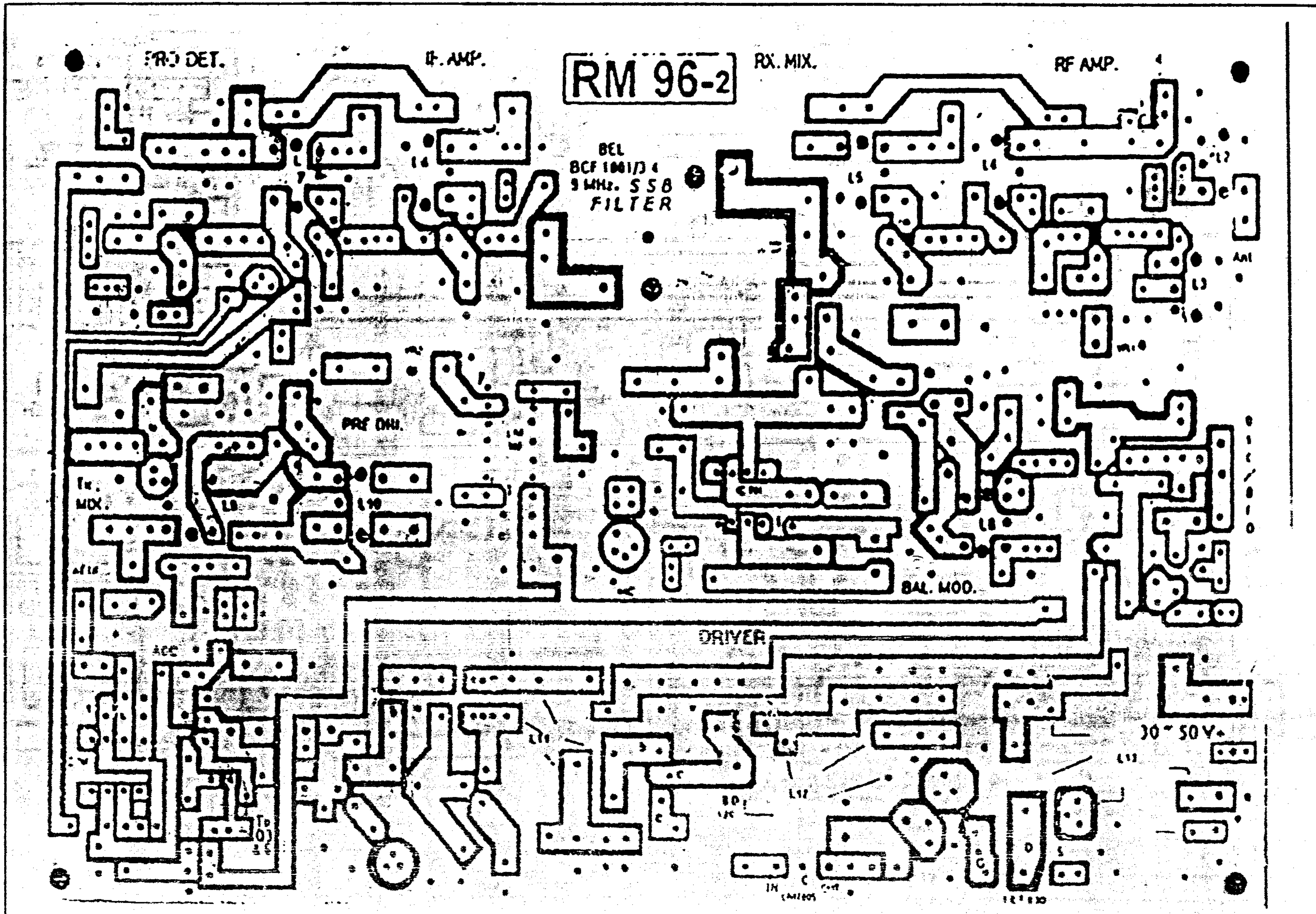


Fig-4 Rx/Tx CHANGE OVER





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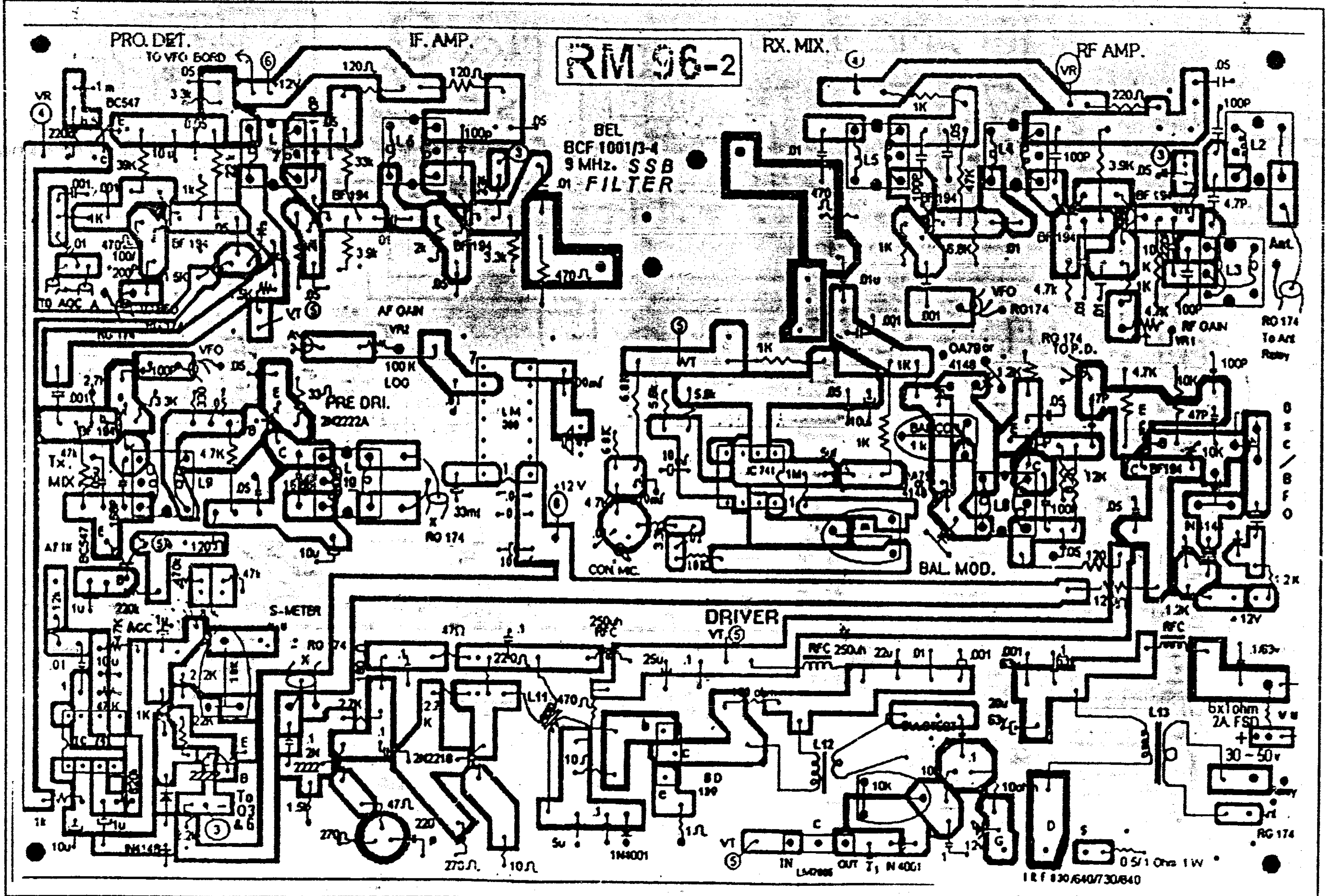

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Fig-11. PCB (Actual size)

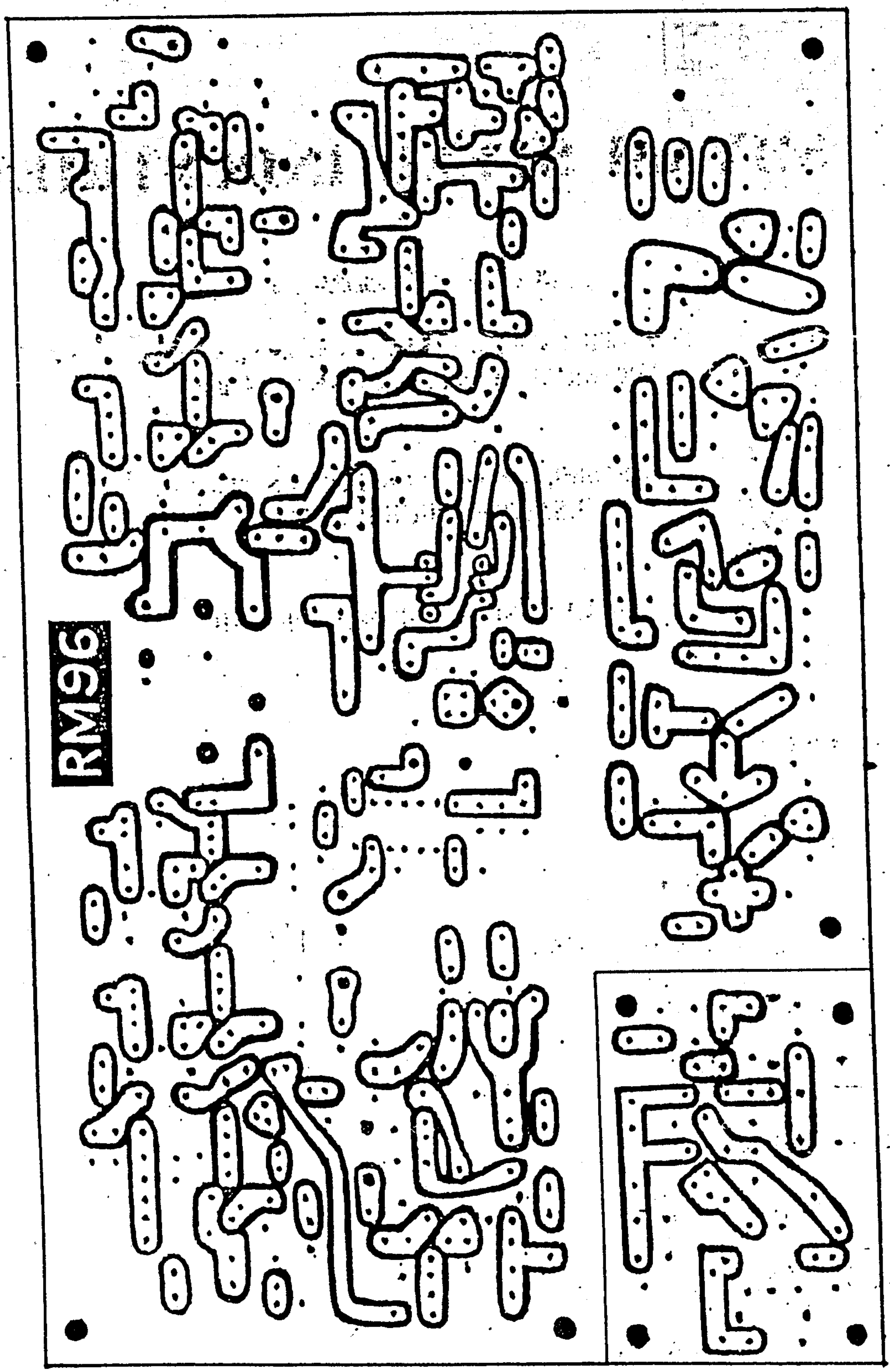

Fig-12. COMPONENT LAYOUT (COMPONENT SIDE) RM96.