NSH-1

(A single conversion Super Heterodyne
40m band receiver for SWLs & New Comers)

by N.S.HARISANKAR VU3NSH

SPECIFICATION AND FEATURES

- Single Conversion
- Stable VFO
- BFO with pitch control !!
- 2W AF output
- Roll - off AF filter !!
- No wire link or jumper on PCB!!
- Two types of antenna input !!
- All operating controls are at one side !!
- Multi pitch for 2 types of ceramic filters
- DG FET RF amplifier and mixer
- Gain control for RF Amp
- Easily available and economical components
- 3 pole band pass filter

Now a days the art of homebrewing is changed to **`plug and play'** manner and that leads to the ruin of the real charm of the same and due to this the SWLs and HAMs loosing their skill and knowledge in radio techniques. These kind of guys making lot of pit falls while making their own RF coils, assembling and at alignment. I hope this project 'NSH 1' will give some knowledge and a practice about receiver assembling, calibration etc. in 'do it yourself manner'.

This is a single band solid state amateur band receiver project, meant for SWLs and new comers. The complete sections are on a single PCB and all components for this project are available in the local market. The criteria of this project is simple circuit with low priced components, all operating controls on front panel including BFO pitch control, RF gain control, volume control, tuning and AM - SSB/CW selector etc. for good speech quality audio, this circuit employs a simple speech filter known as AF roll-off filter, which will give good speech quality and it can cut the noises of neighboring stations. I spent 40 days for circuit designing, assembling, testing, calibration, PCB designing etc. I started the first PCB which is manually designed for the test. The main aim is to avoid unwanted jumpers and zigzag connections on the PCB. After testing the PCB is finalized. The track side of the PCB design is as ground plain or called copper pour or polygon type to prevent unwanted QRM - like inter stage signal coupling, leakage and other parasitic problem. The total size of the PCB is 21.5 cm x 9 cm.

I wish to thank VU2ARA, VU2HRS, VU2VWN, VU2ITI, VU2VKC, VU3FID, VU2LLN and SWLs, Mr. Rejeesh, Mr. Sajeesh, Mr. Vinod for giving enormous support and help regarding this project. This project is dedicated to my mother Smt. N.S. Jayavalli and all SWLs and HAMs

BEFORE SOLDERING THE PCB NSH-1

- Avoid chaotic start, read the assembling manual thoroughly.
- Check all components like transistors, resistors, coils etc. with multimeter
- Check all styroflex (polystyrene) capacitors and its value with capacitance meter.
- Assemble each section and check and tune it like AF amp, VFO, BFO etc.....
- For best results in SSB, use Murata Ceramic Filter CFG 455 J

In NSH-1 PCB, you may find additional holes and soldering points. These are to accommodate different size of components in styroflex capacitor area, Ceramic filter, S-meter etc.

FOR PROPER ALIGNMENT USE

1. Multimeter - Analog or Digital
2. RF milli voltmeter or RF probe
3. RF signal generator or RF oscillator - 7 MHz ± and 455 KHz
4. Frequency counter - 30 MHz type
5. Capacitance meter (which is usually found along with multimeter)

ASSEMBLING THE PCB

First you should assemble Audio Amplifier, then test it by touching your finger or a live soldering iron at volume control input, it will produce humming sound on speaker. You can vary the volume control to confirm its action. If it is OK, then assemble speech filter based upon compressing of BC 549 C with associated resisters and capacitors. After soldering this section put your finger at 20nF and 1K ohm junction. The speaker will produce a sharp audio hum.

The next stage you have to assemble is the VFO (Variable Frequency Oscillator) known as Low Frequency Oscillator (LO). This is the most critical section. The main capacitor for this stage is the polystyrene (Styroflux). This VFO section is based on BC 549 C bi-polar transistors with associated components forms a collpitts oscillator. The frequency is varied (while tuning) by a gang capacitor for tuning across the band. The VFO frequency can set at a mid position of the gang by adjusting the slug core of L5. the VFO is to be tuned between 6.545 MHz to 6.645 MHz for the 7 to 7.1 MHz reception (Subtracting 455 KHz from 7MHz = 6.545 MHz and Subtracting 455 KHz from 7.1 MHz = 6.645 MHz). The required gang capacitance is around 15 to 20 pf. We can use 2J or 2X gang with a series capacitor to pull down the total capacitance of 15 to 20 pf for 7 to 7.1 MHz Rx spread. The most important thing for the perfect stability is the emitter - base voltage of the first transistor, it must be a positive voltage level (keeping the first transistor in class A mode). Normally due to erratic component, real value and printed value of the capacitor, vague design, erratic feedback occurs and due to this voltage becomes zero or negative. This will give heavy drift from the set-up frequency and also will generate lot of harmonics. In this design the emitter base voltage is around (0.37V) read by me and the maximum drift read is around 30 Hz !!! If the feedback level of a VFO stage is low, the oscillation may swing. If the feed back level is heavy, the oscillation goes to clamping or saturation. Normally every home brewers using FET VFO for the stability, escaping from bipolar VFOs and they are not at all achieving the stability. One can assemble this bipolar VFO with the cost of single FET. I have assembled three numbers of bipolar VFOs and fully satisfied with their performance. The RF voltage from VFO is set by trimming L6 to maximum level. The capacitor 100 PF styroflex parallel with tank coil L5, or, 3 nos. of parallel connected 33 PF styroflex can be used for the better stability. In this design I am using 30PF air gang capacitor (TDK Japan) in VFO. The capacitor 22PF series with the gang is deciding the band spread level. Trim L6 core for getting maximum RF voltage at output to mixer FET injection. It should be 0.7V to 1V. If the voltage is more than one volt then reduce the coupling capacitor 180 pf to 100 pf at buffer transistor input.

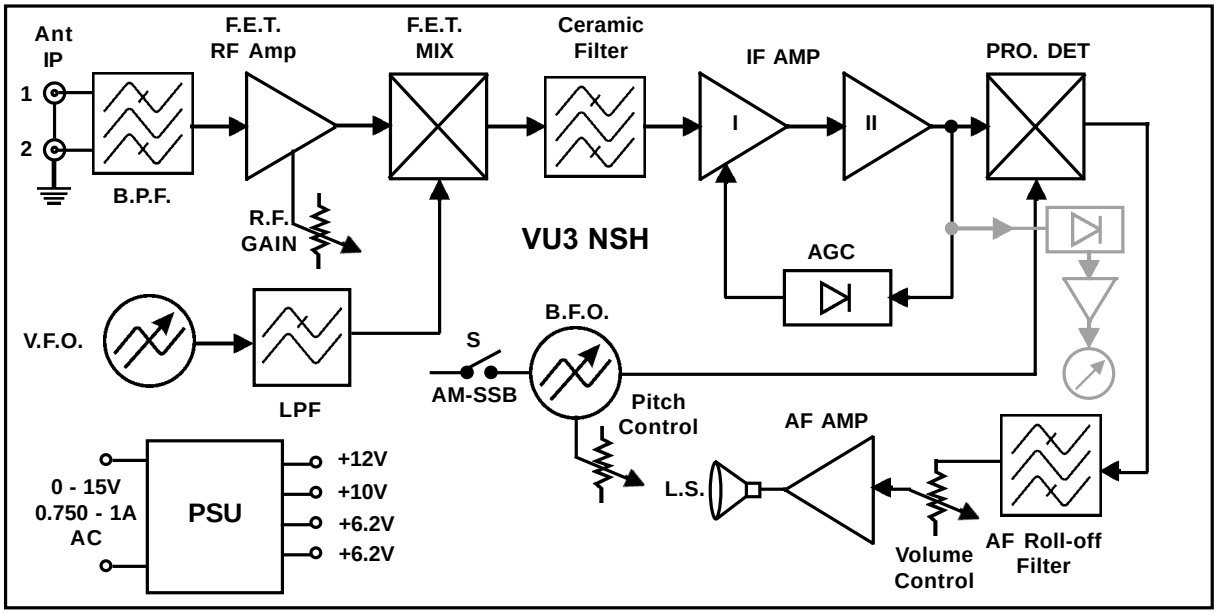
For tuning system, I am using 36mm Japanese Vernier as a slow motion drive. One can use the simple and pretty old tuning system employs dial drum, tuning spindle dial cord which is much popular in the Radios. Then assemble the varactor tuned BFO (Beat Frequency Oscillator). After assembling this section, set the potentiometer position at mid and set the white IF to 455 KHz with the help of a frequency counter. The counter should be connected at the secondary winding of the white IF in the BFO stage. The secondary winding is not at all used in this circuit, which is lying empty. After setting the 455 KHz, shift the control to right and left, then you can see a frequency shift. The shift is sufficient for LSB - USB reception. The IF stage is commonly used in the radios and all IFTs are normally available (rosy with PF) in the market. Then assemble the product detector, which employs BF495 transistor. The IF signal injected at the base and the BFO injected at the emitter. This stage is working like a mixer. The BFO signal amplitude should be 5 to 20 times grater than that of the strongest incoming SSB or CW signal if distortions to be minimised. To receive AM, it is nearly necessary to disable the BFO circuit. Two input

signals (IF & BFO) are fed into the product detector. The difference in frequency (after filtering and removing the IF and BFO signal) is fed to AF stage. AM signals can be copied satisfactorily on receiver which have good IF selectivity. The AM signal is tuned in as though it were an SSB signal when properly tuned, the heterodyne from the AM carrier is not audible The regenerated AF signal is taken through an RC pi-filter which is connected with the roll off AF filter input. The IFT's should be tuned for 455 KHz with using a modulated signals from signal generator. The ceramic filter SFU 455 B is a wide band width type. It is easily available in the general market. The specific SSB narrow filter is CFG 455 J. This will give an accurate band width for SSB reception. The mixer stage employs a popular dual gate MOS FET. Using FET, in mixer stage, eliminate the cross modulation problem and reduce noise levels. At gate - 1, the RF signal is injected from RF amplifier and in gate - 2, LO signal is injected from VFO. Due to FET mix the LO injection should be high for the high input impedance of FET. The RF amplifier is based on dual gate FET BF 966 S. At gate 2, the control voltage is supplied through a Potentiometer, this will acts as RF gain control. In gate 1, the RF signal is injected from Band Pass Filter (BPF).

The front end is having 3 pole band pass filter, it will pass the wanted frequency of 7 MHz to 7.1 MHz. Tune L1 for 7025 MHz, L2 for 7050 and L3 for 7075 MHz. The antenna input is marked like A and B. At point A you can connect any tuned antenna like inverted V or flat dipole. At point B you can connect a fixed short length wire or a whip like 1.5m etc. and trim the trimmer for getting more gain. After aligning L1, L2 and L3, tune L4 to get maximum signal. It should be on 7050 Mhz. For a S meter, there can be a conventional type VU meter or you can apply simply, any readily available, LED VU meter. For the input signal to VU meter circuit you can take it from AGC line, AF roll off input, or from AF filter output near to volume control input point and it is up to you. One can select the level from second IF output through a detector diode and a simple buffer amp stage for an analogue meter reading (as shown in the block dig.).

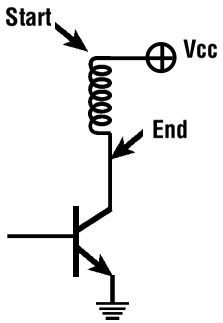
The coils L1 to L6 should wind on slug core IF can type. Put some glue like 'quick fix' on the winding surface. First make more winding and then make less winding at mid position (32 turns first, then 2 turns over it). While winding you must avoid gap in between the turns and it should be tight winding. The tank coil L5 is winding from mid position to top. Refer the **START** point 'S' and the **END** point 'E'. After winding L5, L6 you should put some wax on it's coil . You cannot apply wax on the coils of L1, L2, L3 and L4. You should wrap a bit of cello type on the coils of L1, L2, L3 and L4. The winding wire is 35 SWG or 36 SWG only. All windings are in clockwise. For a frequency read out, PIC IC based frequency counter is most suitable for this project. The software setup of PIC IC; in one mode it should be 455 KHz + VFO frequency for 7MHz to 7.1MHz reading, in second mode you can read direct counting so that you can read BFO frequency.

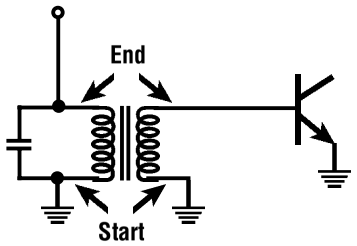
BLOCK DIAGRAM

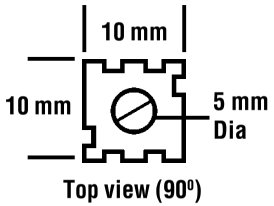


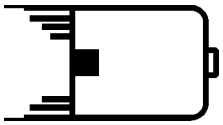
NSH1 40 m AM SSB CW Receiver Coil Winding Data

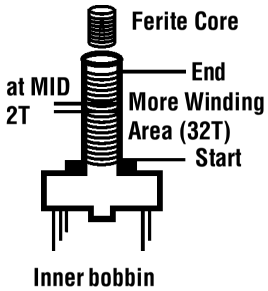
Start winding from Cold End, i.e., (DC Supply or DC Ground End) . Refer figure.

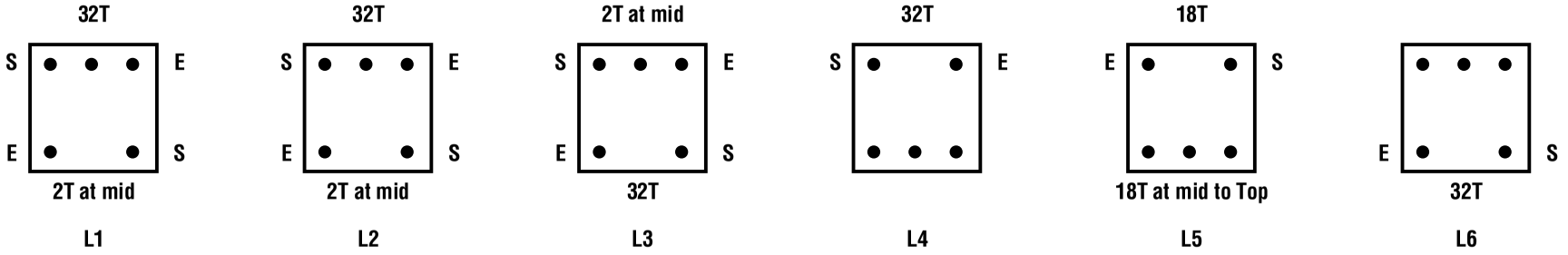




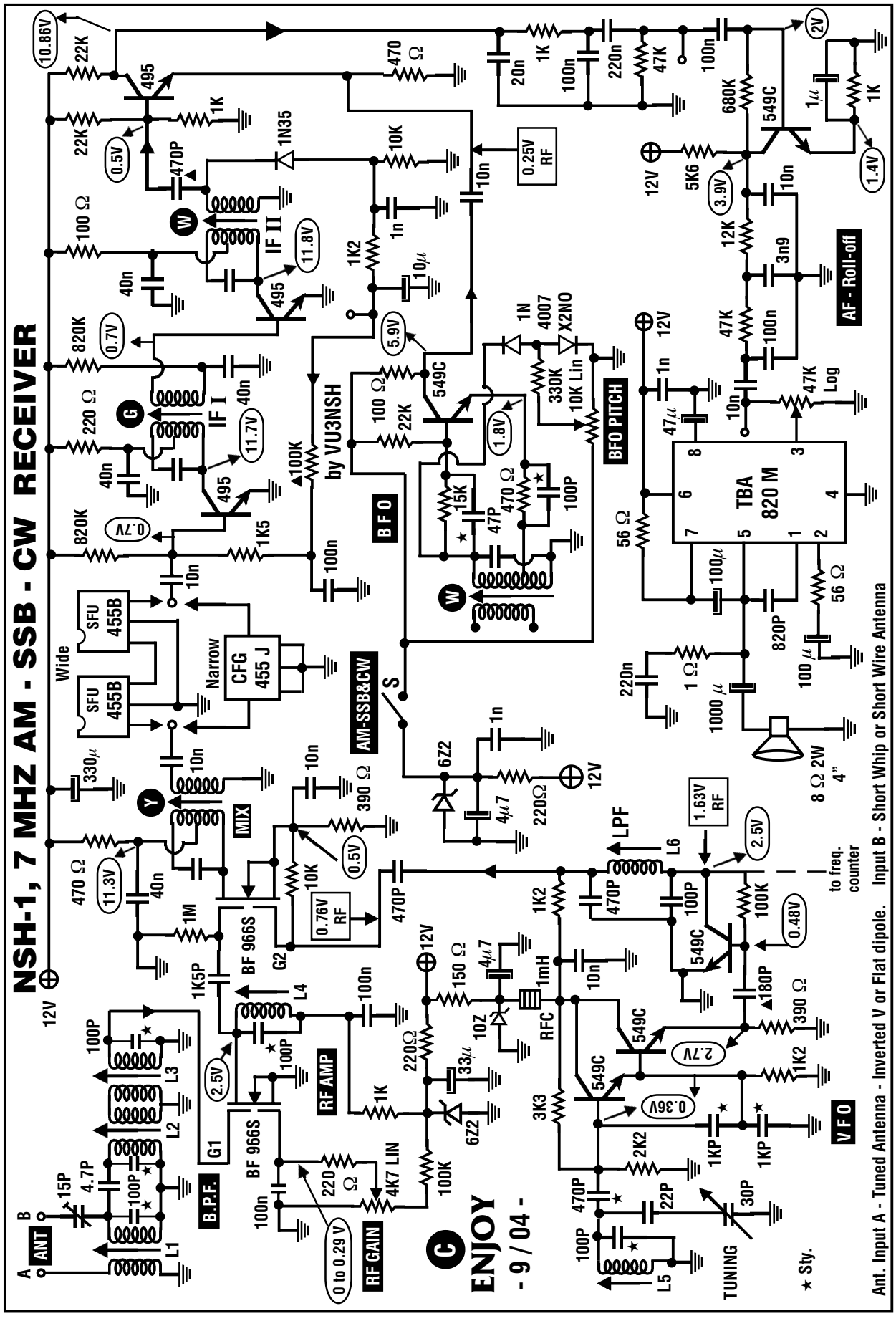


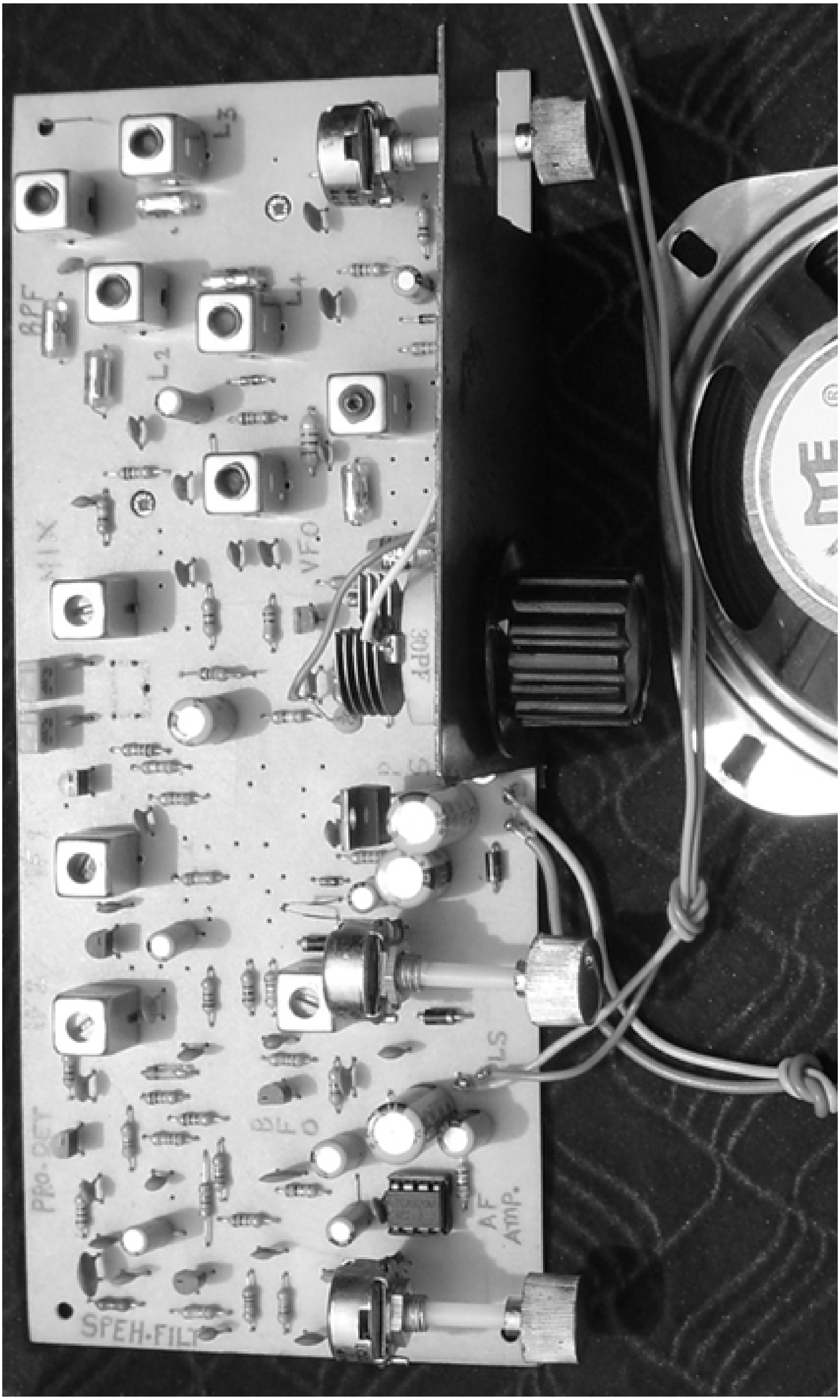






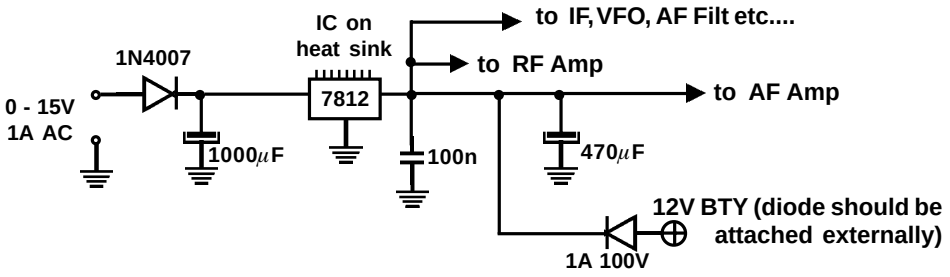
Views of Bottom of the coils



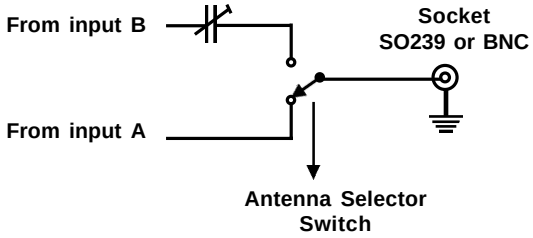


'NSH -1' Assembled Prototype 7 Mhz. AM-SSB-CW Receiver

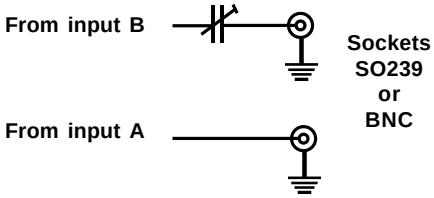
POWER SUPPLY



ANTENNA CONNECTIONS

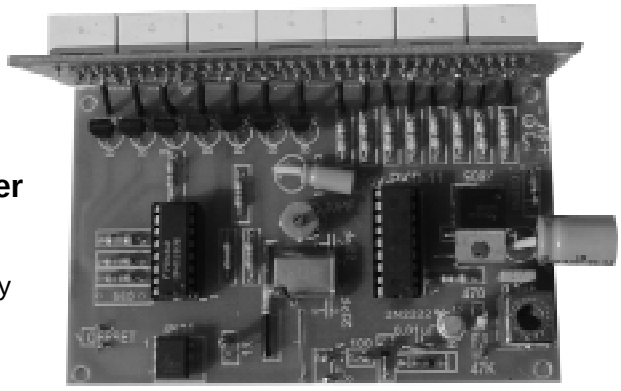


With Selector Switch



Without Selector Switch

Front view of the Assembled PCB



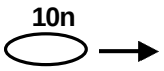
PIC IC based Frequency Counter

This is capable of counting
direct frequency and the offset frequency

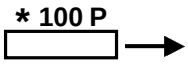
BFO FREQUENCY STANDARD LEVELS

Mode	BFO Frequency	Audio Beat
USB	456.350 K	1.35 K
LSB	453.650 K	1.35 K
CW	454.300 K	700 Hz

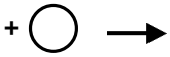
In NSH-1 PCB



all are ceramic capacitors.



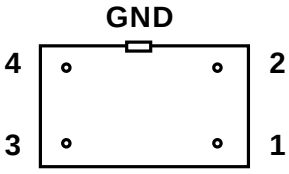
all are styroflux capacitors.



all are electrolytic capacitors.

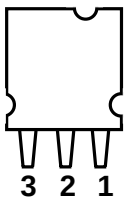
representing speaker connection, AM SSB switch connection and power supply connection

The marking near to 180pF at VFO stage & in product detector may be changed. If the VFO output level more than 1V RF, then change 180PF to 100 PF. If the audio shivering happens (due to high IF injection) then you sould reduce the 470 PF capacitor (IF Injection to product detector) to 100 PF, 82 PF or 56PF to get clear audio.



1- input
3 - output
2 & 4 - ground

CFG 455 J



1- input
2 - ground
3 - output

SFU455 B

REFERENCE:

* ARRL 1976, 1984.
* Electronic Principles by Malvino.
* Exploring Solid State Amplifiers by Joseph J. Carr
* 73 Amateur Radio Today 2000
* RM 96 Project
* Audio IC Circuits Manual by R.M. Marston
* muRata, Telefunken, Elektor, Fairchild, Vishay

The ** mark near to IFTs are styroflux capacitors, if you are using the IFT with PF type, then you cannot connect nothing on that area. If you are using IFTs without PF then you must use 2700 PF styroflux at ** area.

All electrolytic capacitors are 25V type, ceramic capacitors are 60V type, All resistors are ¼W 5% carbon type. If possible use 1% resistor (MFR) at VFO area.

Due to 455 KHz IF (Low Frequency IF), this receiver is having broadcast band (BC). Image problem occurs in evening and night time. For avoiding this problem, the only solution is to keep the IF frequency in a higher level like 9 MHz. Because of using 9 MHz IF, the filter should also in 9 MHz and this will cost Rs. 1,500/- plus. So this is not at all an economic project. Other solution is the Duel Conversion. But this will give a lot of troubles for a beginner in the case of test instruments, alignment etc. In this design, at front end, 3 pole BPF is used to minimise the image problem. If you are facing the image problem, you can change the antenna input to the point A or B, or you can reduce the RF amplifier gain for reducing the overloading.

For PCB, Contact:

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