

REPAIR MANUAL

SR-150 TRANCIEVER

BY WALT CATES 11-08-2026

FUNDAMENTALS OF VINTAGE TRANSCEIVER REPAIR

"Is there a right way to approach vintage radio repair?" I get this question more often than you may think. The answer is a definite yes. Over the last 65 years (at the time of this writing 2026) I have evolved a process that never fails me.

The first rule is, never remove the case before you have the manual with alignment instructions, block diagram and schematics. In this age of the internet, manuals for most Amateur radio equipment are but a few clicks away. Take a few minutes and follow the alignment procedure through the block diagram and the schematic. This simple task will save you hours of misdirection.

Once you are familiar with the rig at the subsystem level there is a definite order of function to follow. 1, Clean the rig, go to https://wd0gof.files.wordpress.com/2019/02/rig-cleaning.pdf

A, Clean the chassis.
B, Clean the switches.
C, Clean the relay contacts
D, Clean and lube mechanical drives.

2, Visual inspection. Look for damaged or burned components, broken wires and mechanical issues.

A, Replace any damaged parts.
B, Test and replace bad or weak tubes.
C, Recap as required.
D, Check and adjust any and all mechanical stops and drive train adjustments.

3, Power up and check the power supply.

A, Are all the voltages correct at the source?
B, Is the ripple on each voltage in spec.?

4, Verify all the oscillators, frequency, stability and output level.

NOTE: Nothing in a receiver or transmitter is going to work properly if the oscillators are not on frequency and their outputs are the proper amplitude. The original manuals were written to the test equipment available at the time. Items such as frequency counters were expensive and not often found on the Ham bench. Often times critical adjustments were considered to be "factory adjustments" only. Consequently, when field adjustments were allowed the procedures quit often relied upon a zero-beat processes with external and internal receivers. These processes more often than not compounded errors through the synthesis chain. I recommend that you include a frequency counter as a basic necessity on your repair bench. Be very precise in setting the frequency of all oscillators.

5, Trouble shoot and repair the receiver section.

A, In most cases once the power supply and the receiver is working to spec 85 to 90 percent of the rig is good.
B, As a general rule start at the audio output stage.
Inject signals and back up toward the antenna following the path as indicated by the block diagram.
C, When signal tracing through the receiver, remember the AGC or AVC systems are closed loop circuits. AGC or AVC actions will mask loss of gain in the receiver train. It is best to disable these circuits and work at minimum input signal levels until you have proper function in the receiver. The same holds true for AALC circuits in the transmitter section. A search of the web will yield many useful documents on AGC, AVC and AALC circuits.

6, Trouble shoot and repair the transmitter section.

Given that you have the receiver working very close to spec., you should start at the microphone input. Trace the signal through the mic amps to the modulator. Once the audio train is proven proceed to the various mixers, then the driver and finally the power amplifiers.

7, Do a full and complete, by the book, alignment.

THIS IS A NO SHORTCUTS TASK, be very precise.

8, Get it on the air and have fun with it.

Remember, if the rig has tubes it has voltages that can KILL YOU.

Observe the “free hand in the hip pocket rule”.



Photo courtesy of W4AWM

Notes:

SUPPLEMENT TO

OPERATION AND MAINTENANCE MANUAL
HALLICRAFTERS SR-150

INTRODUCTION

The SR-150 was produced by Hallicrafters from 1961 to 1963. It is a 19 tube cw/ssb 80 thru 10-meter transceiver. The transmitter **input power** is 150 watts pep ssb and 125 watts cw. The transmitter and receiver are VFO controlled. Other features include receiver incremental tuning, RIT, allowing the receiver to be tuned 2 KHz on either side of the transmitter frequency, dual conversion, VOX, PTT, CW break in, 100 KHz crystal calibrator, product detector, combination S METER and RF output meter, and crystal-lattice filter. Both AC and DC power supplies are available and are a separate component.

Of all the transceivers Hallicrafters produced the SR-150 is arguably the best performer within its range of functions. In recent years (circa 2013) it has experienced a renaissance in popularity. Once properly refurbished it is an outstanding performer. It is rare to find one that is original and pristine most have been "improved" to the point of worthlessness. But with a little tender loving care it can be brought back to life. For those with little or no experience with the SR-150, where to start, and how to proceed can be a daunting task. One section in this document deals with this resurrection process. The REFURBISHING AND REPAIR section takes a systematic approach to rehab. If it is followed in order you will minimize the frustration of restarts and backups. It assumes a working knowledge of radio and tube circuit theory. For the most part it will lead you to the stage or stages where faults have occurred. At this point you must have the skills to locate the failed component.

Over the years technical data on this system has scattered to the four winds. The purpose of this document is to assemble as much technical information as can be found into one clear and easy to read document

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WARNING
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1. SR-150 REFURBISHING AND REPAIRING

SO, YOU JUST GOT AN SR-150 FROM E-BAY OR SOMEONE THAT SAID, "IT WORKED FINE THE LAST TIME I TURNED IT ON". NOW WHERE DO YOU START? THE FOLLOWING PROCESS HAS EVOLVED OVER YEARS OF REFURBISHING THE SR-150. IT SHOULD BE FOLLOWED IN THE ORDER IT IS WRITTEN. THIS PROCEDURE IS DESIGNED TO PROGRESS IN AN ORDERLY MANNER TO MINIMIZE RUNNING IN CIRCLES. BE AWARE THIS IS NOT SOMETHING THAT IS ACCOMPLISHED WITH GREAT SPEED. THE AVERAGE TIME TO COMPLETION IS AROUND 60 HOURS. SOME HAVE TAKEN AS MUCH AS 200 HOURS, SOME AS FEW AS 20 HOURS.

A complete cleaning and mechanical inspection are always advised. Cleaning of the rotary switches and the relays is of particular importance. Refer to the RIG CLEANING section for details. Look closely for broken or burned components. Check the rotation of the controls and mechanical stops of the main tuning dial. Try to eliminate the mechanical problem first. Inspect L32 for heat deformation on the close wound end. This is a high failure rate item when the rig is mistuned or misused in TX mode. See the PA LOADING COIL L32 section for repair details.

1-1. RECAPPING;

There are only four capacitors in the SR-150 chassis that are considered ***must replace*** components. They are C63, 5uf/25v, C100, 5uf/25v, C114, 10uf/50v and C115, 2 X 30uf/350v. Capacitors C63, C114 and C115 each carry heavy current loads. Therefore, the ESR rating of replacements is important. They should have an ESR rating of 1.0 ohms or less. ESR's of 0.3 ohms and lower are available. This is not a place to save money. C115 is a dual cap. There are sources for this capacitor, ***but*** be careful. Some manufactures of these parts use inexpensive low-quality parts. Don't buy from suppliers who will not quote or guarantee the ESR rating. Very low ESR individual capacitors are readily available. So, replacing the dual cap with two capacitors under the chassis is sometimes a better solution. Generally speaking, shotgun replacement of the paper caps is not recommended.

1-2. RELAYS

Relays K2 and K3 are the most problematic components in the 150. Relay K1, not so much, usually all it needs is contact cleaning. Relays K2 and K3 in parallel provide approximately 380 ohms resistance for the cathode of V13. So, the common 12vdc relay will **not** substitute for them. Years of misuse and spraying with contact cleaner has warped the contact substrate of K2 and K3. The contact substrate is a laminate with 2 layers of phenolic bonded together. Contact spray softens the bonding material which then allows heat to warp the substrate. **Rule #1 for relays** is never spray relays with anything. **Rule #2** never use sandpaper on the contacts. You can test them in the rig using a VOM, two clip leads and a 10-volt supply. More often than not they need to be removed repaired and reinstalled. Go to section 3-5 for information on K2 and K3. **They need to be verified as operational before you proceed to the next step in this process.**

1-3. AFTER MARKET MODIFICATIONS

If you find any modifications, re-wirings or added components remove them and return the rig to the original configuration.

1-4, TEST EQUIPMENT

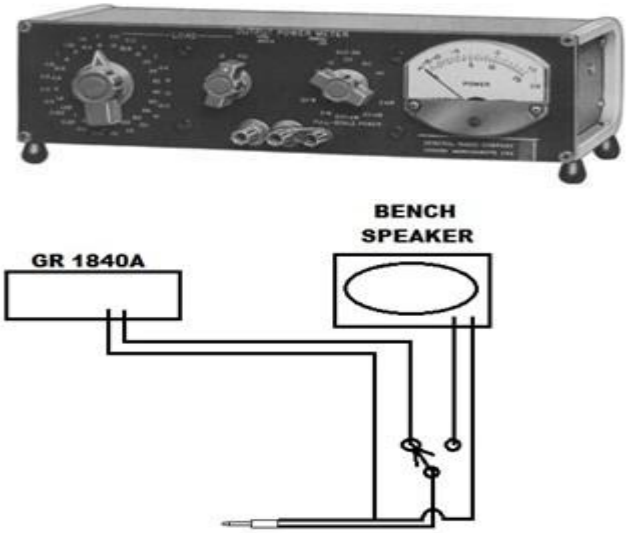
There is no need for expensive or elaborate test equipment. I purposefully minimized the test equipment I used to develop this document.

1-4-1, SIGNAL GENERATOR

The signal generator needs to cover, minimum, 50KHz to 30MHz. The key feature is a calibrated output. The output should be metered with a step attenuator, and capable of precise output from 0.1uv to 300kuv. For the development of this document, I used the URM25-D.

1-4-2, AUDIO POWER METER

An audio output meter such as the General Radio 1840A (my choice) is all that is needed. There are many that are up to the task. The key features are: Internal variable load (at least 3 ohms to 1.5k), variable full-scale power, 2mw to 20w and a meter calibrated in watts and DB. Fully self-contained no power no batteries. The majority of the receiver test specs involve a fixed signal input and a minimum or fixed audio output across a fixed load. Other specs involve a change in audio output across a given load due to a change in input signal. All of these measurement requirements are satisfied by a good audio power meter.



Typical setup for 1840A

1-4-3, OSCILLOSCOPE

You will need to accurately measure DC levels as well as AC and RF signals. I used a Hantek DSO5102 to develop this document ($219 @ amazon). This is not an endorsement of Hantek. I got it because I had never used a digital scope and it was inexpensive. What I like about a digital scope is all the information presented on the screen; frequency, period, mean voltage,
peak to peak voltage, signal minimum, signal maximum, pulse width, rise time and a myriad of other features I have yet to explore.

1-4-4, FREQUENCY COUNTER

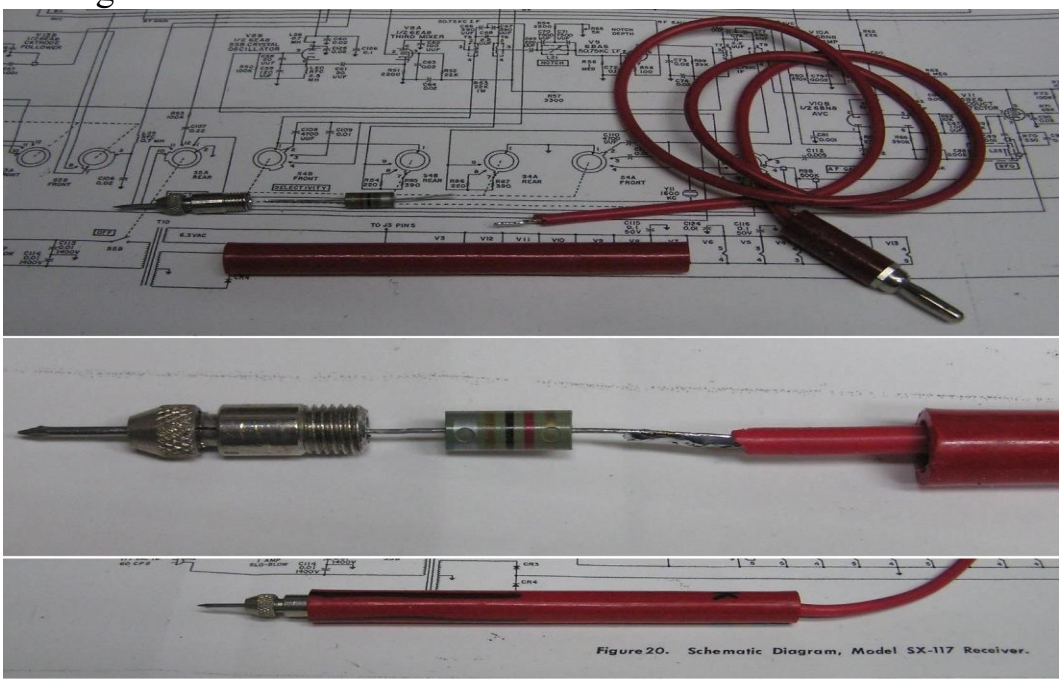
You need a range up at least 40MHz with a sensitivity of 0.150v or less.

1-4-5, TEST METER

Here you can save a little money. Nothing in the SR-150 (or most of the vintage receivers of the era) requires measurements of the four digit or better accuracy. The $4.00 on sale DVM at Harbor Freight is perfect. Just be sure you get the one with the 1000vdc scale.

1-4-5-1, RF BLOCKING PROBE

The inexpensive DVM's and VOM's work fine unless you are trying to measure a dc voltage with RF present, like the plate, grid or cathode of an oscillator or mixer. It is simple to make an RF blocking probe for an inexpensive meter. Install a 270uh to 1mh choke in the barrel of a dc probe. It will work with oscillators and low power mixers. Don't go messing about in the PA of a transmitter with one.



1-4-6, AUDIO OSCILLATOR

Be careful here. Most function generators will not work. Most function generators are 50-ohm output, you need 600 ohms. Most function generators are limited to 10 to 12vpp output. You need at least 30vpp. I used a WAVEFORMS 401B for the development of this document. The old HP 200 series are great and inexpensive.

1-4-7 WATTMETER/LOAD

The minimum for servicing the SR-150 is a full-scale meter presentation of, and load handling capability of 250watts. Any of the Bird products are highly recommended.

1-4-8, CAPACITIVE TUBE PICKUP

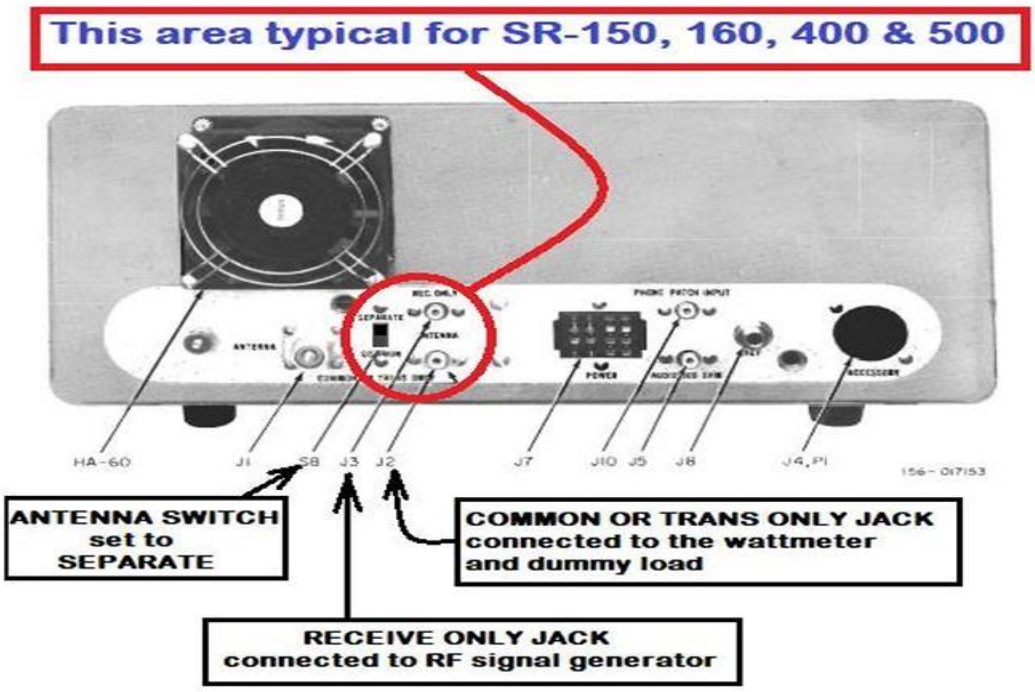
The capacitive pickup tool is a metal sleeve that slides over a tube to sample any RF present. It is used most commonly to sample oscillator, driver and mixer signals without presenting a load to the circuit. It fits snuggly over the tube without contacting the chassis. The most common method of construction is the cut the base off a tube shield. It will be used to test the driver, mixers or any oscillator.



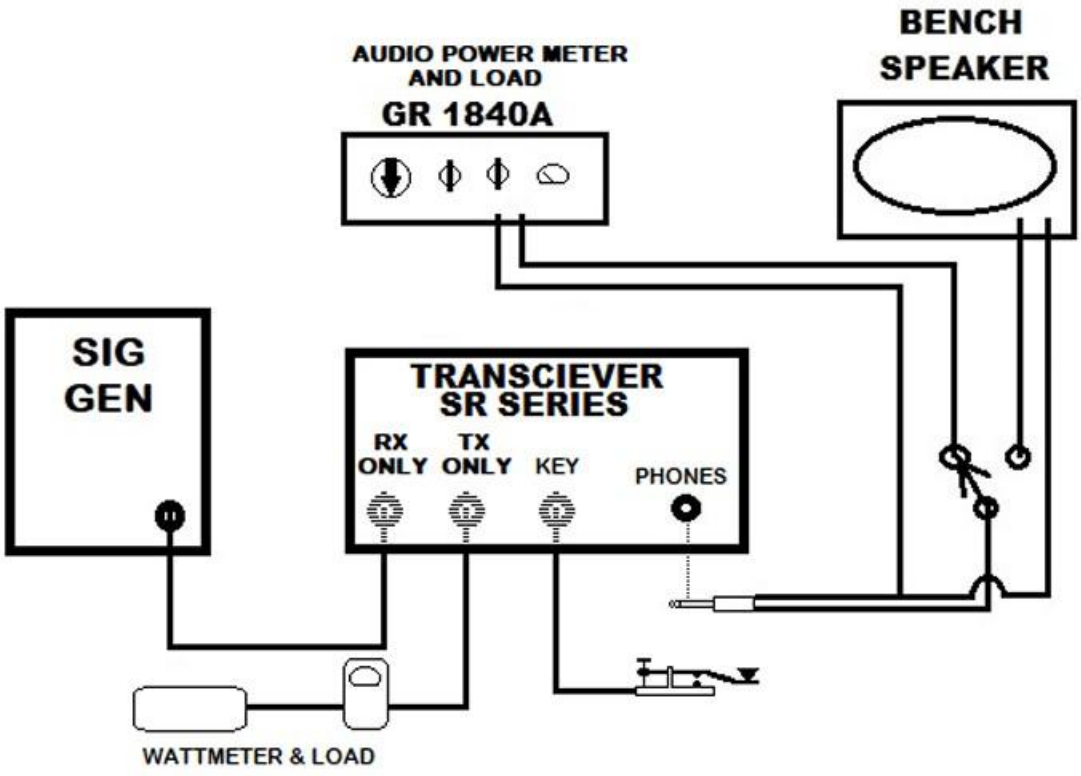
1-4-9, SR-150 THROUGH SR-500 TEST BENCH SETUP

When performing maintenance on a SR-150,160,400 or 500 I set the antenna selector (rear of the rig) to the SEPARATE position. Then I connect the signal generator to the REC ONLY jack and the Wattmeter and dummy load to the COMMON connector. That way you do not have to swap cables and worry about inadvertently transmitting into your signal generator.

Then I plug a telegraph key Into the KEY jack in the rear of the rig. Then when in MOX and CW positions and the telegraph key is <u>not</u> pressed you are in the receive function and can make receiver adjustments. When you <u>press</u> the key you automatically shift to the tx mode and can make transmitter observations. This keeps the tx duty cycle very short because you don't inadvertently leave the rig in the CW keyed mode too long. It also saves wear and tear on the FUNCTION switch.



TYPICAL BENCH SETUP



1-5. FACTORY UP-GRADES

It is highly recommended to up-grade the SR-150 to the production run 7 level before starting the restoration. See the chart in section 2, PRODUCTION RUN UP-GRADES for a list of changes.

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1-6. INITIAL POWER UP

BE AWARE: *The SR-150 has an unusual characteristic upon power-up. On initial power-up the radio is in the TX mode, the meter pegs full scale, and the meter slowly returns to zero. As the meter passes through S2 to S5 the relays energize and full RX mode is achieved. For about a second before the relays energize the radio will put out full power. Normally you will never notice this anomaly. However, if you are connected to a signal generator this pulse of power could damage the generator. Or if the antenna connector is open you may experience high plate current which may blow the power-supply fuse.* **SOLUTION**: *Always turn the MIC GAIN and the RF LEVEL to minimum before turning on the transceiver.*

First and of critical importance, you must have a power supply that has been tested and meets all the original specifications. NOTE: The actual B+, high voltage and negative bias voltages measured in your system will vary from the values on the schematic and in this document. The AC input voltage must be from 105 to 125vac. A 5v change in the AC voltage will equate to about a 20vdc difference in the high voltage, 10vdc in the B+ and about 5vdc change in the bias voltage. The voltages measurements in this document relate to 123vac bench supply. You will not be transmitting power until late in this process so temporarily replace the 3-amp slo-blow fuse with a 3amp normal delay fuse. It is ***not*** necessary to start with a low AC voltage and increase the voltage over time to cook the rig. There are no domino circuits in the SR-150. If you have a short somewhere, you may cook a resistor and it will smell bad but it will lead you straight to the problem. So, set **all the gain and drive controls** to minimum. **Every** time you turn on your SR-150 all these controls should be at minimum. The **STANDARD PRE-POWER UP CONFIGURATION** will always be: all gain controls set to minimum, RIT off, RIT CONTROL at mid-range, CAL ADJ at mid-range, CAL OFF, preset the PRESELECTOR to the approximate position in the band you will be operating, set the FINAL TUNING to the approximate position in the band you will be operating and set the FUNCTION switch to either USB or LSB depending upon which band you will be testing. Ok it is time to apply power. Attach the power supply and plug it in. Set the operation switch to STBY. Now let it sit there for 10 to 15 minutes. Locate R95, 2500-ohm, 10-watt resistor connected to V12. The voltage at the tie point of V12 and R95 should be 150vdc and 250 – 280vdc at the other. If not, you have a fault that must be fixed before you proceed. Otherwise, the only thing we need to adjust at this time is rough set the bias voltage. On the underside of the Final tubes locate the tie point of R105 (10K) and L36. This is where we will measure the bias voltage in the *receive mode*. Set your meter on the 200vdc range. Now adjust the bias adjust control on the power supply for -105vdc. Turn the power off; plug your meter into the red (+) and blue (-) test jacks on the power supply chassis. Set the meter on the 2vdc range. Set the function switch to LSB, connect a mic and set the RF GAIN and MIC GAIN to minimum. Turn the power back on. Allow warm up and key the mic. The meter should read less than 0.5vdc. If it reads higher than 0.5 VDC adjust it down with the bias control (This is a preset voltage setting, later in the transmitter tests the bias setting will be set to its operating level. The point here is to minimize stress on the final tubes until you are ready to work on the transmitter section). If you cannot adjust it or it is very high then you have a problem in the final PA or bias divider and this must be corrected before you proceed, go to the TX BIAS FAULT section. If all is well with the bias you are now ready to proceed to the CHECK AND
ADJUSTMENT OF OSCILLATORS section.

1-7. CHECK AND ADJUSTMENT OF OSCILLATORS:

Before starting any receiver or transmitter troubleshooting or RF or I.F. alignment it is **imperative** that the xtal oscillators and the VFO are **precisely** on frequency. If you will devote the time to these considerations you will be rewarded with a rig that performs as well as any modern rig. A frequency counter and scope are required. The procedure in the book will work ok, but will compound errors. If you get all the oscillators “on freq” with proper output levels individually, then all else will fall into place. Do not make any adjustments until the rig has been on for at least 30 minutes. Optimize the VFO **last** to insure it is stable. Do not hurry. Take your time, these processes are critical.

1-7-1. CARRIER OSCILLATOR:

The carrier oscillator is comprised of V10 and its associated circuitry. First thing is to check the output of the carrier osc in both USB and LSB modes. After warm up you should have approximately 30 Vpp on pin 7 of V6. Now adjust T4 for max. The voltage on pin 4 or 3 of T4 should be 9 Vpp. If these voltages are more than 10% low then you most likely have a fault in the oscillator and this fault must be corrected before you proceed.

Once you are satisfied with the oscillator output set the function switch to USB. Connect a scope to pin 7 of V6 to monitor the output voltage of the osc. Connect the frequency counter to either pin 4 or 3 of T4. You will find that if you adjust T4 in one direction from the peak the signal drops off very fast. In the other direction it falls more slowly. T4 should be adjusted about 2% to 5% off peak toward the slow fall off side. Switch back and forth from USB to LSB to insure both oscillators start without any hesitation. In USB mode adjust C106 for exactly 1651.70 KHz. Switch to LSB mode and adjust C103 for exactly 1648.1 KHz. Adjustment of T4 and C106 and C103 can interact. Re-check the output voltage and re-check the frequency back and forth several times to ensure that everything is stable and there is no hesitation in the oscillator startup.

1-7-2. HETERODYNE OSCILLATOR:

The Het Osc is comprised of V8 and its associated circuitry. This oscillator is the most troublesome of the three. There are no adjustments to pull the frequency of each xtal. So, if you do not have a box of spare xtals you are rather limited in what you can do to put it precisely on frequency. First thing, check the oscillator output. Connect the scope to the tie point of C80 and CR2 which are located in the cathode ckt of V8. The minimum peak to peak voltages for each band should be: 80 meters 8 Vpp, 40 meters 5 Vpp, 20 meters 5 Vpp, 15 meters 3 Vpp, 10 meters (all 4 bands) 2 Vpp

If the output does not meet these minimums, then this repair **must** be accomplished before proceeding. Once you are satisfied with the oscillator output disconnect the scope and connect the frequency counter to the tie point of C80 and CR2 and check the frequency on each band. If the xtal frequencies are **all** high or **all** low then swapping out C74, C 76 and C77 may bring them back in spec. With the four 10-meter xtals you are pretty much stuck with where ever they are unless you have a bag of xtals to swap. For the 80-, 40-, 20-and 15-meter bands, each band has a warping cap (C73, C72, C71 and C70 respectively). These warping caps can be swapped out to pull individual xtals on to frequency. The end unit frequency spec is + or – 3 KHz at any dial point across any band. With the VFO and Carrier oscillators dead on whatever error you have in the heterodyne oscillator is what you will have to live with

1-7-3. VFO:

The VFO is comprised of V9 and associated circuitry, VFO correction circuitry and the RIT/CAL circuitry.

The RIT/CAL ckts are used to change the bias voltage on a varicap in the VFO. This is used to make minor corrections to the frequency of the transmitter and receiver. The supply for the RIT/CAL ckt is the regulated 150vdc line. The 150vdc regulated line by normal standards is pretty stable. The voltage

divider for the RIT/cal ckt is isolated from the reg 150v line by a 180k resistor. The leads from the divider ckt wander back and forth from the front panel to Relay K1 and back to the VFO. All this boils down to lots of stray pick up. There is a simple solution to the problem (drawing located in SUBSYSTEM TECHNICAL INFORMATION section). Replace R81 (180K) with an 82K resistor and parallel C100 with a 1N4742 zener diode. This will lower the dynamic impedance at the feed point of the CAL/RIT divider from approximately 14k ohms to 5 ohms. This modification is a highly recommended option. If you decide to perform this option it must be done before you proceed with the alignment of the VFO.

Before any alignment or tracking of the VFO can be successfully undertaken, two peripheral systems must be proven to be functioning properly. They are; the RIT/CAL network and the USB offset network. This process is written specifically to the SR-150. However, it can be adapted to all the SR series transceivers. *NOTE: The USB/LSB offset in the SR-160 and SR-500 is handled by the frequency synthases process and therefor there is no SSB correction circuit.*

1-7-3-1. RIT/CAL

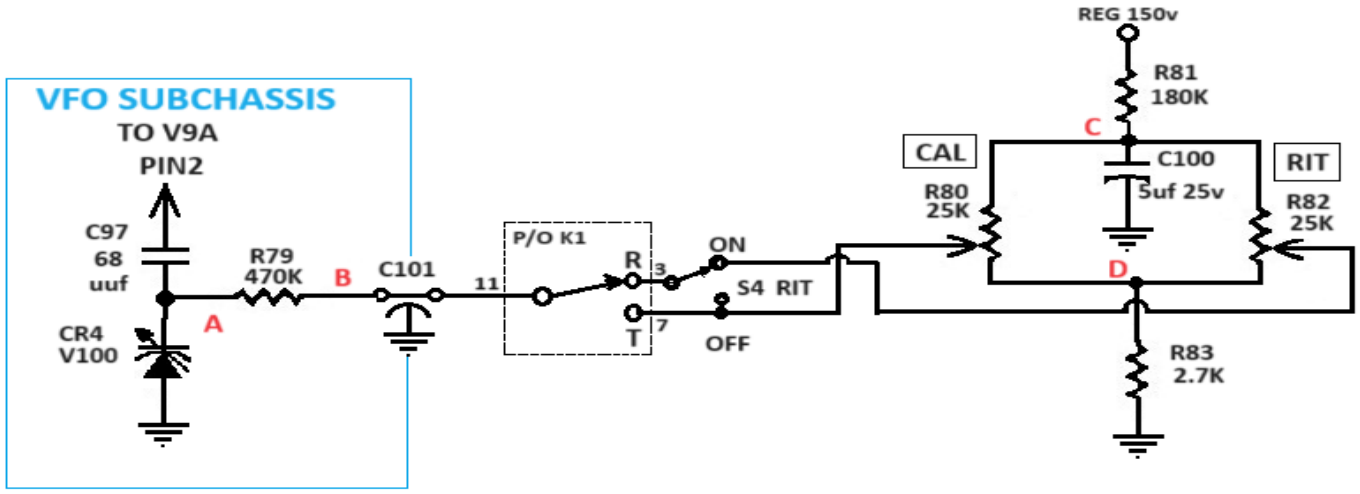
Remove the VFO oscillator tube V9, to remove the RF from the circuits under test.
You will need a high Z voltmeter, 100K per volt or better for accurate measurements.
Remove the VFO cover.

1-7-3-1-a. STATIC VOLTAGE TEST.
Set the FUNCTION switch to the STANDBY position. Allow 5 minutes warm up time. Set the RIT switch to off. Adjust both the CAL and RIT controls to the center of their rotation. REF: figure 1 below.
>Measure the voltage at test point D, it should measure approximately 2vdc (+/- 20%).
>Measure the voltage at test point C, it should measure approximately 12vdc (+/- 20%).
>Measure the voltage at the RIT wiper arm as you rotate the control, it should vary from 2 to 12vdc. Return the control to the center of its rotation.
>Measure the voltage at the CAL wiper arm as you rotate the control it should vary from 2 to 12vdc. Return the control to the center of its rotation.

1-7-3-1-b. LEAKAGE TEST.
Power down and remove the cover shield from the VFO.
With RIT off measure the voltage at the relay side of C101.
>Adjust the CAL control for maximum voltage at C101, test point B.
1>measure the voltage at the junction of R79 and CR4, test point A. it should equal the voltage at C101.
>Adjust the CAL control for minimum voltage at C101.
2>Again, measure the voltage at the junction of R79 and CR4, it should equal the voltage at C101.
If either of the measurements in step 1> or 2> are lower than that measured at C101 either CR4 or C97 is leaky.

If CR4 is bad you may not find an exact replacement. The 1N3182 is the best replacement. Second choice is the1N4386. The 1N3182 has a Q of 20. The 1N4386 has a Q of 150. Sometimes when using the 1N4386, if you have bad grounding in the VFO, you will get FM'ing of the VFO signal.

FIGURE 1



REINSTALL V9

1-7-3-1-c. VFO CAL SWING TEST

Power up in STANDBY, LSB mode. Warm up for 5 minutes.
Connect a frequency counter to the junction of R15 and C83. Tune the CAL control from min to max.
The frequency swing should be a minimum of 3KHz.

1-7-3-2. VFO CORRECTOR TESTS

1-7-3-2-a. STATIC VOLTAGE TEST

Remove the VFO cover and locate the tie point of R75, C95, C96, and CR3 this is test-point B.
Power up in STANDBY mode, LSB, any band, any dial setting.
1, Measure the voltage at A and B.

1.1, The measurements should be equal approximately -17vdc*.

Switch to USB.
2, The voltage at A should be 150vdc.
2.2, The voltage at B should be 0.4 to 0.7vdc, depending upon the characteristics of CR3.
3, The measurements in CW mode should be equal to those of USB mode.

***The actual voltage at test point A is determined by the condition of your final tubes. When you set the idle current, a weak set will require a lower bias setting. High gain tubes will require a higher bias voltage. The unloaded (RX mode)-95vdc noted on the schematic assumes a mid-range spec. set of tubes.**

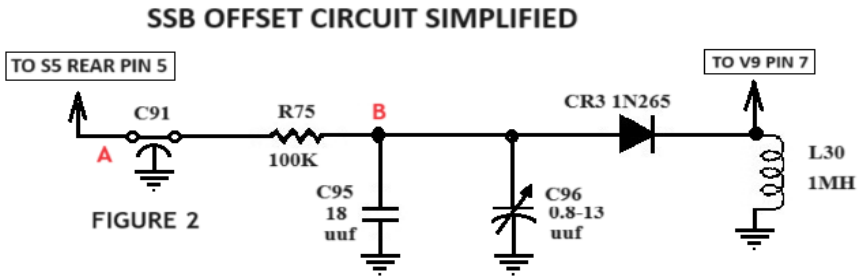


FIGURE 2

1-7-3-2-b. OFFSET FUNCTIONAL TEST

The VFO correction ckt corrects for the frequency off set between USB and LSB (NOTE: CW operates in the USB MODE). Before the VFO is aligned it must be established that the correction ckts are working properly. Connect the frequency counter to the tie point of R15 and C83 (C83 is in the cathode ckt of V9B).

-Select USB and adjust C96 through its range to insure that you can get at least a 3000HZ swing.

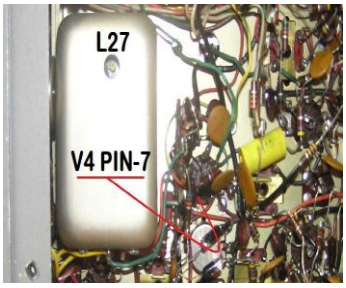
-If you can, then readjust it for a difference between USB and LSB modes of exactly 3600HZ. If you cannot, there is a fault in the corrector ckt that must be repaired before you can continue with the VFO alignment.

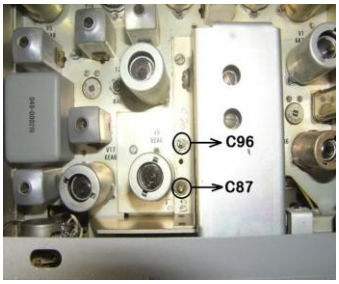
1-7-3-3. VFO ALIGNMENT

Before starting the VFO alignment go to section 3-2-1 and perform the VFO DRIFT TEST.

SETUP

Preset C87 to center. Carefully rotate the screw clockwise until it hits the stop. Then rotate counterclockwise COUNTING THE TURNS until you hit the stop again. Now go clockwise half the total turns. Power up, warm up (30 minutes), adjust the VFO to 300 on the dial, OPERATION to STANDBY, FUNCTION to LSB, RIT to OFF, CAL ADJ to center of its rotation, RIT control to center of its rotation.





ADJUSTMENT

Connect a frequency counter to pin 7 of V4. With the VFO dial set to 300 adjust L27 for an output frequency of 4.5519MHz. That will be your starting point. Then go back and forth from 100 to 400 on the dial. Adjust L27 for 4.7519MHZ at 100 and C87 for 4.4519 at 400. It can be tedious since the adjustments do interact. A technique of over or under correction on one end or the other may be needed.

Once you are satisfied with the alignment at 100 and 400 check the frequency at 0, 100, 200, 300, 400, and 500. You are shooting for the following:

DIAL	FREQUENCY
0	4.8519 MHz
100	4.7519 MHz
200	4.6519 MHz
300	4.5519 MHz
400	4.4519 MHz
500	4.4519MHZ

The spec tolerance is +/- 1KHz at any point on the dial. However, experience has shown that a properly operating VFO can easily meet +/- 500Hz. Remember dial accuracy across the band is dependent on the accuracy of all the oscillators. Better performance is well worth extra effort in the alignment.

You are not quite done yet. Once you are satisfied with the alignment switch from LSB to USB the VFO should increase 3600Hz. If not adjust C96 to get it right on.

Now you are done with the oscillators..

1-8. RECEIVER TESTING

All of the receiver testing will be accomplished by performing tests outlined in the RECEIVER FAULT ISOLATION section. The Hallicrafters spec states the receiver sensitivity as 1uv signal in for 20db signal plus noise to noise. The gain is specified at 1uv in for ½ watt audio output. It is quite common for the SR-150 to meet both of these specs at 0.5uv. I have seen quite a number achieve spec at 0.2uv.

1-8-1. EQUIPMENT REQUIRED:

HF RF signal generator capable of 0.1 microvolts to 300 millivolts and covering 1600 KHZ to 30 MHZ
Audio output meter

The General Radio 1840A is an excellent choice. Audio distortion analyzers similar to the HP 334 series is a more versatile choice but require periodic calibration. Either can be found for under $200.

Scope 100 MHZ or better with 1:1 and 10:1 probes or switchable probe. Two probes will be required for some tests.
Audio oscillator with 600-ohm output Z_0 capable of from 0.7 millivolts to 15v peak to peak output.

1-8-2. RX FAULT ISOLATION PROCEDURE:

There is not anything inherently clever about this process. What it does offer is signal injection levels and output results gathered from hundreds of tests performed on SR-150's over 30 years. For those who wish to expound on the evil effects of probe loading and ckt miss-matches, I concede you are correct, it does happen. But the process works, it is repeatable and simple to follow. Throughout this process we will be injecting signals at different points throughout the radio and monitoring the audio output from the receiver. In most cases the output we are looking for is 1 watt of audio output. It is recommended to use an audio output meter. This is helpful because audio output meters similar to the GR 1840A allows for dB measurements as well as power output. Any 10-watt resistive load may be used in place of the audio power meter. When using an alternative load, you will need to monitor the voltage across the load. Then you will have to convert the RMS or peak to peak voltage to watts depending upon your use of a scope or RMS voltmeter.

Read the entire procedure thru before you start. To eliminate problems caused by the AGC install a clip lead from the tie point of R20, 220k and R116 820k and ground. These resistors are located on the 4-lug terminal strip adjacent to the socket of V17. Set up the receiver on the 40-meter band at 7.3 MHz. Adjust the RF GAIN and AF GAIN to max. This process is written specifically for resurrecting long dead rigs. Multiple faults are assumed.

Note; There were 7 production runs of the SR-150. The following signal levels apply directly to runs 3 through 7. Production runs 1 and 2 will require as much as 10% more signal for the same audio output levels. Refer to SECTION-2 for details to determine which production level you have. IT IS HIGHLY RECOMMENDED TO UPGRADE TO LEVEL 7.

1-8-2-1 RECEIVER TROUBLESHOOTING TABLE.

	INJECTION POINT	Injection signal	Generator output	Audio out	If OK go to next step. If not check suggestions below. #
1	PIN 1 V13 1X probe	1KHz	8 vpp	1 wt.	V13 and associated circuitry, check K1 switching
2	Pin 8 V11 1X probe	1KHz	0.3 vpp	1 wt.	V11 and associated circuitry
3	BOTTOM C64 1X probe	1KHz	1 vpp	1 wt.	Shielded wire, R91 and grid ckt of v11
4	Pin 1 V6 1X probe	1650KHz	0.015v	1 wt.	Check pin 7 V6 for 25vpp from carrier osc, V6 or its associated circuitry.
5	Pin 2 V5 10x probe	1650KHz	0.015v	1 wt.	V5 and its associated circuitry
6	Pin 2NV17 10Xprobe	1650KHz	350uv	1 wt.	V17, FL1 and their associated circuitry
7	Pin 2 V4 10X probe	6.2MHz*	800uv	1 wt.	V4 and associated circuitry
8	Pin 2 V3 10X probe	6.2MHz*	200uv	1 wt.	V3 and associated circuitry
9	Pin 7 V2 10X probe	7.3MHz*	100uv	1 wt.	Check relay side of C27 for at least 10vpp of carrier injection, otherwise V2 and associated circuitry is suspect.
If step 9 is successful perform a pre-alignment at this point. First reduce the drive from the signal generator until you have ½ watt audio output with the AF GAIN at max. Ensure the main tuning is peaked, then adjust T1, T2, and T3 (top and bottom slug) for max audio output. Throughout this process ensure the main tuning is peaked. Keep the audio output at or below ½ watt by adjusting the injection level. This is not intended to be the final I.F. alignment but will enhance later alignment and final adjustments.					
10	Tie point C17 & L12. 10X	7.3MHz^	400uv	1 wt.	6MHz trap, band switch or K2
11	Pin 6 V1 10X	7.3MHz^	10uv	1 wt.	V1 and associated circuitry
12	J1	7.3MHz	1uv	1 wt.	Circuitry between J1 and V1

Circuit analysis and voltage charts are found in SECTION 5.

^ Some adjustment of the main tuning and PRESELECTOR will be required.

*Some adjustment of the main tuning will be required to get max peak

***Voltages are RMS unless otherwise noted.

1-8-2-2 Final receiver test.

With the ground still connected to the AGC line. Ensure the equipment is set up as in step 12 in the table;
1, remove the gnd from the AGC line. If the audio output decreases more than 2db or goes away you have a fault in the AGC and this fault must be cleared before continuing.
2, Ensure the RF GAIN is at max, adjust the signal in to 1uv and set the AF GAIN for ½ watt audio out. Connect the gnd jumper to the tie point of R22 and C39 (this is in the area of V4). If the audio output from the receiver increases with the grounding of this point then you have a defective R10 (RF GAIN POT). You can have up to 1db difference and the receiver will function properly. More than 1db and the sensitivity will be adversely affected. Also, The S meter will not function correctly. See the section on RX GAIN ANOMALY for aid in clearing this fault.

YOU ARE READY TO PROCEED TO THE TRANSMITTER TESTING SECTION.

The S Meter Scale

S-reading	HF uv(50Ω)	Dbm	Signal Generator emf dB above 1uV
S9+10dB	160.0	-63	44
S9	***50.2***	***-73***	***34<***
S8	25.1	-79	28
S7	12.6	-85	22
S6	6.3	-91	16
S5	***3.2***	***-97***	***10 <***
S4	1.6	-103	4
S3	0.8	-109	-2
S2	0.4	-115	-8
S1	0.2	-121	-14

TRANSMITTER TESTING

1-9. TRANSMITTER TESTING

1-9-1. TRANSMITTER TESTING EQUIPMENT REQUIRED

Wattmeter/load 50 ohm 250 watts full scale
Scope 100 MHz bandwidth
Microphone dynamic 600 ohm
Multimeter 2 VDC full scale and 10 VDC full scale recommended *Optional*
telegraph key

1-9-2. TRANSMITTER TESTING PROCEDURE

Earlier you replaced the 3-amp slo-blow fuse with a 3-amp normal delay. It is now time to re-install the 3-amp slo-blow fuse. Set the main tuning dial to 7.25 MHz. Set the band switch to 40 meters. Set the rest of the controls to the **STANDARD PRE-POWER UP CONFIGURATION.** Set your meter to the 2 VDC full scale range and plug it into the red (+) and blue (-) test jacks on the power supply chassis (this is to monitor the PA plate current). Connect a wattmeter/50-ohm load to the antenna jack of the transceiver. Set the OPERATION switch to STBY and allow 15 to 20 minutes for warm-up.

Earlier in this process the –bias was rough set. Now it needs to be set more precisely. Set OPERATION switch to LSB, ensure MIC GAIN and RF GAIN are at Ø. Attach your mic and key the transmitter with the mic. Adjust the BIAS ADJ control on the back of the power supply for a reading of Ø.7 volts (This indicates 70 milliamps of plate current) on the meter plugged into the power supply. **WARNING;** keep your eyes on the meter as you key the mic. Quickly un-key the mic if the meter pegs. If you cannot adjust the bias or it pegs you have a problem in the PA or bias voltage divider ckt. This may be a tube or a DC problem. Check V14 and V15. Then check the voltages on V14 and V15. This fault **must** be cleared before you can continue, go to section 1-9-5, TX BIAS FAULT and section 5-16 for more information. If you are able to set the bias to 0.7 VDC observing the meter and adjust the BIAS ADJ control to see if you can get 1.5 VDC on the meter. **Quickly** return the setting to Ø.7 vdc. If you are unable to get 1.5 VDC then one or both of your final tubes are weak. Replace them with a matched pair. If replacing the tubes does not clear the fault then you have a problem with the HV, B+, or the screen voltage or bias. This fault must be cleared before you continue.

The next series of tests will be conducted in the MOX, CW mode. You will need to switch the FUNCTION switch from LSB to CW quite often. You MUST keep the transmit duty cycle short. I find it easier to plug a key into the key jack on the rear of the transceiver. Then you can set the FUNCTION switch to the CW position and leave it there and press the key when you want power. This saves wear and tear on the FUNCTION switch and reduces the chances of leaving the transmitter keyed to long. For the remainder of the tests when you are instructed to "**key the transmitter**" you will either switch the FUNCTION switch from LSB to CW or press the key.

Assuming you have properly set the **STANDARD PRE-POWER UP CONFIGURATION** and are in STBY. Tune the main tuning and band switch for 7.26 MHz. Set the meter monitoring the plate current to the 10 VDC range. Switch to MOX and key the transmitter. Observe the plate current while advancing the RF GAIN. Do not let the plate current exceed 250 mills (2.5 VDC on the meter). If you do not get an increase in plate current advance the RF LEVEL to the 3 o'clock position. Adjust the PRESELECTOR and FINAL TUNING controls to find a peak in the current. Keep the plate current below 250 mills by reducing the RF LEVEL as needed.

1-9-2 continued
If you are unable to get an increase in plate current proceed to the TX DRIVE FAULT ISOLATION section 1-9-3. This fault must be cleared before you continue. When you clear the fault return to this point in the process. If you got the peak in the plate current, key the transmitter again, adjust the FINAL TUNING for a dip in plate current. As the dip occurs you should get a peak in power output. If you get no dip or if the power peak and current dip do not coincide it means the PA needs to be neutralized. We won't worry about neutralization at this point. *Keep the transmitter duty cycle as short as possible at all times.* Observe the preselector setting. The pointer of the PRESELECTOR control should be in the center of the 40-meter bar. If not move the pointer to the center of the bar, key the transmitter and peak L10 and L40 for max power out. Key the transmitter and re-peak the PRESELECTOR and dip the PLATE TUNING. Key the transmitter and momentarily advance the RF LEVEL to max while observing the wattmeter you should get between 40 and 100 watts. Recheck the location of the PRESELECTOR pointer and repeat as necessary to get it centered. At this point you have proven 80% of the transmitter circuitry. Now check the rest of the bands. You will need to adjust the driver grid and plate coils on each band. Set the PRESELECTOR pointer to the center of each band segment and the main tuning to 250 on the black scale. Key the transmitter and adjust the following;

L11, L41 – 80 meters
L10, L40 – 40 meters
L9, L39 – 20 meters
L8, L38 – 15 meters
L7, L37 – 10 meters (You may not have all the 10meter xtals. Test only one of whatever xtal channels you have.)

Do not worry about low power at this time. If you can get 40 watts or better on all but the 10-meter bands you are good at this point. If you have a band that doesn't function then the fault most likely is in the band switch, the driver grid or plate coils or plate loading ckt. Those faults must be cleared before you proceed. You are now ready to neutralize the PA and perform the overall alignment. A precise neutralization procedure can be found in the SUBSYSTEM TECHNICAL INFORMATION section of this document. There are still a few ckts you have not proven. A full alignment will proof the rest of the system. Go to Section 4 and preform the alignment procedures detailed there. That will complete the alignment. You will find the setup for VOX in section 5 of the Hallicrafters manual. The RECEIVER and TRANSMITTER performance data sheets in the DATA SHEETS section contain the minimum performance standards for the unit.

1-9-3. TX DRIVE FAULT ISOLATION

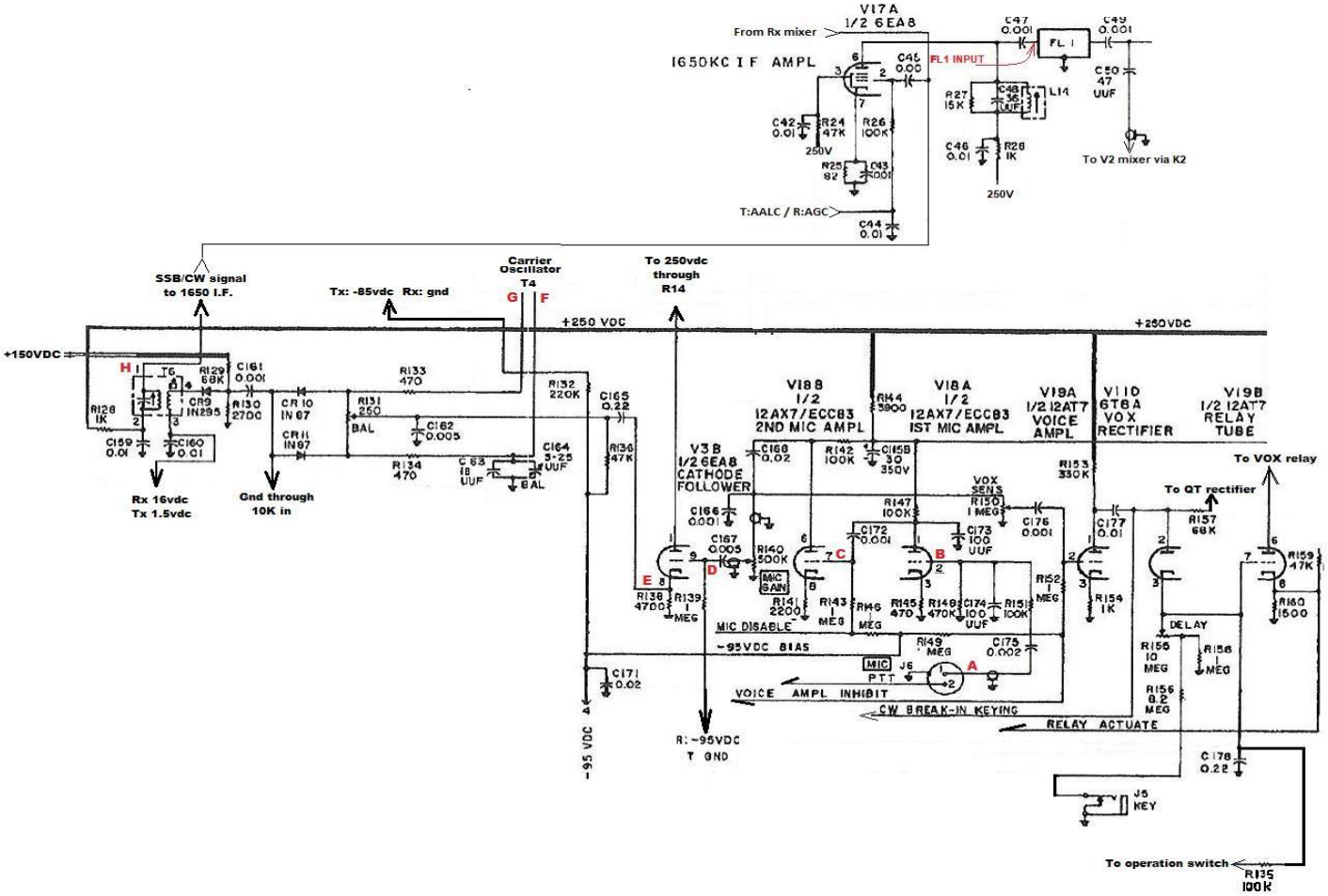
The receiver works well but there is no transmitter power out. If the receiver does not work you must make it work first, go to RECEIVER FAULT ISOLATION.
We will start at V7 the transmitter mixer.
Set the STANDARD PRE-POWER UP CONFIGURATION. Set the main tuning to the black scale 400. Select the 40-meter band. Connect the X10 scope probe to Pin 1 of V7. Remove V9 from its socket. Power up and set the OPERATION switch to MOX. Allow 5 minutes warm up then key the transmitter. You should see a signal of approximately 3 Vpp on the scope. Move the scope probe to the frequency counter. The counter should read 13.5 MHz. If the signal is not there or not close to the proper frequency you have a problem in the HET osc or the CR2 switching circuitry.
If the signal is correct unkey, power down, replace V9 and pull V8. Power up, warm up, move the scope probe to the scope and key the transmitter. You should see a signal of approximately 5 Vpp on the scope. Move the probe to the frequency counter, it should read very near 6.1 MHz.

Unkey the transmitter. If the signal is not correct and given that we have already demonstrated nominal receiver operation the possible faults have been narrowed. These possibilities are: FL1 bandpass (see 1-9-6), relay K1, T6 and its diode switching or the FUNCTION and OPERATION switches wiring. This fault must be cleared before continuing.

If both signals were correct reinstall V8. Connect the probe to the scope and Pin 2 of V16. Advance the RF LEVEL control to max. (IN THE FOLLOWING STEPS KEY THE TRANSMITTER IN SHORT BURSTS ONLY.) Key the transmitter and tune the PRESELECTOR and L10 for max signal on the scope. You should see a 2.5-volt signal on the scope. Move the probe to the frequency counter. The counter should display the transmit frequency of the band you are on. If you got the signal but it is off frequency or there was no signal then there is a fault in V7. If the signal is good there, and there is no or low power output there is a fault in the driver or finals. **NOTE the preselector and L10 will need to be retuned when the scope probe is removed from pin 2 of V16. Remove the probe and re-peak L10 and the preselector.**

Connect the 10:1 scope probe to the tie-point of C135 and R162. NOTE: This connection will detune the driver plate. Adjustment of L40 will be required. Key the transmitter and adjust L40 for peak voltage. If you see 100vpp and still have low power output, the driver is good and the fault lies in the PA section or the RX/TX switching. See section 5-16. If you fail to get 100vpp at the tie point of C135 and R162 you have a fault in the driver ckt.

1-9-4 SR-150 MIC AMP/BAL MOD CIRCUIT TROUBLESHOOTING GUIDE



SEE FOLLOWING PHOTOS FOR TEST POINT LOCATIONS.
The measurements taken at test points **A** through **D** are taken with the radio unkeyed.
The measurements taken at test point **E** is taken with the radio keyed in SSB mode.
The measurements taken at test points **F** and **G** are taken with the radio unkeyed.
The measurements taken at test point **H** are taken with the radio keyed in both CW and SSB modes.

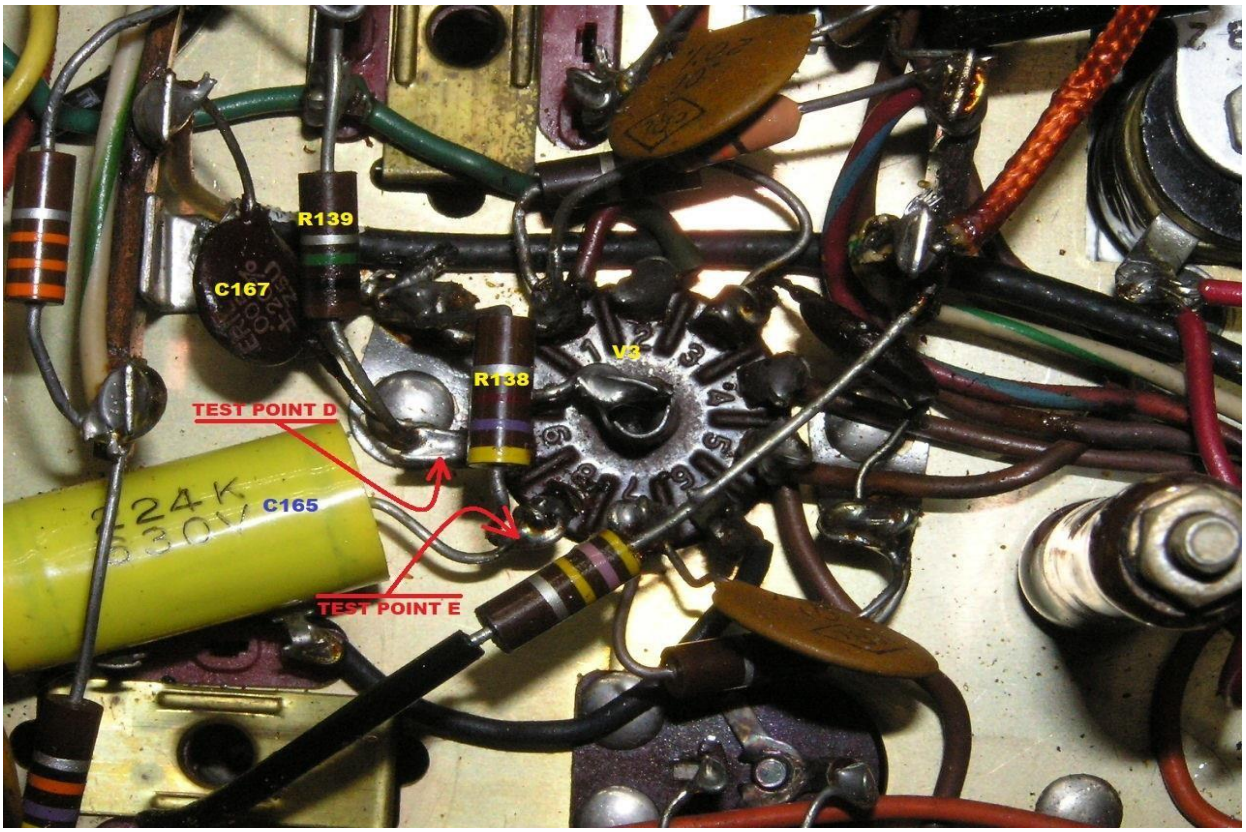
A Inject 1000Hz signal from 600ohm source and adjust for 0.020vpp.
B Measure 0.010vpp audio on pin 2 of V18A.
C Measure 0.400vpp audio on pin 7 of V18B.
D Measure 5.00vpp audio on pin 9 of V3B.
E Measure 5.00vpp audio on pin 8 of V3B.
F measure 6.00vpp carrier signal unkeyed.
G measure 6.00vpp carrier signal unkeyed.
H in CW mode keyed; 10vpp.

Note: the scope probe will load **T6**. To get a true reading at test point H you will need to peak **T6** for max signal with the probed connected. **H**
in SSB mode keyed; 5vpp.
Once you have observed test point H connect the probe to FL1 input, key up in cw mode, readjust T6 for max signal @ FL1.
FL1 INPUT In SSB mode7vpp (with 0.02vpp injected @ **A** and mic gain @ max), in CW mode 50vpp.

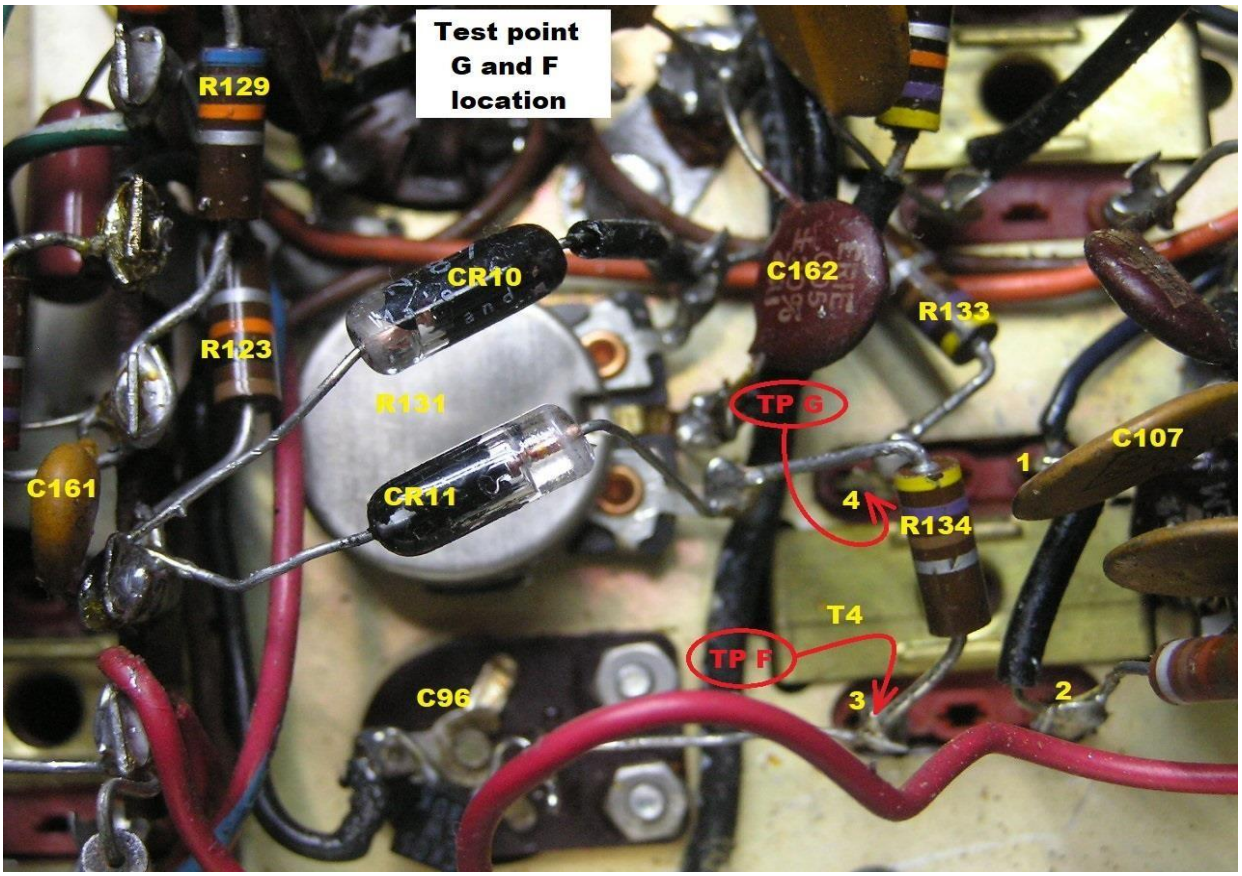
TESTPOINTS A, B, AND C



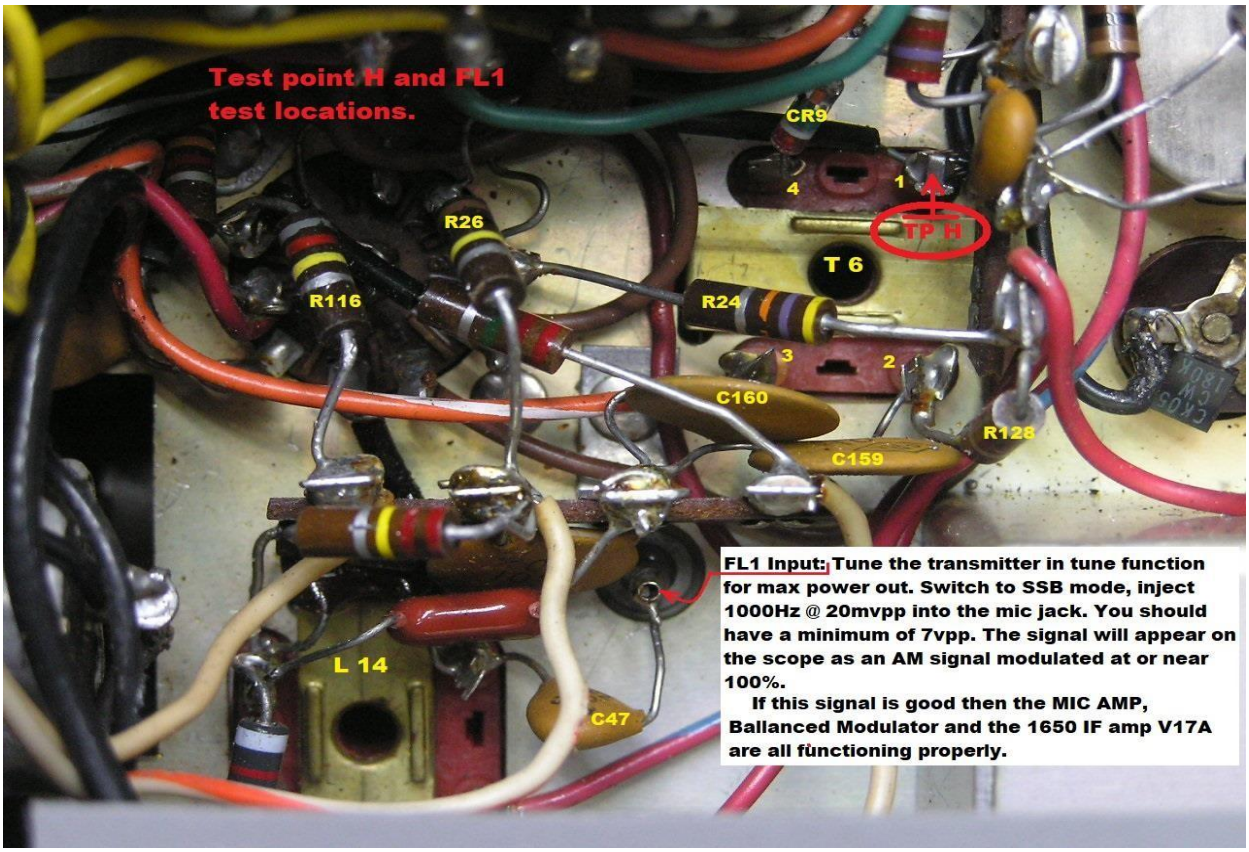
TESTPOINTS D AND E



TESTPOINTS F AND G



TEST POINT H AND FL1 INPUT



1-9-5. TX BIAS FAULT

If you are unable to set the BIAS adjustment properly there are four possibilities: bad tubes, bias divider, function and operation switch, and power supply.

TEST POINT	CONDITIONS	RESULTS	FAULTS
A. L43 to gnd. #	LSB, STANDBY	Negative voltage same on both ends of L43	L43, should be 15 to 30 ohms
B. Tie point of R125 and R124 to gnd.	LSB, STANDBY Rotate the bias pot from min to max. After recording min and max voltage adjust for -105vdc	The voltage should adjust from -80 to -127vdc. There is a lot of variations in the power supplies so voltages may differ widely. Minimum range is -85 to -110vdc.	Power supply Function switch Operation switch Switch wiring
B-1. Tie point of R127 and R126 to gnd.	LSB, STANDBY Adjust bias for -105 vdc.	Switch from STANDBY to MOX, the voltage should not change.	Operation switch or wiring is at fault.
B-2. Tie point of R127 and R126 to gnd.	LSB, STANDBY	Switch from LSB to CW, the voltage should not change.	Function switch or wiring is at fault.
C. Tie point of R127 and R126 to gnd.	LSB, MOX, MIC GAIN @ min. With bias adjusted for -105 vdc key transmitter with mic.	Voltage should drop to approx. -65 vdc.	Short on bias switching line. Shorted or gassy tube.
C-1 Tie point of R127 and R102 to gnd.	LSB, MOX	105 in RX mode. Gnd with mic keyed	L18 open L33 open K3 contacts.
D. Volt meter – lead to TP 202 of power supply. Volt meter + lead to TP 201 of power supply.	LSB, MOX, MIC GAIN @ min.	Key the mic and adjust bias pot for 0.7v on meter.	
D-1 same as D.	Same as D.	Will not rise to 0.7.	Bad final tube.
D-2 same as D.	Same as D.	Will not reduce to 0.7v.	Bad final tube.
D-3 Tie point of R127 and R126 to gnd.	With bias set for 0.7vdc as in step D.	Voltage should be in the range of -50 to -60 volts.	Below -50 indicates weak final tube. Above -60 indicates gassy final tube.

**L43** is the production run 7 modification that replaced R110 100k, with a 270uh choke. It is **highly** recommended that you perform this mod.

1-9-6. LOW POWER IN CW MODE

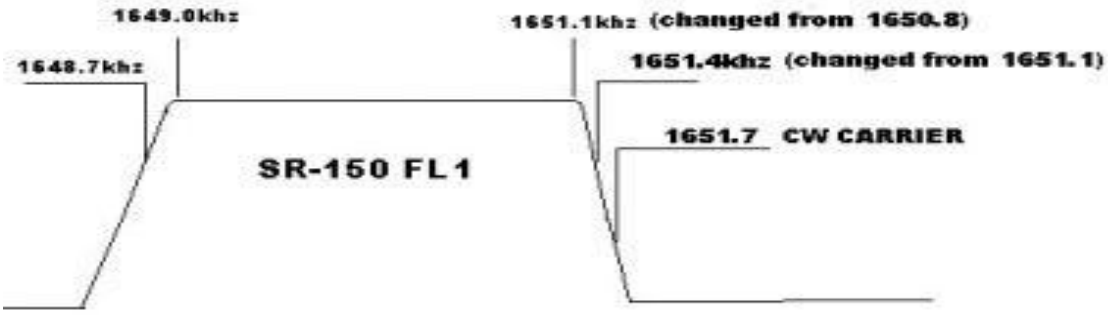
Tune the rig up on 3.90MHz in the CW mode. Connect a dynamic mic to the front panel jack, then switch to LSB mode, MOX. Key the mic and slowly repeat the words "three four three four three four"as you advance the MIC GAIN to the saturation point. If the power out is substantially higher than it was in the tune function a fault lies somewhere in the 1650 IF system, could be alignment or component drift.

BACKGROUND:
The rig was designed as an SSB rig primarily. CW stretches the limits of the 1650 KHz filter. The CW and TUNE functions use the USB carrier xtal regardless of what band you are on. The passband of FL1 is from 1648.700KHz to 1651.400KHz. In TUNE mode the balanced modulator CR10 & CR11 is biased to a full off-balance mode letting the 1651.7 KHz from the USB carrier osc pass through. This 1651.7 KHz is ideally 12 to 15dB down the skirt of the filter passband, and this normally is enough to saturate the TX mixer. With ageing of the filter and associated circuitry, it sometimes drops to 18 to 25 dB down and the tune and cw functions suffer power loss.

QUICK FIX:::: Adjust the USB Xtal (trimmer C106) to get 1651.550KHz instead of 1651.7MHz. That will move the carrier back up into the bandpass of the filter. LSB voice will not be affected. CW and USB voice will be shifted up 300 HZ which can be easily off set with the cal function. I have offset the USB osc as much as 500Hz and still gotten in-spec performance. Recheck the power out it the Tune function. You can continue to operate in this condition. However, caution, this is a cover-up. There is a fault and it will most likely continue to degrade.

Interestingly when the SR-2000 was designed a capacitor was switched into the USB oscillator in the CW and Tune functions to correct this offset. The SR-2000 design was actually approved and put into production BEFORE the SR-400 cyclone years ahead of the 400A. I do not understand why they did not include this function in the 400's.

Ideally tuned passband should look like below. 1648.7 and 1651.4 are -3db 1651.7 is -12db.



This anomaly is common to the 150 and the 400's.

2. PRODUCTION RUN UP-GRADES

2-1. FACTORY REVISIONS PER BULLETIN 1962-2

RUN 1 1st 6 digits of Serial # 415000-xxxxxx- = run 1	MODIFICATION (	REASON FOR MODIFICATION
RUN 2 415001	Add capacitor C14, 100pf 500v plastic mica (part # 482161101) between the wiper arm of QT Gain control R96 and ground Change capacitor C163 (27mmf) to 18mmf, 500v plastic mica (part # 482-132180)	Improves by-passing action, eliminates possibility of 1650KC regeneration in receive position This change facilitates carrier balance adjustment. (Note added by WD0GOF in 2013; This was mandatory only in run 3 and later.)
RUN 3 415002	Change C62 and C65 (470pf) to 0.001uf, 500v ceramic disc. Change capacitor C116 (0.005uf) to 0.001uf, 500v ceramic disc. Add silicon diode CR12, 1N456 between R1 and the control grid, pin 6 of V1. (Cathode of CR12 to R1) Change resistor R100 (4700ohms) to 2700 ohms. Change resistor R101 (2700 ohms) to 4700ohms. Change resistor R116 (1.5 meg ohms) to 820K ohms.	Reshapes the receiver audio response to reduce the highs. Improves AGC action and also provides complete cut-off of the RF tube during transmitting.
RUN 4 415003	Change capacitor C76 (4.7pf) to 10pf, 500v plastic mica. Change resistor R64 (47k ohms) to 220K ohms. The lead that was connected to ground is now connected to pin 3 of V8. Capacitor C100 is moved to the tie point of R81 and R82 and ground. A ground lug is installed under the adjacent escutcheon mounting screw	Ensures starting of the heterodyne oscillator if the crystal has a tendency to be sluggish. Corrects chirp when going from receive to transmit.
RUN 5 415004	Add two resistors, R161 and R162, one each to the grids, pin5 of V14 and V15 both terminated at R105. These resistors are both 10 ohms, ½ watt, 10%.	Removes parasitics noticed in some unit when operating on 15 meters
RUN 6 415005	Change R123 (150 ohms) to 10K ohms Change C166 (0.005uf) to 0.001uf, 500v, ceramic disc. Add C181, 0.01uf, 20% ceramic disc between the terminal strip connection of R85 and the ground lug of the same strip. Change C113 (0.01uf) to 0.005uf, 500v, ceramic disc. See section **2-2** for details of click mod	Improves transmitter audio response. Reduces spurious signal at 21425KHz receive and reduces motor boating when sidebands are switched. Removes transmitted “click” from SR-150 when switching from transmit to receive.
RUN 7 415006	Replace R110 100k ohms with 270uh choke designate L43	Improves grid bias and grid drive to V16.

2-2. KEY CLICK MOD

Key click modification instructions

The following procedures outline the modifications necessary to remove the transmitter “click” from the SR-150 Transceiver, when switching from transmit to receive.

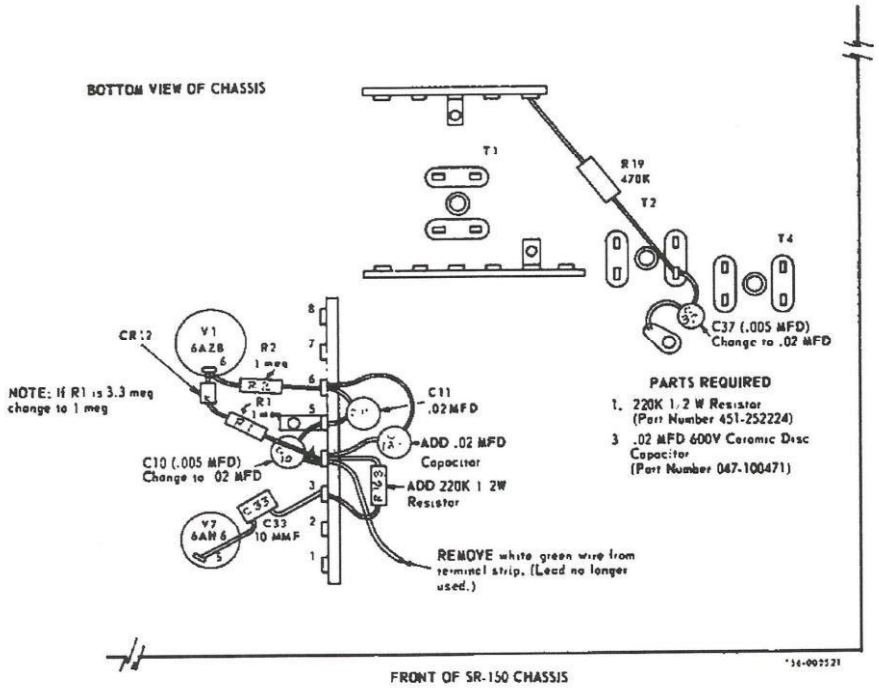
1. Remove white/green wire from terminal 4 of terminal strip near tubes V1 and V7. (Junction of R1, 1 Meg and C10, .005 uf)

2. Replace capacitor C10 (.005 uf) with a .02uf disc capacitor. (Connected between terminals 4 and 5 of terminal strip.)

3. Add a .02 uf disc capacitor between terminals 4 and 6 of terminal strip. This will be designated C180

4. Add a 220K ohm, ½ watt resistor between terminals 3 and 4 of terminal strip. This will be designated R163

5. Replace capacitor C37 (.005 uf) with a .02 uf disc capacitor. (Located at 6 MHz IF can, T2



3. SUBSYSTEM TECHNICAL INFORMATION

3-1. PROPER MICROPHONE SELECTION

This has been a much maligned and argued topic. So, I am going to stick to the few stated facts and specs that we can glean from the manuals. The following does apply to the SR-150/160/400's/500/2000.

From Hallicrafters documentation:

1. The **dynamic** mic was the recommended mic. This was found in several brochures and other documents.
2. The rig's mic preamp input Z for the 160 and 500 is stated to be 48K. For the 150, 400's and 2000 is stated to be 100K
3. With mic gain at max no more than 4 millivolts (RMS) at the mic input will be required to produce the minimum specified ssb output in the phone portion of any band.
4. Hallicrafters testing procedures clearly state that the TX frequency response tests are performed with an audio oscillator with a **600-ohm** output Z.

From the AUDIO ENGINEERS SOCIETY (www.aes.org/e-lib)

1. Microphone output is measured at a dB level relative to: A, 0db=1volt per microbar or B, 0db=1 volt per micro Pascal. Both the microbar and the micro Pascal are units of measure of air pressure on a given area of surface.
2. There is a 10db offset between the microbar and the micro Pascal scales.
3. The load on a microphone should be at **least 10 times** the microphones impedance. Loading a microphone at or near its characteristic impedance will skew the frequency response and allow increased cable magnetic and RF pickup.

From the spec sheet circa 1963 for both Shure and Turner:

1. 500 to 1200-ohm Dynamic mics were specified to provide a -50 to -52 dB signal into a 100K load using the microbar standard (Shure 405K Shure used the term "controlled magnetic" for their Dynamic mic).
2. Most of the Dynamic mics were specified to be operated into a 100k or higher load.

Assumptions:

The Hallicrafters specs state: The microphone preamp in each rig is hi-Z, either 48K or 100K. They preferred a dynamic mic. Documentation also uses either 4 millivolts or 5 millivolts (RMS) as the standard mic signal. Now due to the 10 dB offset from the microbar and the micro Pascal standards I would ***assume*** that Hallicrafters was using the micro Pascal standard which was the predominant standard in the 50's and would match the 4 to 5 millivolts requirement.

Conclusion:

If you want your SR series gear to sound right: and you abide by the specs and assumptions above: then you want to find a Dynamic Mic in the order of 500 to 600 ohms that will deliver 4 to 5 millivolts (RMS) into a 48K or 100K load. If you are unable to find the specs on the mic don't fret, read the "good stuff" below.

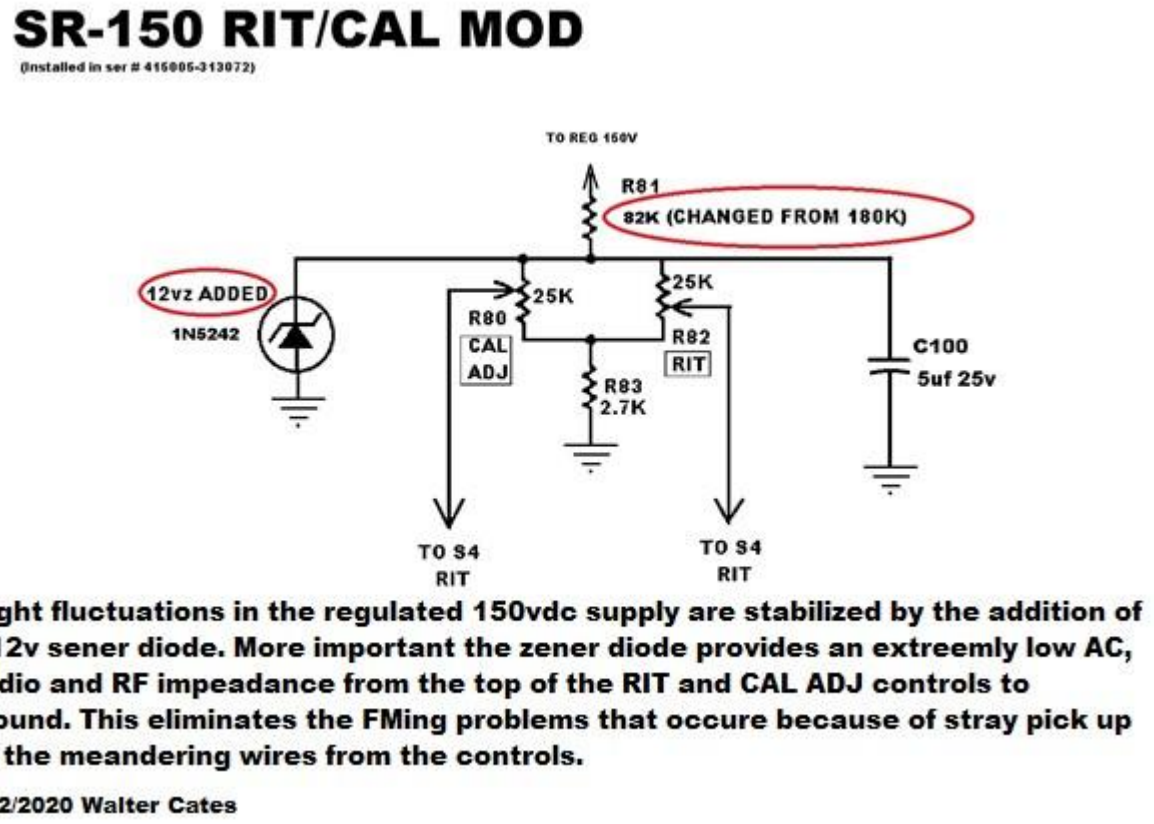
We really don't need to know anything about the mic. Say you have an unknown mic in the goody box. We know the input Z for the SR is either 48K or 100K. Then place a resistor equal to the input Z of your rig (either 48K or 100K) across the voice line of the mic and the mic gnd and measure voltage across the resistor when you speak into the mic. As you speak into the mic and repeat the words ***three, four, three, four*** you will cover most of the voice spectrum and the normal max and min volume for ***your*** voice. If the output voltage does not meet the 4 or 5 millivolts for the rig it *aint gona work*. Since the MIC GAIN control is two stages after the mic input you must be careful of over driving the amp. If the mic output level is more than 3 or 4 times the requirement you will probably over drive and distort the signal in the preamp and sound like you have a mouth full of marbles.

3-2. VFO DRIFT

3-2-1. VFO DRIFT TEST

Power up using the standard power up and allow 30 minutes for warm up. Connect a frequency counter to the junction of R15 and C83. In any 1-minute interval it should not drift more than 100 HZ. Within any 10-minute interval it should not drift more than 300 HZ. If it fails the test almost any part in the grid or cathode of V9A could be the cause. The most likely suspects would be C89 and C90. C89 is a N30 2% capacitor and C90 is a N470 5% capacitor. The relationship of the temperature coefficients of these two capacitors is key to the stability of the oscillator. You must replace them with parts of like characteristics.

3-2-2. RIT ZENER MOD



3-3. SR SERIES RIT/CAL ADJ DISCUSSION

The RIT/CAL ckt is virtually the same for the SR series gear from the SR-150 thru the SR-2000

The CAL function is needed primarily to offset the slight errors in the xtal oscillators. During assembly and test at the factory xtals were hand selected for minimum error. However, any error of a few cycles or more can be heard by the ear. So, like most rigs of the era a method of calibrating each band was needed. If everything is aligned and tracked correctly the CAL operation corrects for the entire band. The CAL operation must be performed each time you change bands and should hold until the band is changed again.

The RIT (receiver incremental tuning) function is used to offset the transmitter and receiver frequencies. Even if your rig is perfectly tuned and on frequency those you operate with may not be. A difference of just a few cycles

can cause you to walk up or down the band. When the RIT function is turned on the transmitter is still controlled by the CAL control but the receiver frequency is varied by the RIT CONTROL. In the CW mode the RIT functions as the BFO.

The CAL ADJ and the RIT CONTROL are both used to fine tune the bias voltage on the varicap (also referred to as a veractor diode) in the VFO. With the RIT off both the TX and RX are fine-tuned by the CAL ADJ pot. With the RIT ON the RIT CONTROL fine tunes the RX and the CAL ADJ controls the TX. These two pots are in parallel in the varicap voltage divider network. On a perfectly aligned band when the CAL ADJ pot is in its electrical center position then the RIT CONTROL will also be in the center of its rotation.

If all the oscillators in the rig are dead on then the RIT CONTROL and the CAL ADJ will run in the electrical center of their rotation. But we have a problem with the heterodyne oscillator. Each band has its own xtal and there is no way to adjust individual xtals to get the oscillator to run exactly on frequency on each band. In the old days when xtals were cheap and readily available we would select xtals to get them as close to on freq. as possible. Now, I am lucky to have 1 or 2 spares.

NOTE: The specs are a little vague on the tolerance for the oscillators in the series. The overall spec for maximum band to band shift is ***2 KHz*** which seems like a lot. However, I did find one spec sheet that stated that the minimum swing on the CAL and RIT controls is 3 KHz while another stated 4.5 KHz. In either case this is more than ample to off-set any osc differences if they are within specs.

What this means is that we can have as much as 2000 Hz difference from band to band (if we are in spec). This is OK because with the CAL ADJ we can bring the rig dead on as we go from band to band. However, if we use the CAL ADJ pot to calibrate a band and we use the RIT function the RIT CONTROL pot will need to be offset an equal amount off center to match the CAL ADJ setting. This is normal and it is common for the RIT to be a little off top dead center if the CAL ADJ is offset.

3-3-1. SSB RIT OPERATION

ASSUMING YOUR RIG IS PROPERLY ALIGNED. Select the band and mode of operation, set the RIT off, turn on the CAL oscillator. Tune the VFO dial to the nearest 100 KHz point to where you intend to operate. That is, if you are going to operate at 7.240 (west coast swap net) adjust the dial to 7.240 exactly on the dial. Adjust the CAL ADJ for a zero beat. Turn ***on*** the RIT and adjust the RIT CONTROL for the same zero beat or tone. Now flip the RIT ON/OFF back and forth while adjusting the RIT CONTROL until there is no difference in the tone when switched. Ok now, assuming the VFO is in proper tracking alignment, you are calibrated for that entire band and ready to operate.

3-3-2. CW RIT OPERATION & THE SR-150.

I have received these questions many times. “Why is it that the only way I can get satisfactory operation in CW mode is when the RIT is turned on?” Also “I don’t seem to have enough tuning range on the RIT” or “I have to turn the RIT CONTROL almost to its limit to copy code”.

First, why is the RIT necessary for CW operation? In short that is the way the rigs were designed. In CW mode the RIT functions as the BFO. These rigs were primarily designed for SSB phone operation. It would appear that the rig was designed for SSB operation and then they looked at it and said “how will we make it work on CW”.

When you switch to cw mode, regardless of the band you are operating, you are in USB mode (Therefore once again I stress the carrier oscillators must be **on freq**). In the cw mode the balanced modulator is biased to a full unbalanced condition and the USB carrier osc signal is passed thru with no sidebands. If the USB oscillator is as little as 400 HZ off

the system operation will be degraded. The transmitter and receiver are locked dead on. With the RIT off you are receiving and transmitting on exactly the same freq and there is no "BFO". The RIT/ON function allows you to shift the **receiver** off the zero beat to a comfortable tone to copy code without moving the transmitter freq. In order to get proper operation in the cw mode you need to **calibrate** in the **CW** mode

Assuming the rig is functioning properly and the VOX is set up properly: Set up with your keying device plugged in, VOX, CW, RIT-ON/OFF is **off** and RIT CONTROL is in the **center** of its rotation. The CAL control is in the **center** of its rotation. **(Check the knob position. The knob index line or dot should rotate an equal distance in each direction.)** Turn the CAL on and set the main tuning to the nearest cal point to where you intend to operate. Adjust the CAL control for a zero beat. Switch the RIT-ON/OFF switch to **on**. From this point on the RIT ON/OFF switch remains on. The zero beat will have a weak side and a strong side. Now ease the RIT CONTROL to the strong side for let's say a 500 Hz tone (or whatever tone is comfortable for you to copy). Now when you tune the Main Tuning to a station and get the same 500HZ tone (or your comfort tone) your transmitter carrier should be centered on the other station. Now you are calibrated and ready to tune up the transmitter and operate. You should not have to touch the RIT CONTROL again unless you wish to change "BFO tone".

Second, "not enough range" or "I have to use almost all of the RIT CONTROL to get good copy". This is a definite indication of a failure or need for alignment. The RIT CONTROL should provide for a 4 KHZ shift in the receiver and that should be seen as + and – 2 KHZ from the center of the mechanical rotation of the RIT CONTROL. To check this, go to the center of the 80 or 20 meter band in the STBY mode. With the RIT-0N/0FF control in the off position adjust the CAL and the RIT CONTROL for the center of their rotation. Turn on the CAL and adjust the main tuning for a zero beat... If the dial reads within 2 KHZ of a 100 KHZ tuning point it is in spec. Now switch the RIT-0N/0FF to on, and adjust the RIT CONTROL for a zero beat. If you need to rotate the RIT CONTROL more than 45 degrees off mechanical center then repair or alignment is indicated. To further check VFO alignment, with RIT off and cal on, tune the main tuning knob across the band taking note of the position of the zero beat at each cal point. If the error at any cal point is more than 2 KHZ then repair, alignment or tracking of the VFO is needed.

Bottom line is if your CAL and RIT CONTROL are top dead center on each band you have an **exceptional** rig and all your heterodyne xtals are dead on. If they are not, you have a **normal** rig.

IMPORTANT FINAL NOTE: Any time you are aligning and tuning the VFO you ***must*** ensure that the RIT is turned **off** and the CAL ADJ pot is in the **center** of its rotation.

3-4. RELAYS K2 & K3

The design of the SR-150 uses the V13 cathode current in receive mode to do four things.

1: In receive mode to reverse bias CR9 to block the output of T6 which feeds V17 in the TX mode.

2: In the receive mode it reverse biases CR2 which kills the heterodyne oscillator signal to the transmit mixer.

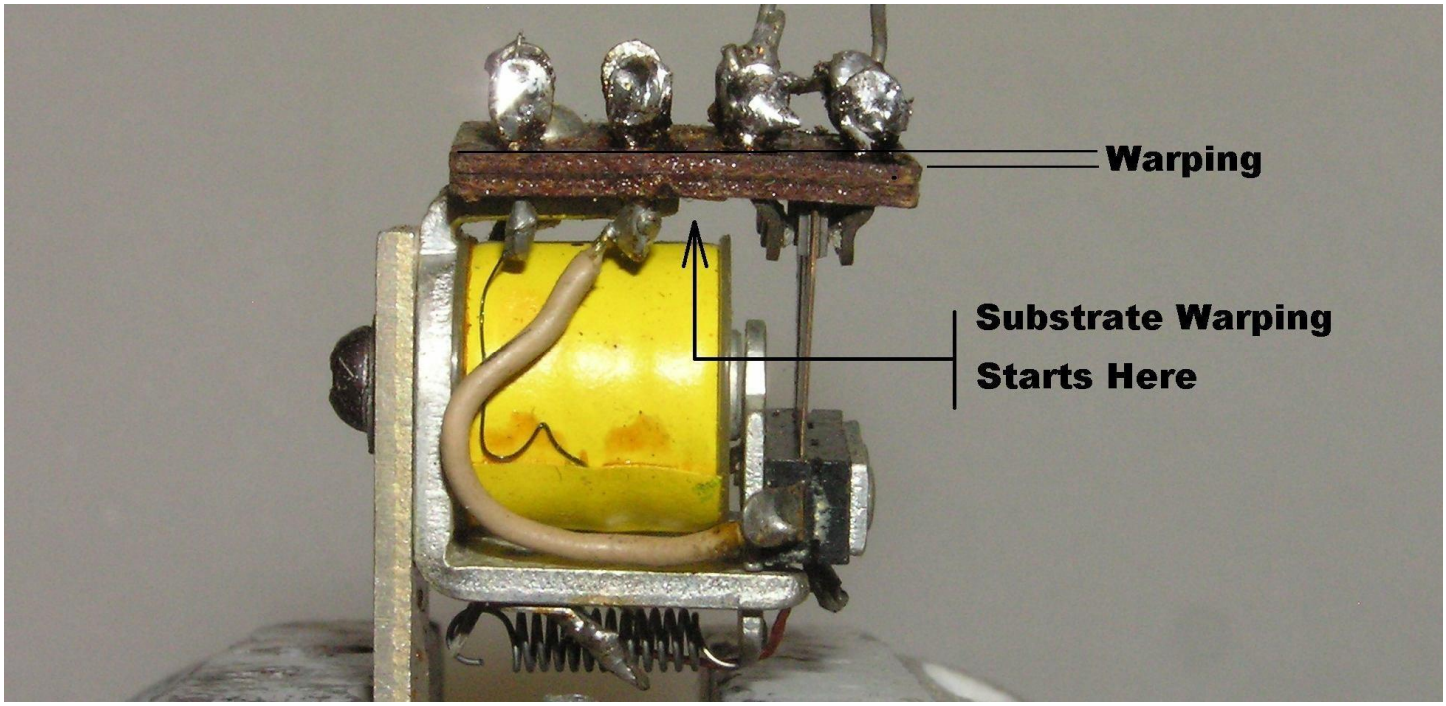
3: It energizes K2 and K3, to enter receive mode.

4: In receive mode the 6AQ5A V13 expects to see around 360 ohms to ground, K2 and K3 are 780 ohms each, in parallel equaling 360 ohms.

5: In a properly functioning ckt the voltage at the cathode of V13 runs 1.5 VDC in transmit and 16 VDC in receive mode. If the voltage in the receive mode is low then CR2 and CR9 will not switch properly. With low voltage on the cathode, V13 will not operate properly causing distortion in the audio output. There are three common failure modes for the relay: 1, contact substrate warping; 2, dirty contacts; 2, contacts loose in the substrate.

In 2011-2012 I got involved in a project to get the original manufacturer to do a build of a number of these relays. We got some (I didn't get any); he does not want to do any more. However, I was able to find the original specs. So, if you want a challenge find a 3PDT relay with a coil resistance of 780 ohms, pull in voltage of 9.0vdc a drop out voltage of 3.5v suitable for switching RF. Or a 6 to 8 VDC relay with a coil resistance of 180, pull in at 4.5v and drop out at 1.75 vdc, two of which could be wired in series.

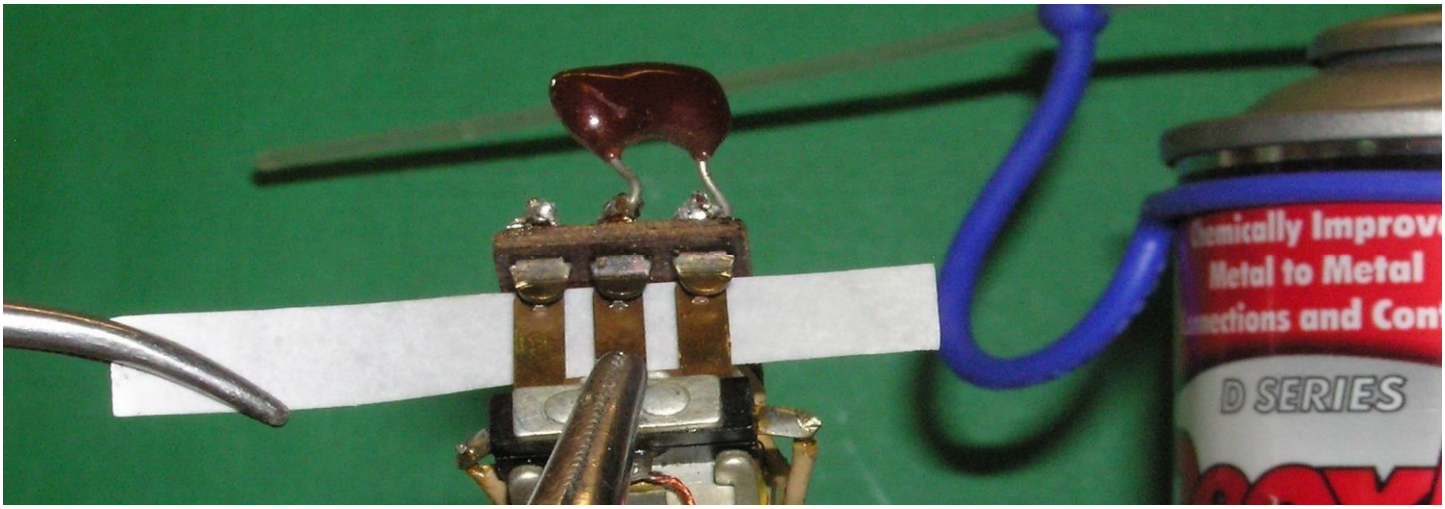
3-4-1. K2 & K3 SUBSTRATE WARPING.



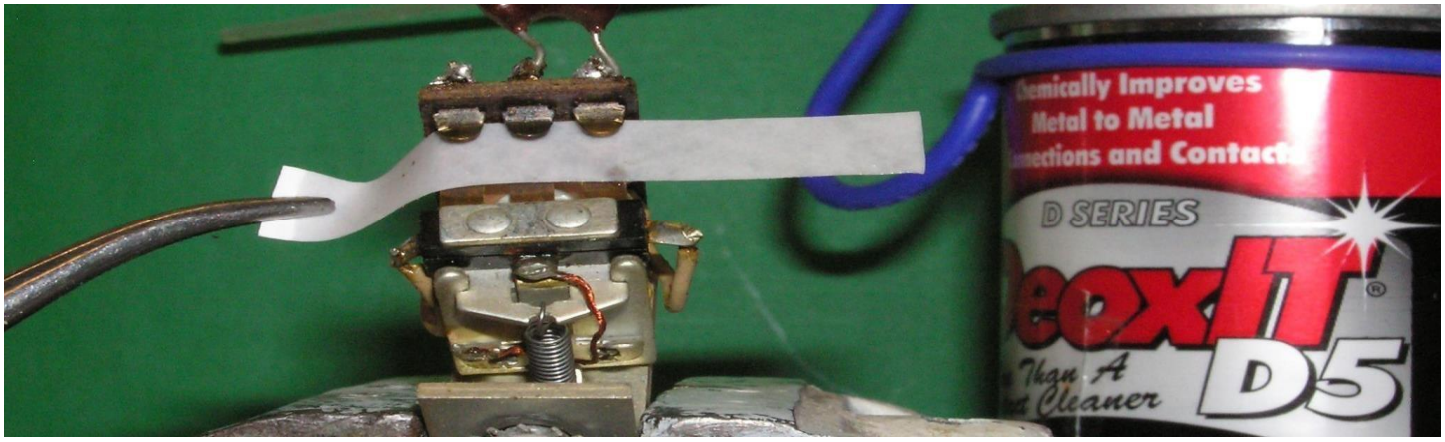
The relay contact gap is .008" and the relay throw is .012". The de-energized contact compression is .002" and that leaves .002" for energized contact compression (or sometimes referred to as wipe compression). It takes very little substrate warping in either direction to eat up the .002" of wipe compression. If warping is the problem, it will affect either the TX or the RX.

The contact arms can be bent. By opening the gap of the NC contacts and closing gap of the NO contacts the relay can be salvaged. It is rare for the substrate to warp in the opposite direction of the photo above. If it does then reverse the adjustment procedure above.

3-4-2. K2 K3 CLEANING:



Spray strip of paper with DeOxit, insert it between the NO contacts, compress the armature and pull the paper, repeat several times.

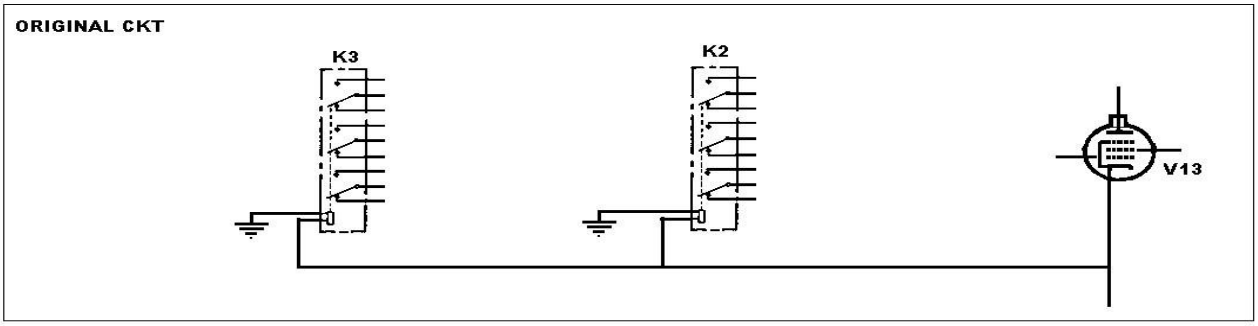


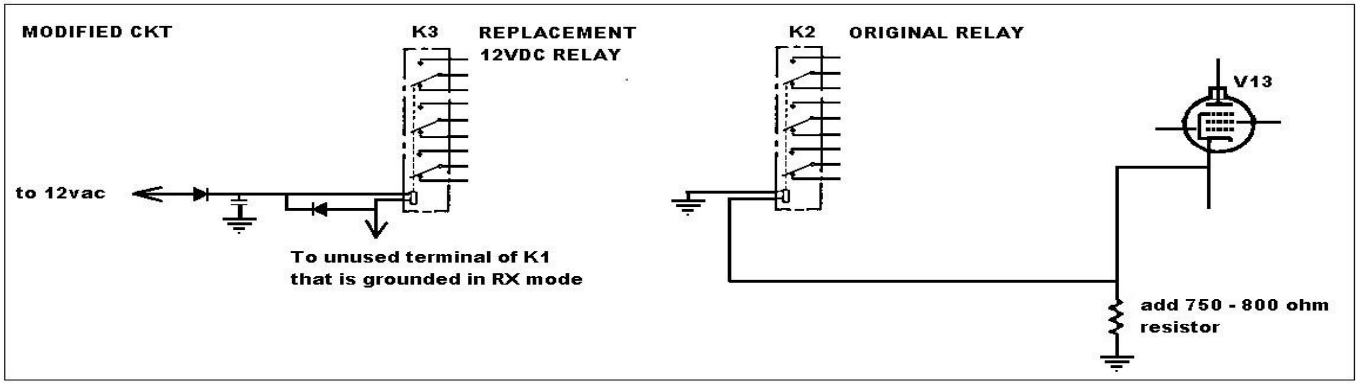
Spray strip of paper with DeOxit. Insert it between the NC contacts, pull the paper and repeat several times.

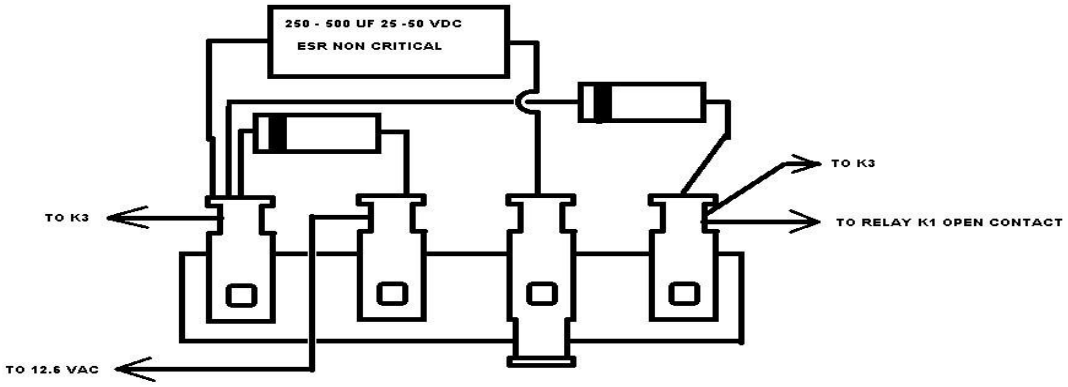
3-4-3. NON-STANDARD RELAY REPLACEMENT

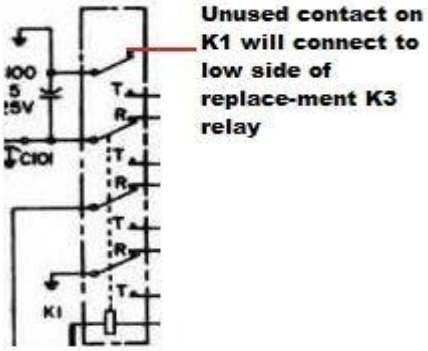
If it turns out that only one of the original relays is salvageable you may want to consider the following. *Warning this modification should be undertaken only by an experienced technician. A moderate level of skill in reading schematics and tracing ckt wiring is required*. Install the working original relay in the K2 position. Find a suitable 12 VDC relay and install it for K3. We will pick up 12.6vac from the filament line rectify it, filter it and connect it to one end of the replacement relay coil. Place a reverse diode across the coil. The other end of the coil will connect to the unused, grounded in receive mode terminal of K1. All of the components, with the exception of the resistor, can be mounted on one 4 contact terminal strip and mounted anyplace that pleases you (see drawing below). There is one thing to check before considering this approach. Some K1 relays do not have that contact. The contacts are stacked. So, if you have a junk box full of relays and can find a similar relay, you can add the needed contact. You will need to add a 750 to 800-ohm resistor from the cathode of V13 to ground to compensate for the coil resistance of K3.

The essential key to finding suitable replacements for K2 and K3 is maintaining the 380-ohm resistance for the cathode of V17.



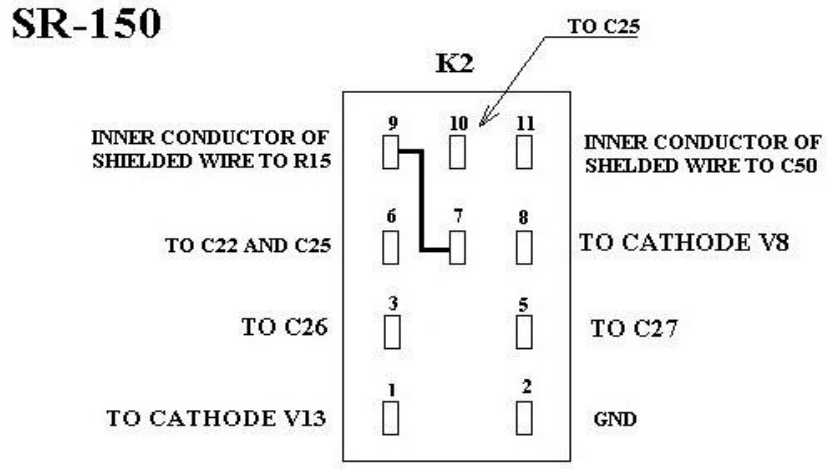


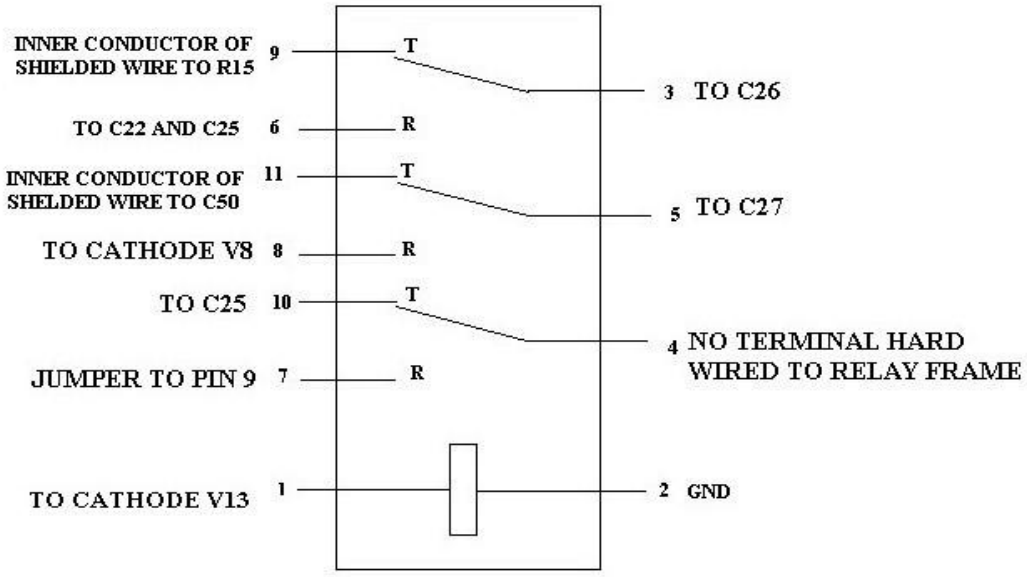




SUMMATION: The functions of K2 and K3 can be accomplished in a myriad of ways. The important thing is to maintain 360 to 400 ohms in the cathode of V13.

3-4-4 K2 WIRING AND PIN OUT

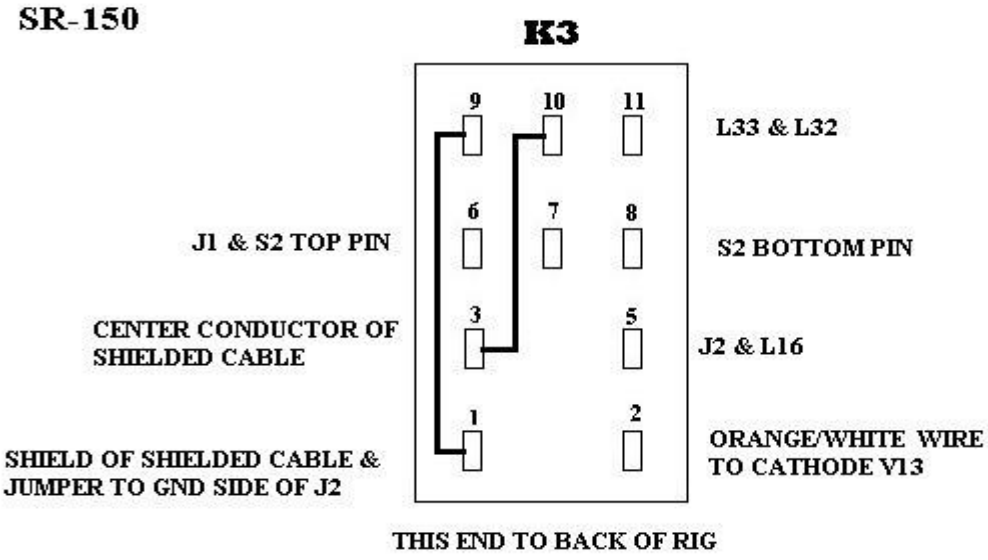


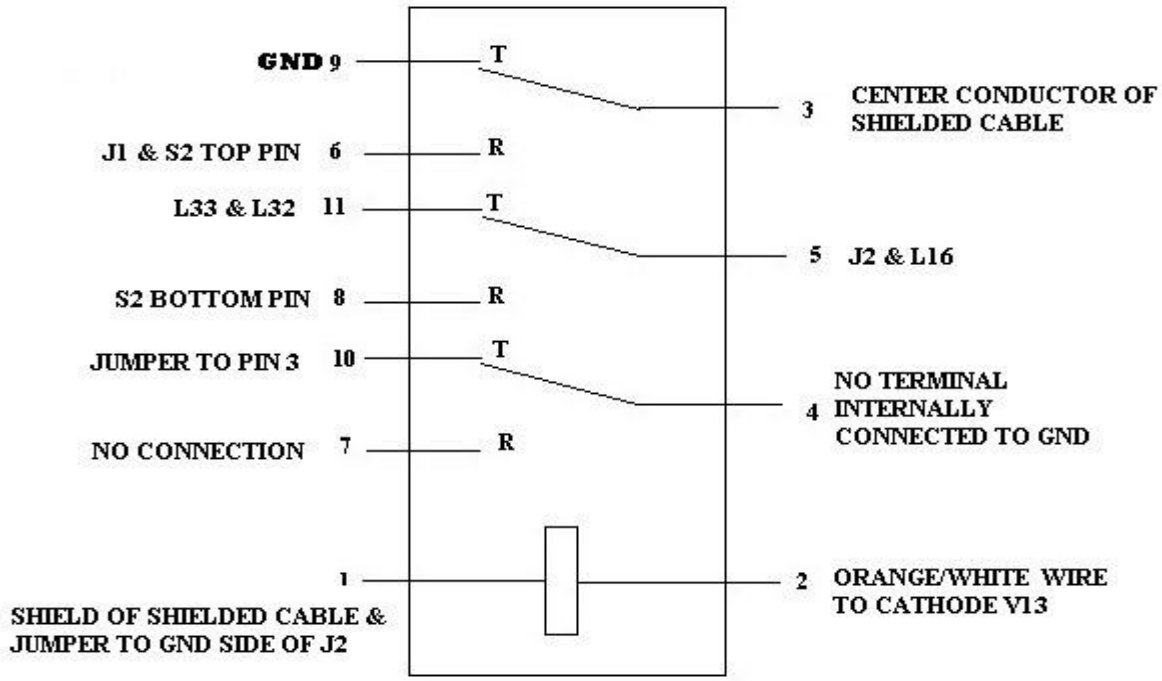


NOTE: no terminal exist for pin 4. it is hard wired to the relay frame

73 WDØGOF

3-4-5 K3 WIRING AND PIN OUT





NOTE: no terminal exist for pin 4. it is hard wired to the relay frame

NOTE: connection for pin 1 and 2 are reversed on some installations

73 WDØGOF

3-5. PA LOADING COIL L32

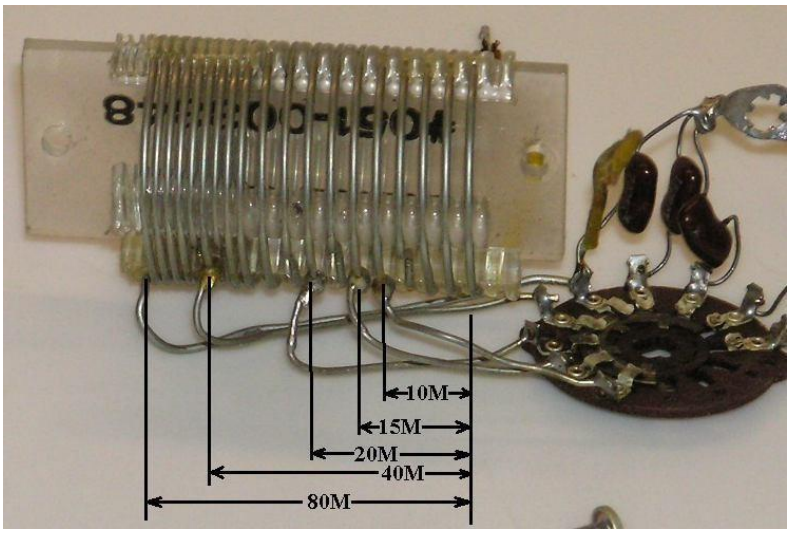
I became a victim of a long time, incorrect assumption. When I first started working on the SR series, I was told that the plate coil of the SR-150 was a weak element that it could be damaged by too much power or mismatch on 15 and 10 meters. I thought "oh well" and accepted it and even helped the myth along. I have found many of these coils deformed and melted and either repaired or replaced the coil and went about my business. While working on a 150 with exceptional power out on 15 and 10 meters I thought it was time to look seriously into the problem. Not having had any real problems in the output ckt of the SR-150 in the past I have not paid it any close attention. When I looked at the circuit and the components, I was a little surprised. The end of the coil that melts is actually shorted out on 40, 20, 15 and 10 meters and is only used on 80.

I got out my IR thermometer and did some testing. There are only two ways I can get that end of the coil to heat up. First, heating occurred if I induced a higher than 1.8:1 vswr on 80 meters. There was no abnormal heating on the other bands until I reached 2.5:1 vswr. Second, heating occurred if I detuned the neutralization and tuned for peak power and not the plate current dip on 80 meters. The coil heats a little on all the bands with miss-match or improper plate dip. However, on 80 the tightly wound end gets hot and right now. On the high frequency bands that end of the coil is the coolest end and it seems to be a heat sink, perhaps even dumping some of the heat from the other end.

Just to be thorough I tested the shorted portions of the coil on each band for any stray resonance. I performed a series of tests using the grid dip meter, sweep generator and spectrum analyzer on the coil cold and under power. I looked at the spectrum for spurs under various conditions of mistuning and found nothing unusual.

So, I think this myth is busted. But what has become very clear is, you must keep vswr low and tune the plate to the current dip. This is critically important on the 80-meter band.

The critical nature of the VSWR and plate current dip applies to the entire SR series HF transceivers. The coils of the rest of the series are much more robust, with the possible exception of the SR-2000 (but then the 2000 is in a class of its own). Damage to coils for the rest of the SR series under normal operating conditions is rare. HOWEVER, VSWR and plate current dip are extremely important to the **life of the P.A. tubes**. Furthermore, an improperly tuned P.A. will generate **splatter, harmonics** and an overall mushy sounding transmitter.



The coil can sometimes be repaired using a heat gun. Slowly heat up the plastic and with a knife spread the coils.

3-6. RECEIVER GAIN IMPROVEMENT

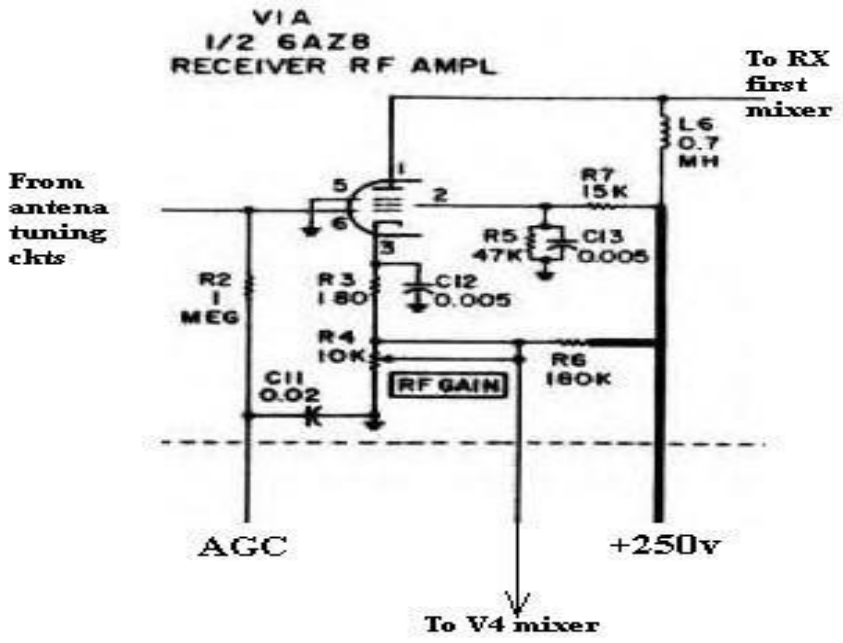
FROM JIM, K9AXN

“The SR-150 is a great radio when it's well. Now, let's make that radio even more sensitive. Change V3, a 6EA8 to a 6GH8A and if you wish to take it a step further, change V5 to a 6GH8A. Don't change V17 as you will have to redesign the S-Meter Bridge.

3-7. RX GAIN ANOMALY

I had a particularly troublesome SR-150 in the shop. No matter what I did I could not get the gain up to norm. The spec states that a 1uv sig at the antenna shall produce 500mw or better audio output. However, the norm for the SR-150 receivers is 500mw or better with 0.5uv or less at the antenna. This particular rig made spec but required 0.8uv to get 500mw output. If everything else had been in spec I would probably have sent the rig on its merry way. However, the AGC figure of merit did not come close to spec. This fault usually indicates loss of gain in the front end of a receiver.

I ended up at the RX RF amp V1.



Note the RF GAIN control also controls the gain of the second RX mixer V4.

When the RF GAIN is at max (fully cw) the wiper is at ground. However, when I measured the voltage at the tie point of R3 and R4 at the max gain setting, there was 0.7 volts present. When I measured the resistance from that tie point to gnd with the pot at max I got 970 ohms. So, with the pot at max gain I put a clip lead from the tie-point to gnd and powered back up. I was pleased to find that I then had 500mw audio output with 0.4uv in. The AGC figure of merit which was running 23db, spec is 50db, was up to 65db. I have a complete set of SR HF rigs and a few spares. And, since the RF GAIN ckt is virtually the same for the entire SR series I tested one of each, SR-160, 400, 500, 2000. Every one of them showed some improvement when wiper arm of the RF GAIN pot was grounded. One was minimal around 1db, the SR-500. The Cyclone II improvement was 9db. The rest were around 3 to 4db.

Interesting side note: In testing these rigs I found that several had 25k elements instead of the 10k called out. This does not affect the operation but I thought I should mention it.

Now it's back to the initial SR-150. I pulled the control, a rather fun chore. Got on the internet and found that 10kX500K ganged controls aren't readily available. So, I disassembled the pot and painted the landing area for the wiper at both ends of the pot with three thin coats silver paint. The paint is a product developed to repair printed circuit traces. I re-assembled the pot and retested the rig and what a pleasant surprise. Prior to the pot repair it took 0.8uv to get 500mw of audio output, now it is 0.4uv. The AGC hit linearity at 25uv before, now it hits linearity at 3.5uv. The AGC figure of merit holds to 65db over 5uv (spec is 50db over).



I believe the construction of the pot precludes any of the controls from reaching ideal 0 ohms and that the vast majority of rigs would benefit from some type of corrective action. I bought my ½ troy oz. bottle of silver paint about 5 years ago for $22.00. That same bottle now goes for $42.00. The GC part # is 22-023 and is RoHS compliant. There is a MG SILVER PRINT CONDUCTIVE PEN product available for $22.95. I have not used this pen but it should be quite similar. If all else fails then BING "SILVER CONDUCTIVE PAINT".

3-8. MIC GAIN AND AUDIO OSCILLATIONS IN THE SR-150

Over the years I have seen a lot of posts concerning gain in the mic amp of the SR-150. Some of these have involved placing a cathode bypass capacitor on the cathodes of the 1st and 2nd mic amp. Recent discoveries indicate it should not be done on the SR-150. This has been the year for the SR-150 in my shop. I have noted a recurring problem. In the RX mode with the audio gain turned fully CCW there will be a faint 2500 Hz to 4500 Hz tone in the speaker. When measured, it will run from 10 to 150 mw. I have had three rigs this year with this problem. Needless to say, the first time I noted the problem it was quite puzzling. When I pulled the 2nd 1650 I.F. tube which killed all the RX noise I found that the level of the objectionable tone was not changed. Changing the setting of the AF Gain control had no effect either. How exactly I ended up in the VOX circuit I can't quite remember. But I noted that if I turned the VOX gain control all the way down the tone went away. I connected the scope to the plate of V18B the second mic amp, and to my surprise I found a 75v peak to peak audio oscillation. I also noted at that time a 10uf/50v capacitor had been added from the cathode to gnd. When I removed the capacitor, the oscillation stopped. I have run into oscillation problems on 4 rigs in recent months and in each case a bypass capacitor has been added to the cathode of one or both mic amps. In one case I did not have a tone in the RX but was unable to properly set up the vox gain and delay and as the tubes warmed up K1 would

energize any time you selected VOX. The oscillation on this one turned out to be about 18 KHz, which is outside the range of my old ears and the response of T5. So, the tone did not appear in the speaker. I have concluded that the un-bypassed cathode resistors in the mic amp ckts do serve the intended purpose of the original design. That is to degenerate the high frequency response of the mic gain train, and that's a good thing. The original design is good and if all the "parts" are good it will work well. One of the most mismatched parts is the microphone. The best information on the mic I could round up is found in the MICROPHONE SELECTION section of this document. Ceramic and xtal mics have far too much output in the
3 KHz to 6 KHz range with the level at 500 Hz usually 3 to 8db lower. **The bottom line is the mic amps in all the SR series rigs are well designed. If you do not have enough mic gain, you have a circuit failure or the wrong mic.**

3-9. PA NEUTRALIZATION

SR-150 NEUTRALIZATION

PROPER NEUTRALIZATION WILL ENHANCE THE PROPER OPERATION, EFFICIENCY AND LIFE OF YOUR FINAL TUBES. THEORY AND OPINIONS ON THE EFFECTS OF INTERELECTRODE CAPACITANCE ARE AS NUMEROUS AS THE WRITERS OF SUCH ARTICLES. SO, TO BE VERY BASIC, WE ARE ATTEMPTING TO NEUTRALIZE THE EFFECTS OF THE INTERELECTRODE CAPACITANCE OF THE PA FINAL TUBES.

HERE ARE A FEW SITES THAT HAVE DISCUSSIONS ON NEUTRALIZATION.
http://www.somis.org/ http://www.vias.org/basicradio/basic_radio_28_04.html
http://www.w8ji.com/neutralizing__amplifier.htm
http://www.kk5dr.com/Tuneup.htm

THE NEUTRALIZING PROCESS IN THE BOOK IS OK, BUT NOT VERY PRECISE. IT WILL WORK, BUT I PREFER A MORE PRECISE PROCESS. THERE IS NOTHING NEW OR REVOLUTIONARY ABOUT THIS PROCESS. IT IS A PROVEN PROCESS THAT HAS BEEN IN USE FOR OVER 50 YEARS. ALL I HAVE DONE IS SPECIFICALLY ADAPTED IT TO THE SR-150. BEFORE STARTING THE
PROCESS, YOU NEED TO TUNE THE TX AS BEST AS YOU CAN AT 21.3 MHZ. AFTER TUNE UP TURN THE POWER OFF AND DO NOT RE-ADJUST THE PRESELECTOR OR FINAL TUNE THROUGHOUT THIS PROCESS. POWER DOWN AND REMOVE THE UNIT FROM ITS CASE AND REMOVE THE PA COVER.

1, DISCONNECT THE PLATE VOLTAGE AT THE BOTTOM OF L31 BE SURE THE LEAD IS OUT OF HARMS WAY.

2, DISCONNECT THE SCREEN VOLTAGE AT THE BOTTOM OF R104 BE SURE THE LEAD IS OUT OF HARMS WAY.

3, REPLACE THE PA COVER.

4, TURN THE RF AND MIC LEVEL CONTROLS FULLY CCW.

5, CONNECT THE TRANSMITTER OUTPUT TO THE SCOPE OR RF VOLTMETER (I PREFER A SCOPE).

6, TURN ON THE RIG AND LET IT HEAT UP FOR AT LEAST 20 MINUTES. THE TUBES NEED TO BE AT FULL OPERATING TEMPERATURE.

7, IN THE CW POSITION KEY THE TX.

8, ADVANCE THE CARRIER CONTROL UNTIL YOU GET ANY WHERE FROM 1 TO 5 VOLTS PP ON THE SCOPE.

9, USING A NON-METALLIC TUNING WAND ADJUST C139 FOR MINIMUM SIG ON THE SCOPE. ADJUST SCOPE SENSITIVITY AND CARRIER LEVEL UNTIL YOU GET A REAL GOOD PRESENTATION OF THE MINIMUM POINT. THAT'S IT YOU'RE DONE.

THIS PROCESS CAN BE ADAPTED TO MOST ANY TRANSMITTER. IF IT DOESN'T WORK THEN YOU HAVE SOMETHING ELSE WRONG.

3-10, SR150 LOW POWER IN CW AND TUNE

Tune the rig up on 3.90MHz. then switch to LSB mode, MOX, key the mic and slowly repeat the words "three four three four three four". If the power out is substantially higher than it was in the tune function a fault lies somewhere in the 1650 IF system, could be alignment or component drift.

BACKGROUND:
The rig was designed as an SSB rig primarily. CW stretches the limits of the 1650 KHz filter. The CW and TUNE functions use the USB carrier xtal regardless of what band you are on. The passband of FL1 is from 1648.700KHz to 1651.400KHz. In TUNE mode the balanced modulator CR10 & CR11 is biased to a full-off balance mode letting the 1651.7 KHz from the USB carrier osc pass through. This 1651.7 KHz is ideally 12 to 15dB down the skirt of the filter passband, and this normally is enough to saturate the TX mixer. With ageing of the filter and associated cktry it sometimes drops to 18 to 25 dB down and the tune and cw functions suffer power loss.

QUICK FIX:::: Adjust the USB Xtal (trimmer C106) to get 1651.550KHz instead of 1651.7MHz. That will move the carrier back up into the bandpass of the filter. LSB voice will not be affected. CW and USB voice will be shifted up 300 HZ which can be easily off set with the cal function. I have offset the USB osc as much as 500Hz and still gotten in-spec performance. Recheck the power out it the Tune function. You can continue to operate in this condition. However, caution this is a cover-up. There is a fault and it will most likely continue to degrade.

Interestingly when the SR-2000 was designed a capacitor was switched into the USB oscillator in the CW and Tune functions to correct this offset. The SR-2000 design was actually approved and put into production BEFORE the SR-400 cyclone years ahead of the 400A. I do not understand why they did not include this function in the 400's.

Ideally tuned passband should look like below. 1648.7 and 1651.4 are -3db 1651.7 is -12db.

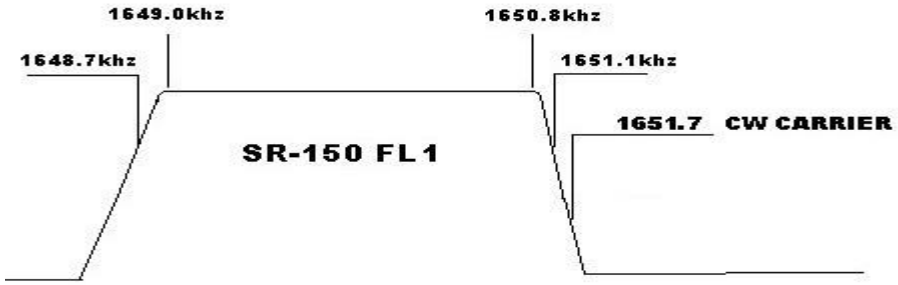
This anomaly is common to the 150 and the 400's.

3-11. SR-150 FILTER PASS BAND

3-11-1 FILTER ORIGINAL DESIGN

In order to maintain the transmitter max 3db roll off on both USB and LSB the filter roll off point at the filter low end needs to be 1648.7 KHz. The high-end roll-off point is 1651.1. This means the filter needs to be swept from 1648.7 to 1651.1 for a 2.4 KHz pass band.

FILTER



3-11-2 SR-150 FILTER PASS BAND EMAIL DISCUSSION

(March 2012, a technical discussion between WDØGOF and K9AXN)

Hi Jim,
I have been playing around with the filter and balanced modulator in the SR-150. The specs on the SR-150 state that SSB transmit audio response is 2100 Hz wide. That is, the -3db voltage points are 600 Hz and 2700 Hz respectively.

The LSB osc freq is 1648.1 KHz; when the balanced modulator is driven with 600 Hz – 2700 Hz the double sideband suppressed carrier would be as follows:

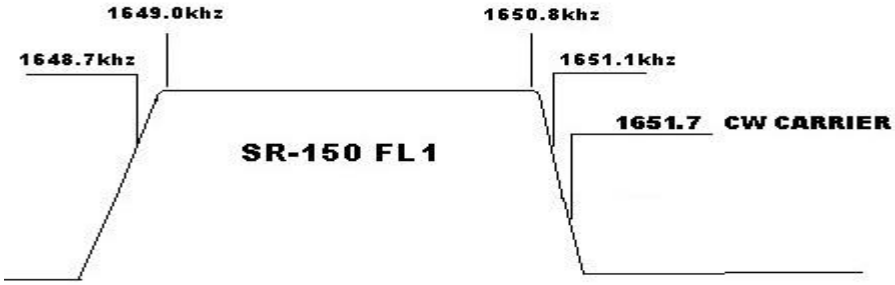
1648.7 KHz to 1650.8 KHz and 1647.5 KHz to 1645.4 KHz

The USB osc freq is 1651.7 the balanced modulator will produce the following;

1651.1 KHz to 1649.0 KHz and 1652.3 KHz to 1654.4 KHz

The blue band spreads are the wanted signals. The other sideband is out of the pass-band of the filter.

It seems to me, in order to maintain the transmitter max 3db roll off on both USB and LSB the filter roll off point at the filter low end needs to be 1648.7 KHz the low freq for LSB. The high end roll off point is the high freq for the USB or 1651.1. So this means the filter needs to be swept from 1648.7 to 1651.1 for a 2.4 KHz pass band.

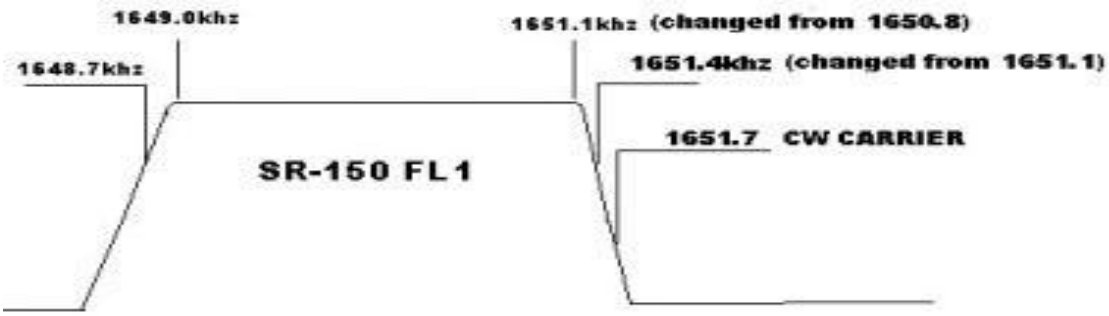


So this tells me that in LSB modulation at 600 Hz the power out should be no less than 3db down. When modulated at 2700 Hz the power out should be full power.

In USB mod at 600 Hz it should be at full power and at 2700 Hz it will be no more than 3db down

(Jim) Good analysis Walt. I believe the lopsided response is a result of moving the USB carrier crystal further into the band pass so the CW/Tune signal will pass through the filter. I believe the filter has a 2.7Kc 3db pass band. The USB carrier is about 350 cycles higher than the 3db point on filter skirt and the LSB is about 600 cycles lower than the 3db point on the skirt. It's been a while but check that filter measurement.
Hallicrafters did this with the SR-150, SR-400, and SR-400A. The SR-2000 was fitted with a 30pf cap on the USB crystal to drag it about 150 cycles into the pass band for Tune and CW enabling a bit more symmetry in SSB mode. Please let me know what you find --- been a while since I've been in that fine radio.

Thanks Jim.
So if I am following this correctly, if the filter is swept for a 2.7Kc pass band the chart should look like this:



This makes good sense for better performance. My only question now is what effect will it have on carrier suppression in SSB? I'll have to test that. Carrier suppression in the SR-150 just does make spec now. However some of that is from not using match diodes in the balanced mod ckt. Considering all this, the direction the factory manual leads us is truly miss-leading.

(Jim) You have it right on this one. The sideband suppression is slightly lower in USB mode in the SR-150/400/400A because they had to move the USB carrier frequency far enough into the filter pass band to generate enough CW and Tune drive. On your drawing, add the LSB carrier and it will make more sense when you release it because it will be farther down the skirt than the USB carrier. The SR-2000 used the 30pf cap across the USB crystal in CW and tune mode to move the carrier from 1.651550 to 1.651450.

One other note, I believe the flat portion is more than 2.1Kc. May be different from filter to filter but believe it to be closer to 2.3Kc. Sounds like you are having a great time with the spectrum analyzer and sweep studies

That is what it is supposed to do. But in some rigs the best you can get is about 54db. If you adjust for min carrier cold then it is about 45db when hot. Of course you should balance it out hot, but then you are out of spec for the first 30 minutes of operation. The balance trimmer cap (5-25pf) is a ceramic NPO cap. It is in parallel with a standard mica cap, 18pf. I have, on a couple radios replaced the 18pf with a mica COG (NPO) and put in a matched set of 1N87's (yes I can still find them) and get 58db hot, that also maintains at least 52db when cold. In some cases, I have replaced the 470 resistors and improved rejection and balance. I have developed a simple test. If you put the balance pot (250ohm) in its mechanical center then adjust the balance trimmer cap for min carrier. Then if it takes more than 1/3 of the pot to get min carrier either the diodes or the 470-ohm resistors need to be replaced. Oh, well I do believe you could write volumes on every little ckt in these rigs. Thanks again for the input and suggestions. But alas, every time we talk, I get 2 or 3 more things to research.

(Jim) Walt, there you go again passing to me more information that I was totally unaware of. I have never paid any attention to the balanced modulator, but now, I will have to add another regression test to a very substantial list. What is your source for the matched 1N87's --- based on your comments, I will need a bunch over time. Would never have guessed the balanced mod would be temperature sensitive but now will have to check all radios that visit my qth including my SR-2000. Walt, every time I think we are done another revelation appears. This sounds like a good one though. I've heard folks frequently that sounded like their radio had a lot of carrier bleed through and this may be the answer.
I can't thank you enough for bringing it to my attention.

I have found sources for matched pairs but they were $18.00 to $24.00 per set. RF Parts has individual diodes for $1.00. I bought 30 and used my curve tracer to match them up. Out of 30 I ended up with 12 perfect matches. http://www.rfparts.com/diode.html. The application in the 150 does not approach any spec limits on the diodes. The most stress they see is in the CW/Tune function with CR10 is biased off and CR11 is biased on to pass the USB osc signal straight thru. At that it is only running 1.6ma. It is good for 50ma.

3-12. AGC ZERO SIGNAL REFERENCE

With the antenna grounded, if the agc in the SR-150 measures between 0 and +0.2vdc the radio works fine, meets all specs, the S-meter functions normally and it seldom has birdies.

If the agc measures in excess of -0.5vdc in the negative direction performance is degraded. Birdies start to show up, the agc figure of merit drops out of spec and the S-meter is totally bogus.

I had a 150 that was particularly bad. The agc, with the antenna grounded, was unstable and read from -1.95 to 2.35vdc. The s-meter was not even close. The figure of merit dropped out of spec with only a 20db over threshold signal increase and it was full of birdies. Spec states 50db over.

I had a hunch that the problem was some of the carrier oscillator was being fed directly into the I.F. I have seen this in the SR-400. I connected the spectrum analyzer to the agc detector (with the antenna grounded) and was surprised to find that there was no carrier osc signal at all. What I did find was VFO at -28db. It was everywhere back to the 2nd receiver mixer (V17A). I measured the VFO input to the 2nd receiver mixer which should be about 0.6vpp. It measured 1.8vpp. I quickly found the problem, C38 which should be a 39pf cap was 390pf. When I replaced the cap, it became a different radio. It met all the specs. The S-meter was even dead on. There was still some VFO at the agc detector but was so far down in the noise I could not get a reliable measurement.

In this case I had a wrong part, but it got me to thinking. I had two other 150's that meet the receiver gain and sensitivity specs. However, the agc figure of merit which normally holds to about +70db did not quite meet the +50db spec and also had some receiver spurious response problems. I benched and tested both and found that the VFO at the agc detector was around -35db. The VFO injection was 0.9vpp and 1.2vpp on the two. They did have the correct value for C38. In one R72 (680 ohm) measured 1.3k. I replaced it with a new 680 ohm and the drive to the second mixer settled down to 0.5vpp. A little lower than what I consider normal, but the radio worked fine and met all specs. In the other radio C86 and C88 were reversed, probably came from the factory that way. When I properly connected the caps, the output settled to 0.6vpp and it too met spec.

I have found a link between VFO injection levels and proper agc action. This does lead me to believe that testing the level of the agc with zero signal, antenna jack grounded, should be considered as an initial test when repairing or restoring the SR-150. This may also be something to consider in other SR series radio. The static level of the agc varies from model to model and I have not established the ideal level for the other models. More testing will need to be done.

3-13. MIC AUDIO FEEDTHROUGH IN RX

There is mic audio feed through. But it is a characteristic of the design. The first stage of the mic amp is operational at all time. If this first stage is over driven an audible tone can be heard in the speaker. Crystal, ceramic or amplified microphones will over drive the mic amp. The max input to the mic amp is spec'd at 0.01v rms, or 0.028v peak to peak. The max input to produce min spec power out is 0.005v rms or 0.014v peak to peak. The max audio feed through at the level to produce full power out no greater than 0.000225 watts or 0.03v peak to peak. In short, the mic circuits were designed around a nominal 0.005vrms input level. There are feed-through paths through the VOX circuitry to the audio output. These paths are active in STANDBY, MOX and VOX. There are two ways around this characteristic. First; The system was designed around a specific class of microphones. That would be a dynamic mic with an output level spec'd at -50 to -53db into a 100k load. Second; Use the MOX function with a mic that opens the voice line when the mic is unkeyed. If you use VOX with a mic that over drives the mic amp you will always have some feedthrough. The feedthrough does not affect the operation it is just somewhat annoying. Generally speaking, though, if you overdrive the mic amps you will be introducing some level of distortion into your transmission.

3-14. PRESELECTOR TRACKING SR-150

Grab your schematic and figure 11 (SR-150 FACTORY MANUAL) and follow along.

The preselector control (C7A, C7B and C7C) tunes three sets of band coils. First (C7A) is the RX RF amp grid. The second (C7B) set of band coils tunes the RX RF amp plate and the 2nd TX mixer and Driver grid. The third (C7C) set of coils tunes the driver plate.

First problem, there are an infinite possibility of positions of the preselector and the coils to reach resonance on each band. The factory alignment procedure does not address this characteristic.

Over time and repeated tune and align operations the peak for the preselector drifts. A common error when aligning is to peak the preselector and then adjust the coils. Over time the peak will drift the preselector off its mechanical design point. This can cause the mixer/driver to oscillate or inability to get max power out of the PA across the bands.

To correct for this condition, we set the preselector to it intended mechanical position and then adjust the coils. Sometimes the preselector is so far off you have to creep it back. That is, move the preselector a small amount in the direction of its intended position, peak the coils and do it again until you walk the preselector and the coils back to their correct position. The photo below shows the proper position for the pointer for each band center.

Second problem, L7 – L11 tune both the receiver and the transmitter. This one is easy. Align the transmitter coils first (L7 to L11 and L30 to L34). Once the transmitter coils are aligned, tune the receiver coils L1 – L5. Do not readjust L7 – L11 for the receiver.



You may have to arbitrate the adjustment of coils L7 through L11 to get spec RX and TX operation. The proper adjustment of L12 will also affect the alignment. This is a simple design, good circuit design. If it will not track then there is a component or components at fault. Questions to ask: Are all bands effected? Is it repeatable or intermittent?

Third problem, If you tune through the rotation of the preselector and the S meter pegs out or in transmit mode you get a power peak; This also indicates a preselector tracking problem.

3-15. S-UNIT STANDARD

IARU Region 1 Technical Recommendation R.1

In the 1930s it was already agreed that S9 corresponds to 50 μV at the input terminal of the receiver,[3] [4] but this was not a measure of the power received as the input impedance of receivers was not standardized. The International Amateur Radio Union (IARU) Region 1 agreed on a technical recommendation for S Meter calibration for HF and VHF/UHF transceivers in 1981.[5]

IARU Region 1 Technical Recommendation R.1 defines S9 for the HF bands to be a receiver input power of 73 dBm. This is a level of 50 microvolts at the receiver's antenna input **assuming** the input impedance of the receiver is 50 ohms.

For VHF bands the recommendation defines S9 to be a receiver input power of -93 dBm. This is the equivalent of 5 microvolts in 50 ohms.[6]

The recommendation defines a difference of one S-unit corresponds to a difference of 6 decibels (dB), equivalent to a voltage ratio of two, or power ratio of four. Signals stronger than S9 are given with an additional dB rating, thus "S9 + 20dB", or, verbally, "20 decibels over S9", or simply "20 over 9" or even the simpler "20 over."
Examples
1, A weak signal with signal strength of S2 corresponds to received power of -115 dBm or 0.40 microvolts RMS in 50 ohms on HF.
2, A strong signal with signal strength of S8 corresponds to received power of -79 dBm or 25 microvolts RMS in 50 ohms on HF.

NOTE: Some signal generators are calibrated in dB above 1uV and have an output in emf. For example, to set an HF receiver's S-reading to S9 set the signal generator output to 34 dB above 1uV

S-reading	**HF**		**Signal Generator emf**
	µV (rms, Relative to 50Ω)	**dBm**	**dB above 1uV**
S9+10dB	**160.0**	**-63**	**44**
S9	**50.2**	**-73**	**34**
S8	**25.1**	**-79**	**28**
S7	**12.6**	**-85**	**22**
S6	**6.3**	**-91**	**16**
S5	**3.2**	**-97**	**10**
S4	**1.6**	**-103**	**4**
S3	**0.8**	**-109**	**-2**
S2	**0.4**	**-115**	**-8**
S1	**0.2**	**-121**	**-14**

3-16, SR-150 HIGH LEVEL SIGNAL DISTORTION

The receiver gain and audio distortion are related. The receiver was designed to function with minimum distortion within a 50db window. With the RF gain at Max that window is from 5uv to 1500uv. Any signal greater than 1500uv will cause crossmod and audio distortions. 1500uv is displayed on your smeter as a signal approximately 10db over S9. In order to eliminate the distortion in strong signals the RF GAIN needs to be reduced. Reducing the rf gain via the RF GAIN control effectively shifts the linear gain window up the input voltage curve. Any attempt to reduce the overall gain in the receiver, in any other way will induced regenerations and birdies.

If you are experiencing audio distortion on signals roughly between S3 and S9 with the RF GAIN control at MAX **you have a receiver gain fault**. Your receiver does not need to be redesigned or modified. You need to find the fault. Refer to https://wd0gof.com/hallicrafters-radio/repair-manuals/ for guidance in fault isolation.

NOTE: When the RF GAIN control is not at max the S-METER is no longer true. So, a report of "S9" or "10 over" will not be true either.

This applies to the entire Hallicrafters SR series and most all other receivers where a gain control sets the gain in the front end.

3-17, AGC/GAIN/SENS/FIGURE OF MERIT

As stated in PERFORMANCE SPECIFICATION #093-801691 for the SR-150 the receiver should meet the following specifications:
Sensitivity – 1 microvolt for a 20DB signal-to-noise ratio.
Audio output -- >5 microvolt in, 2 watts, min.
Overall gain – 1 microvolt in for ½ watt output, min.
AGC figure of merit – Increasing the signal at the antenna terminal from 5 microvolts by 50db to 1580 microvolts (more precisely 1581.13883uv) will produce no more than 10 db of change in the audio output.

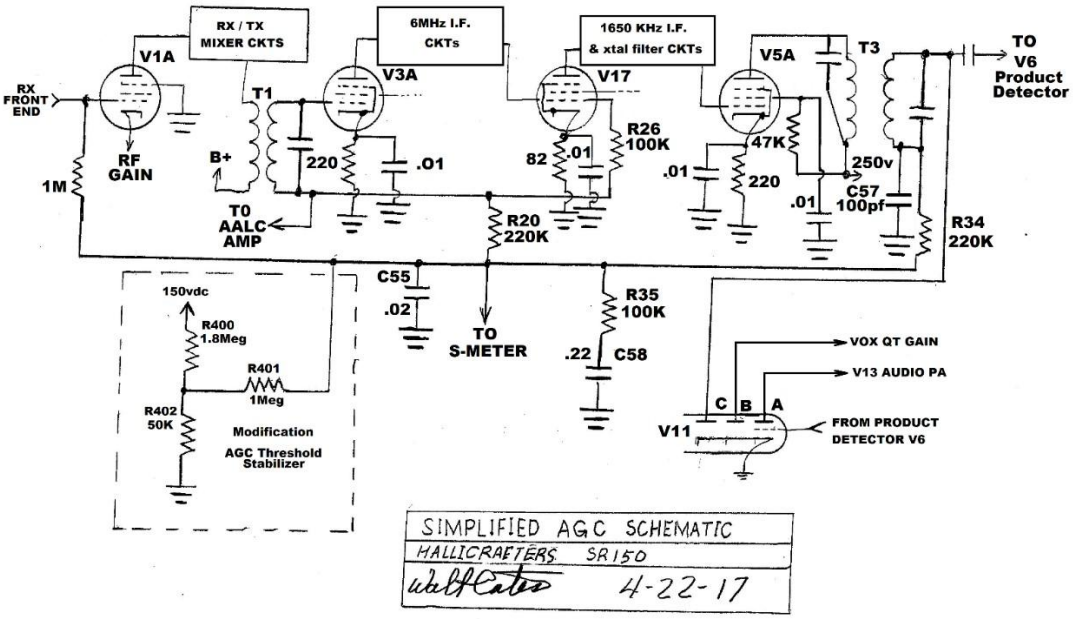
Roughly speaking 2 out of 3 receivers will meet these specifications with no problem. In fact for years, I have replaced the 1 microvolt with 0.5 microvolt as a bench standard. I consider a unit that meets the specifications at 1 microvolt or more to be substandard.

So, what can you do if despite your best effort of optimizing and super tweaking it just will not meet spec? There are two key tests you can perform at this point.

TEST 1:
RF GAIN control test. The RF GAIN control wiper does not reach actual top and bottom of the pot as it ages. A simple test can be performed to prove or eliminate this as a problem. Rotate the RF GAIN control fully clockwise. With a 1 microvolt signal at the antenna terminal tune up the receiver. Locate the junction of R3 (180 ohm) and R6 (180K) in the cathode ckt of V1. Monitor the audio output and ground the junction of R3 and R6. If the audio output increases 1db or more you have a problem with the control. It needs to be repaired or replaced. For in-depth information

on this problem see section 3-8 of the SR-150 SUPPLEMENTAL TECHNICAL INFORMATION. This fault will also affect the AGC FIGURE OF MERIT spec.

Before jumping into the second test let's review the basic operation of the AGC ckts. Section C of V11 is the AGC detector. It rectifies the 1650KHz IF signal and feeds a negative voltage proportional to the signal level back through the secondary of T3. This controls the gain of V1A, V3A and V17. C55, C58, C57, R34 and R 35 filters the negative voltage and sets the attack and decay of the AGC action. This is your basic AGC design approach. Problem is, it is too basic. Major shortfall is there is no adjustment for threshold. The threshold of the AGC action is determined by the idle current of the grids of V1, V3 and V17 and the GM of V11. Over time components age and drift. I have observed, over many years of testing the SR-150, that if the nosignal in voltage at the junction of R20 and R35 is between -0.1 and +0.4vdc you will achieve best receiver performance. My bench test goal is +0.3vdc. Threshold negative voltages of -0.2 or more will produce substandard performance.



TEST 2:

AGC THRESHOLD test. The AGC buss is a very high impedance line. Practically all DC meters will load the ckt. However, you can measure the voltage with a scope in the DC MODE without loading the ckt. Set the RF GAIN to max. Connect the antenna to chassis gnd. Set the scope at 0.5v per centimeter, DC mode. Connect the 10x probe to the junction of R20 and R35. If the voltage is not between -0.1v and +0.4v then you have three options.

OPTION 1: Get at least a half dozen each of V1, V3, V17, and V11. While monitoring the AGC threshold voltage swap the tubes until you get a combination that delivers the proper voltage level and still meets the gain spec. Put on your patient demeanor for this one.

OPTION 2: Accurately measure the grid and cathode resistors of V1, V3 and V17 and R20 and R34 and replace as needed.
OPTION 3: Clamp the AGC line with a high impedance voltage divider. As noted in the attached simplified schematic a positive voltage is delivered to the AGC buss via a high Z source. The slight positive voltage on the AGC buss sets the gain of V1, V3 and V17 to max. Since the voltage is developed via a high z divider it is easily over driven by the rectifier action of V11. The linearity and figure of merit of the AGC are not adversely affected. You can control the threshold. Replace R402 with a 20k pot and a 30k resistor to gnd. In this way you can adjust the threshold AGC voltage for optimal operation.

4. ALIGNMENT

At this point you should have completed the oscillator optimization and alignment in section 1-6. If not then go to section 1-6 and complete the oscillator optimization and alignment before proceeding. The following procedure is a cascade operation and should be performed in the order presented.

4-1. 1650 IF ALIGNMENT

The 1650KHz IF is comprised of V17A, V5A, T6, L14, FL1 and T3.

T6 has a unique function. In transmit and receive is provides grid tuning for the V17A 1st 1650KHz IF amp. In receive mode a bias voltage is applied to T6 pin 3 to switch off CR9 which blocks any signal from the balanced modulator from feeding through to V17A. In this condition T6 resonates the grid of V17A at the IF frequency. In transmit mode the double side band suppressed carrier signal from CR10 and CR11 is passed through T6 to the grid of V17A. T6 and T4 (BFO & CARRIER OSC plate coil) are identical. Resonance of the coil connected to pins 1 & 2 can be achieved by tuning up from the bottom or down from the top. Tuning for resonance up from the bottom will affect the coupling of the transformer and the Q. For best results always run the slug up to the top of the coil and adjust down to the first resonant peak.

Before starting the 1650 IF alignment ensure the proper adjustment of the BFO/carrier oscillator has been completed (Section 1-7-1).

Inject 1650.050 KHz into pin 7 of V17A. The signal level should enough to produce S1 to S3 on the S-meter. Adjust T6 and T3 for max S-meter reading. Keep reducing the signal generator output to maintain less than S3 on the S-meter.

L14/L15 alignment test.
With the signal generator at 1650.050 KHz adjust the generator output for a S9 reading on the S-meter. Note the signal generator output level. Maintaining that exact generator output level tune the generator to 1648.700 KHz. The S-meter level should not drop below S7. Tune the generator to 1651.400 KHz once again the S-meter should not drop below S7. If it is good you are done with the 1650 alignment. If not, the best method is to sweep the IF

using all the appropriate markers which usually means taking it to certified communications repair shop or finding an Elmer with a real good lab. It is possible using the method you just used to test L14/L15 to manually sweep and adjust these coils. It is tedious and you must end up with two ends perfectly balanced. Then you need to tune VFO in 50 KHz increments from 50 to 450, tune the signal generator at each increment and note the S-meter peak reading. There should be no peaks or valleys of more than 1 ½ S-units.

4-2. 6.0 TO 6.5 FIRST IF ALIGNMENT

V2, T1, V3 and T2 make up the first IF.
Before starting this alignment ensure that the VFO alignment in section 1-6-3 has been successfully completed.

Set OPERATION switch to STBY, FUNCTION switch to LSB and VFO to 0 on the black scale.
Connect the signal generator to V2 pin2. Adjust the signal generator to exactly 6.500 MHz. The frequency is a critical adjustment. If your generator does not have an accurate digital readout an external frequency counter is highly recommended. Adjust the signal generator output for an S-meter reading of between S1 and S2. Adjust C32D and C32E for max S-meter reading. Reduce the signal generator output to keep the S-meter below S2 throughout the alignment. Tune the signal generator to 6.000 MHz. Adjust the VFO for 500 on the black dial. Adjust T1 and T2 for maximum S-meter reading. Repeat the adjustments of C32D, C32E, T1 and T2 until no further gain is achieved.

4-3. ALIGNMENT COMPLETION

At this point you should have completed the oscillator and first and second IF alignments. Using the original manual complete the procedures in the following paragraphs;
8-7. RECEIVER RF ALIGNMENT
8-8. 6.5-MC TRAP
8-9. DRIVER PLATE CIRCUIT RF ALIGNMENT
8-11. CARRIER BALANCE
8-18. S-METER ZERO ADJUSTMENT

CONGRATULATIONS, if you have worked all the way through this process, you should now have a fine performing rig. 73, Walt.

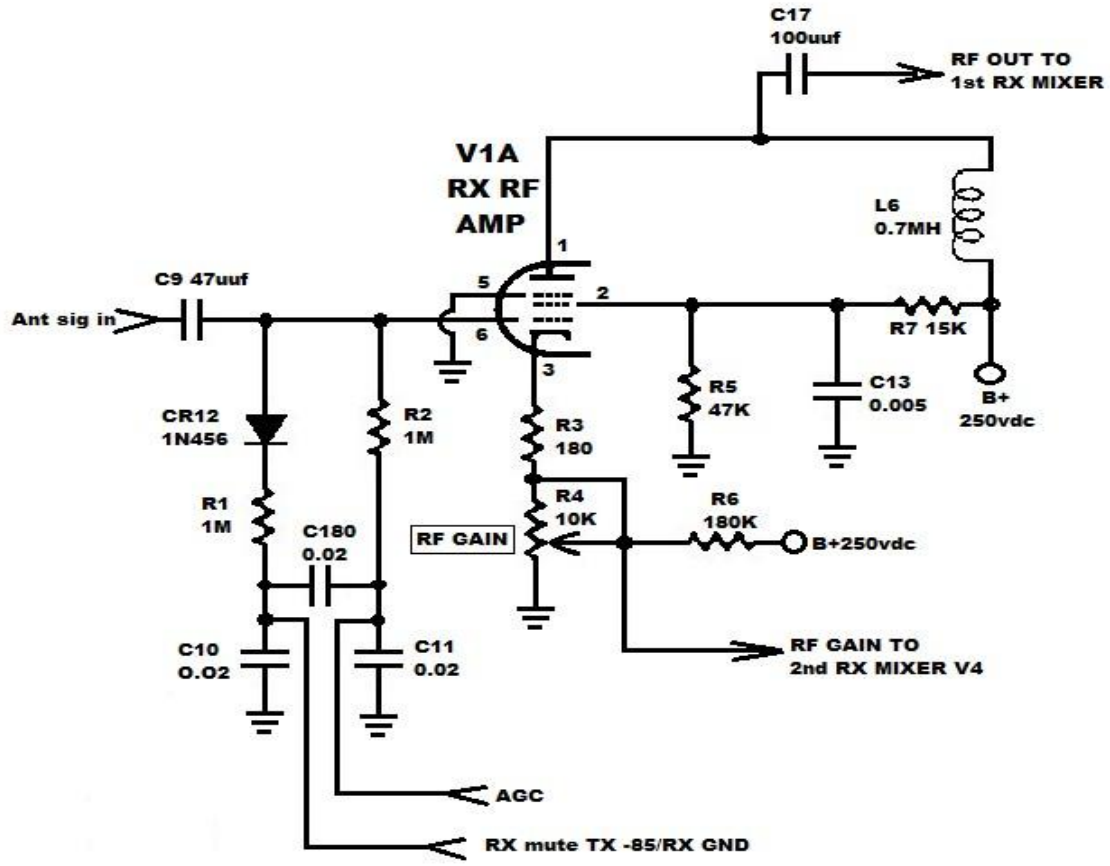
5 CIRCUIT DIAGRAMS AND VOLTAGE TABLES

The following tests and procedures will expose you to dangerous high voltages.

WARNING

YOU WILL BE EXPOSING YOURSELF TO VOLTAGES THAT CAN KILL YOU.
OBSERVE THE ONE HAND IN THE HIP POCKET SAFETY RULE WHILE WORKING WITH THE SHIELDS AND COVERS REMOVED FROM THE EQUIPMENT

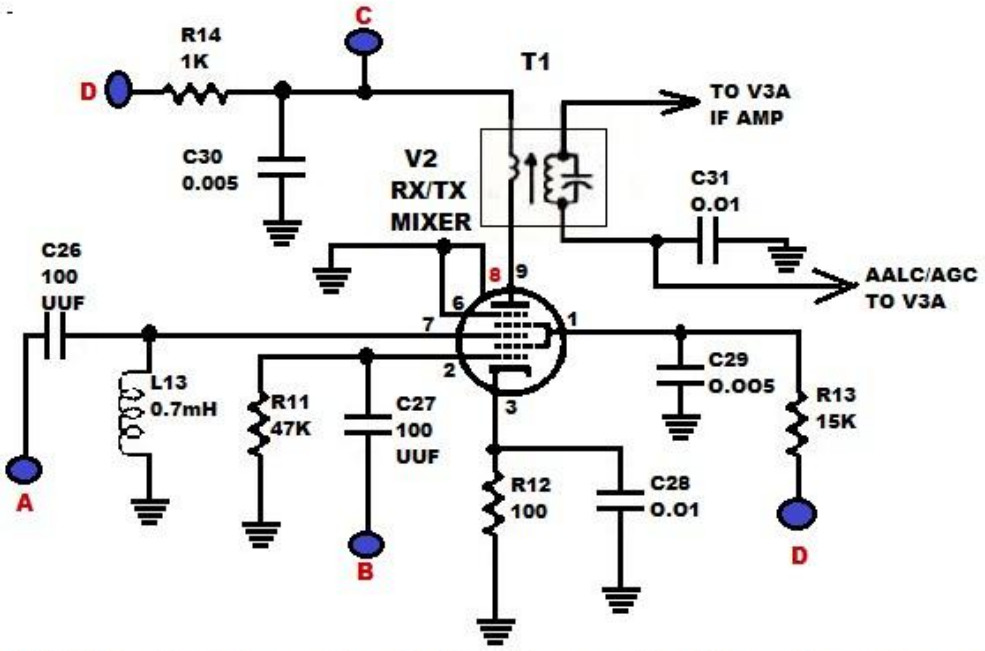
5-1, RECEIVER RF AMP



Test unit B+ 288 v. Measurements made with no signal input. All 4 gain controls at minimum.

PIN	1	2	3	6
RX MODE	288	212	29	0
TX MODE	288	209	28	122

2, FIRST RX/TX MIXER

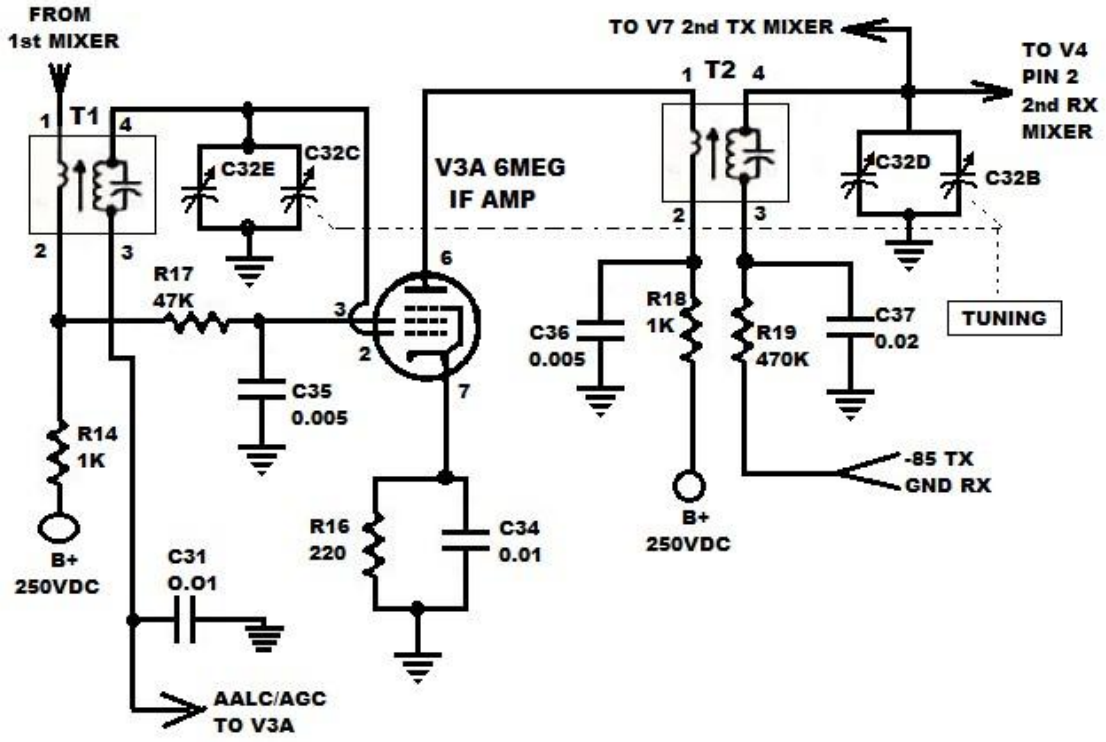


A VFO injection in transmit mode / input from receiver RF amp in receive mode.
B 1650KHz from V17A in transmit mode / Het osc injection in receive mode.
C Secondary B+ to V3B, V5B and screen voltage for V3A.
D B+ 250vdc
Pin 8 of V2 is an internal shield between pins 7 and 9.

TEST UNIT B+ MEASURMENT ___288vdc_

PIN	1	2	3	7	9
RX VOLTAGE	98	-1.3	1.5	0	273
TX VOLTAGE	87	0	1.5	0	268

3, 6 MEG IF AMP

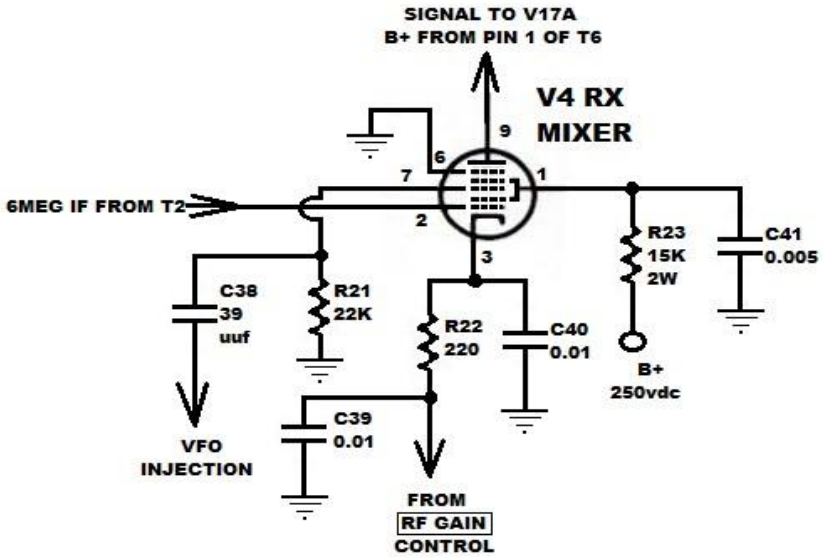


Measurements made in RX mode. Use RF blocking meter lead
Test unit B+ 288vdc

PIN	2	3	6	7
No sig in	0	175	279	2.1
100uv sig in	-3.5	224	284	1.1

V3 (6EA8) can be replaced with a 6GH8 for more gain. Hallicrafters bulk ordered 6EA8 tubes with a tighter specification on GM and interelectrode capacitance. Many NOS tubes which have a wider spec range are low on gain in this circuit. The other half of the tube is used as a cathode follower in the mic amp and gain is not a factor in that circuit.

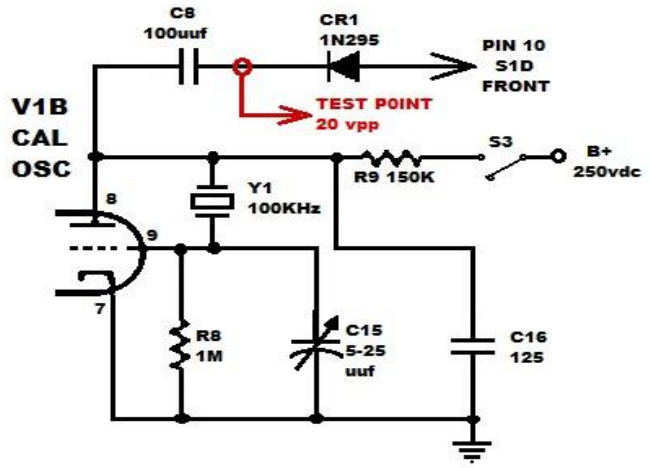
4, SECOND RX MIXER



Test unit B+ 288 vdc. Measurements taken with no signal input.

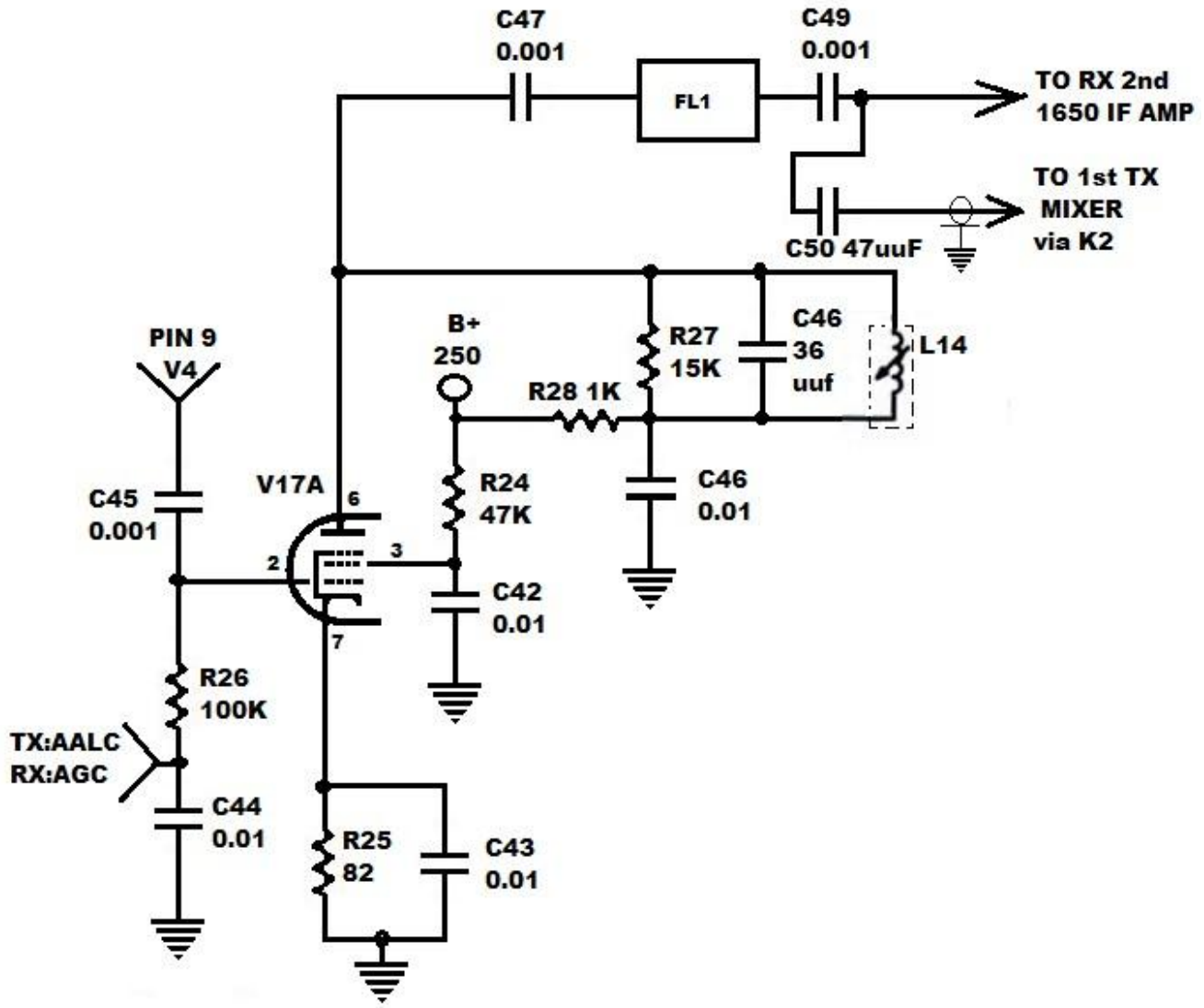
PIN	1	2	3	7	9
VOLTAGE	115	0	3.3	0	280

5-5, CAL OSC.



PIN	8	98
VOLTAGE	70	-62

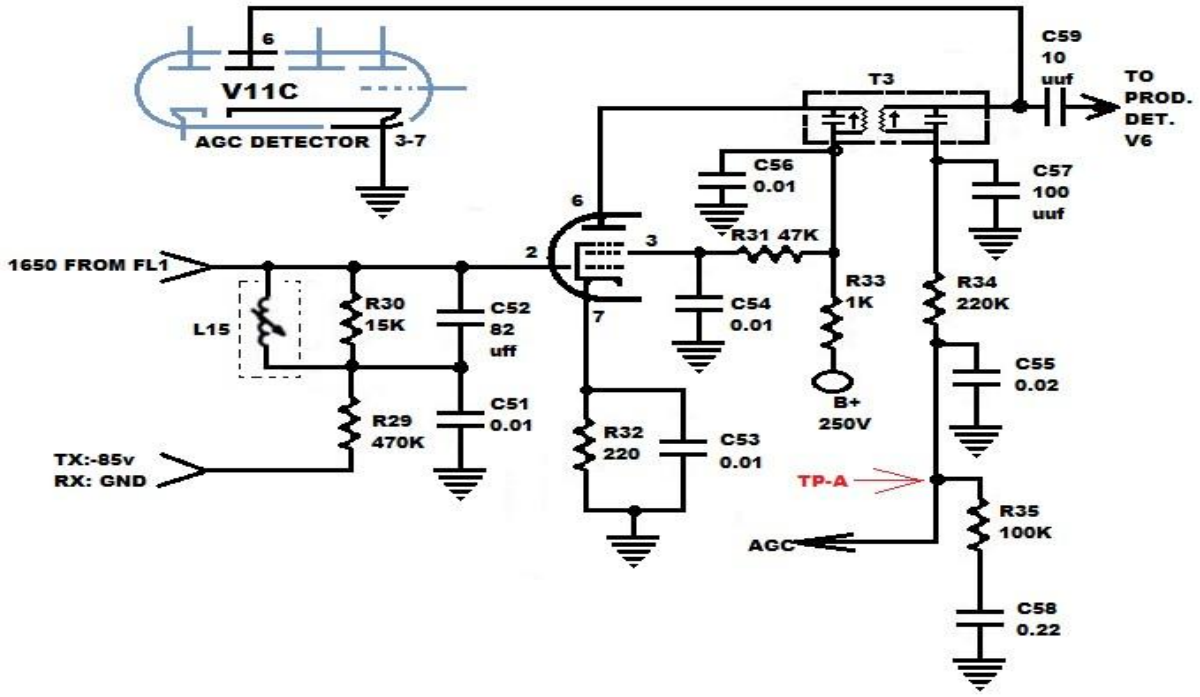
6, FIRST 1650 IF AMP



TEST UNIT B+288vdc. No signal in. All level controls at zero.

PIN	2	3	6	7
RX MODE	-0.1 to -0.3vdc	136	270	1.28
TX MODE	-0.2 to -0.5vdc	146	228	1.10

7, 2nd 1650 IF AMP AND AGC DETECTOR



Test unit B+288v, reg 155v. Measurements made in RX mode no signal input. Use RF blocking meter lead.

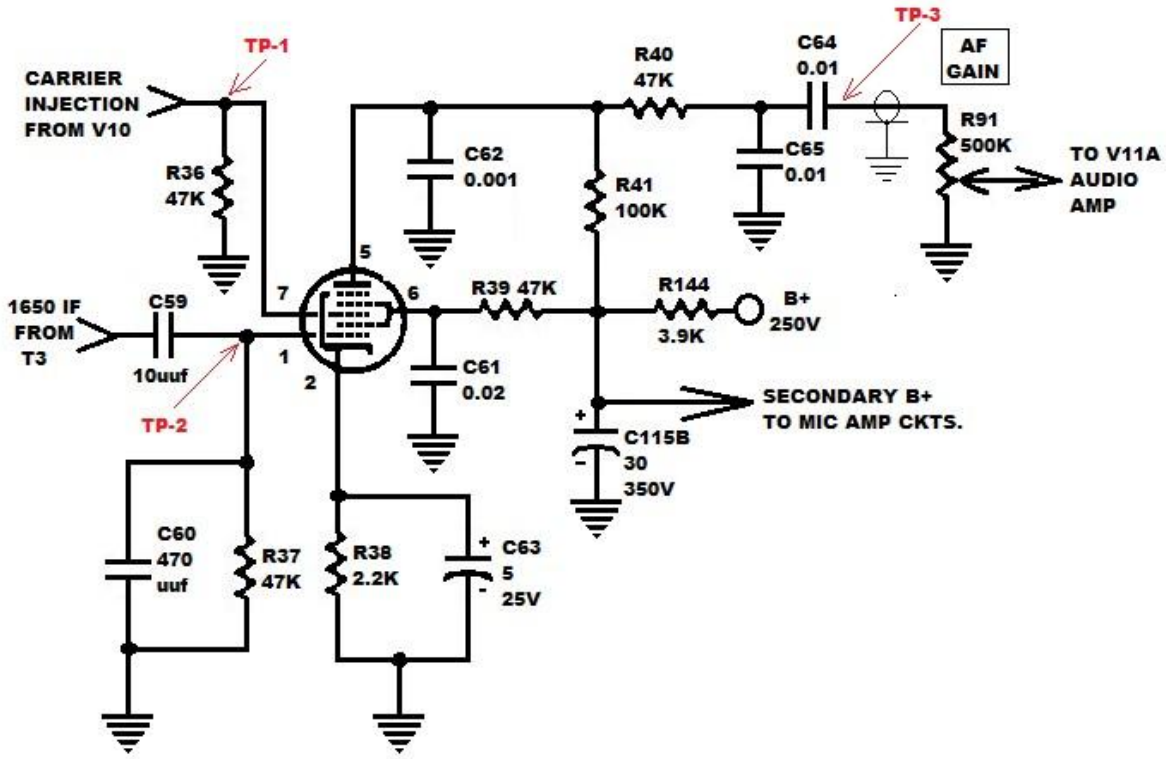
PIN	2	3	6	7
VOLTAGE	0	158	274	2.3

A sample of the 1650 IF signal is presented to V11C, rectified and fed back as the AGC voltage. The R/C networks, R34/C55 and R35/C58 set the attack and decay time for the AGC action. With a scope set to the DC mode using a 10X probe connected to **TP-A** the following voltages should be measured. Connect the signal generator to the antenna jack and inject the following signal levels. Peak the receiver in SSB mode on the 40meter band @ 7.260 MHz. Re-peak RX tuning after increasing injection level.

SIGNAL LEVEL	0.0uv	3.0uv	50.0uv
MEASUREMENT	-1.4	-2.87	-5.7
NORMAL RANGE	0.0 to –1.8	-1.9 to 13.5	-4.8 to -7.5

AGC voltages outside the normal range are indicative of loss of gain or spurious interference. Many faults can cause improper AGC levels, the most common are**:** AGC too low normally indicates loss of gain. AGC to high indicates spurious interference or local oscillators signal level too high or being coupled into circuits where it does not belong.

5-8, PRODUCT DETECTOR



Test unit B+ 288v, reg 155v.

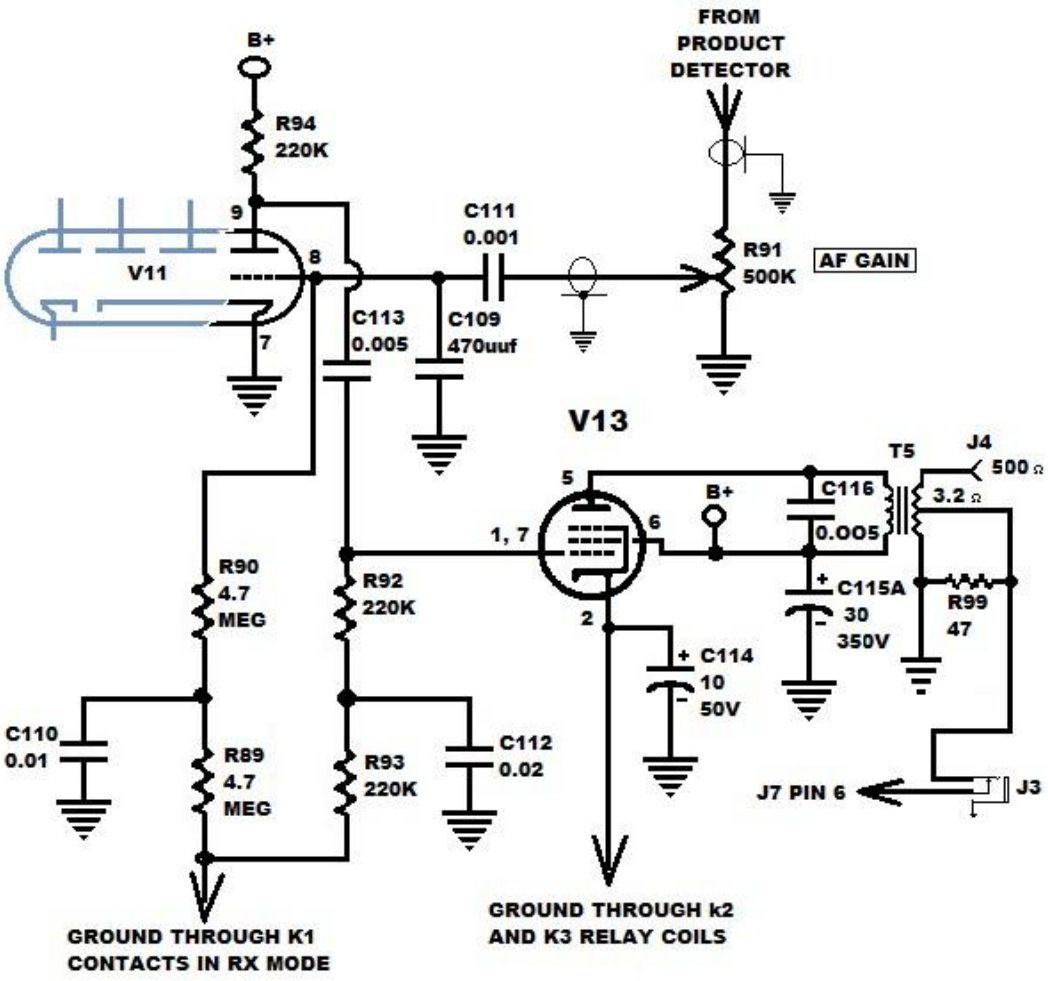
Receive mode; SSB; 40-meter band; 7.260 MHz; signal generator set for 5uv output. AF GAIN set for 0.5 watts audio output.

PIN	1	2	5	6	7
MEASUREMENT	0	7.5	178	139	-8.2

Test point 1, 2 and 3 are measured with an O'scope, using a 10x probe with the same settings as above.

TEST POINT	TP-1	TP-2	TP-3
MEASUREMENT	28.4vpp (rf)	0.280vpp (rf)	3.0vpp (audio)

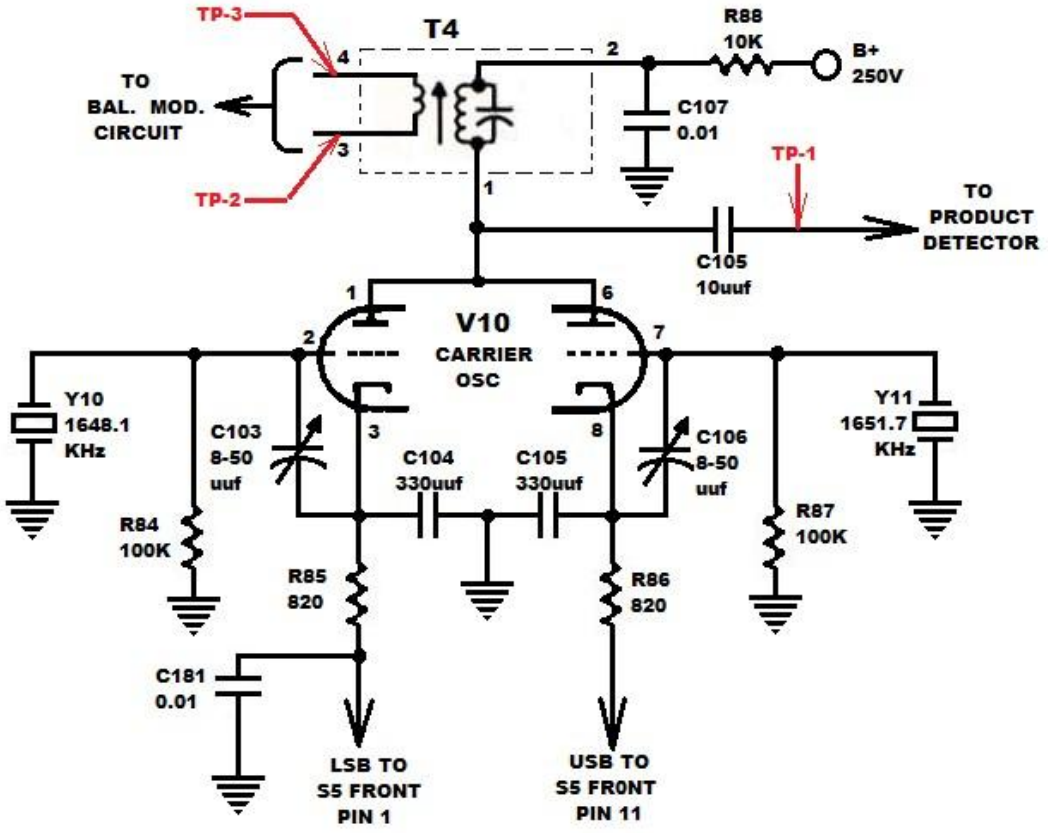
5-9, RECEIVER AUDIO



Test unit B+ 288v, REG155v. Measurements taken in RX mode with 5uv in/40 meter/7.260MHz, RF GAIN at max, AF GAIN set for 0.5 watts audio out.

	V11			V13			
PINS	**7**	**8**	**9**	**1, 7**	**2**	**5**	**6**
VOLTAGE	**0**	**10.5**	**96**	**0**	**15.6**	**288**	**288**

5-10, CARRIER OSCILLATOR

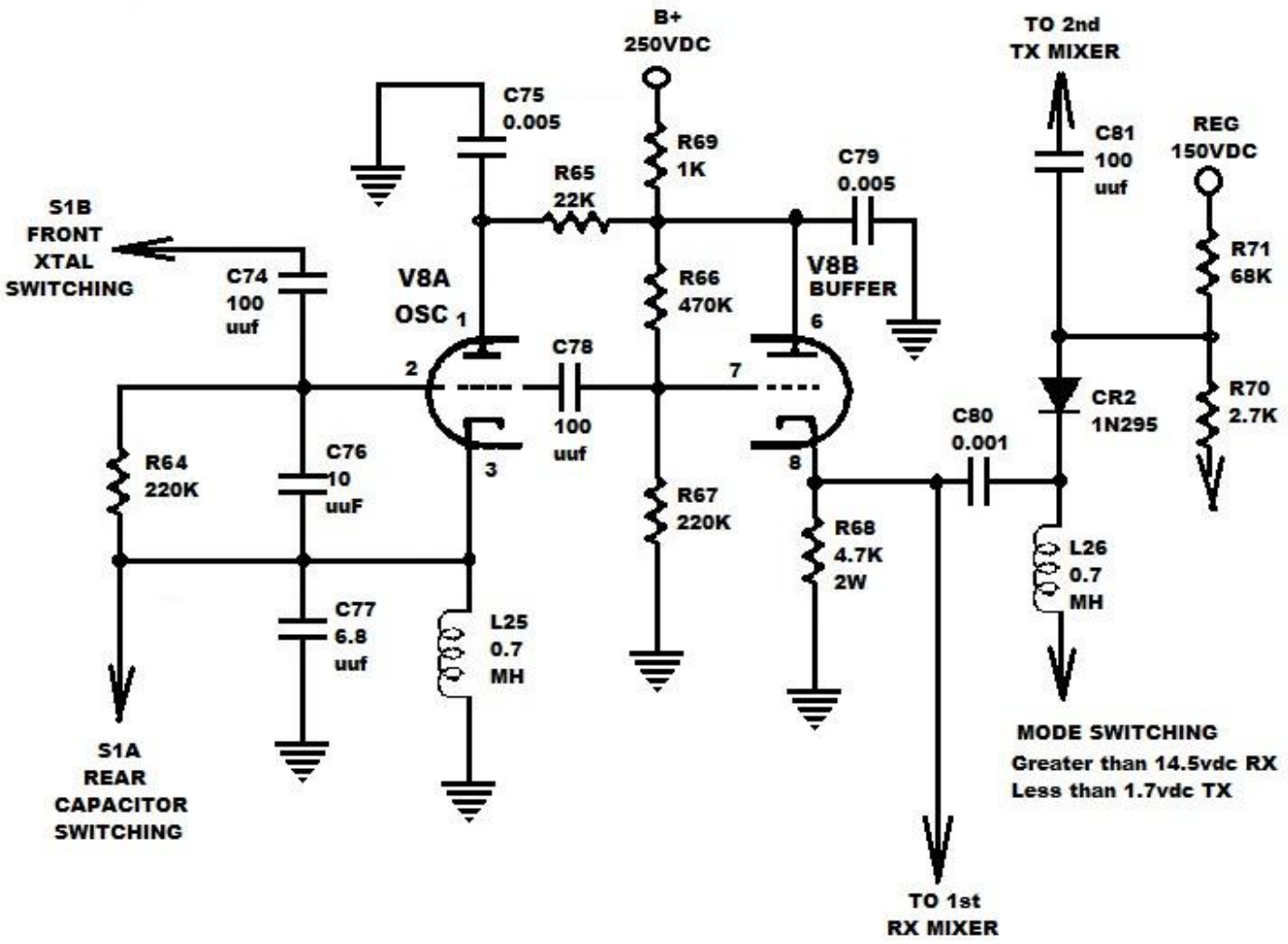


Test unit B+288 v, REG155v. Use RF blocking meter lead for measurement.

V10 PINS	1&6	2	3	7	8
USB MODE	195	0	11.2	-4.3	3.7
LSB MODE	195	-5.0	3.6	0	10.8

Test points 2 and 3 should be balanced and measure 9vpp. Test point 1 should be 30vpp.

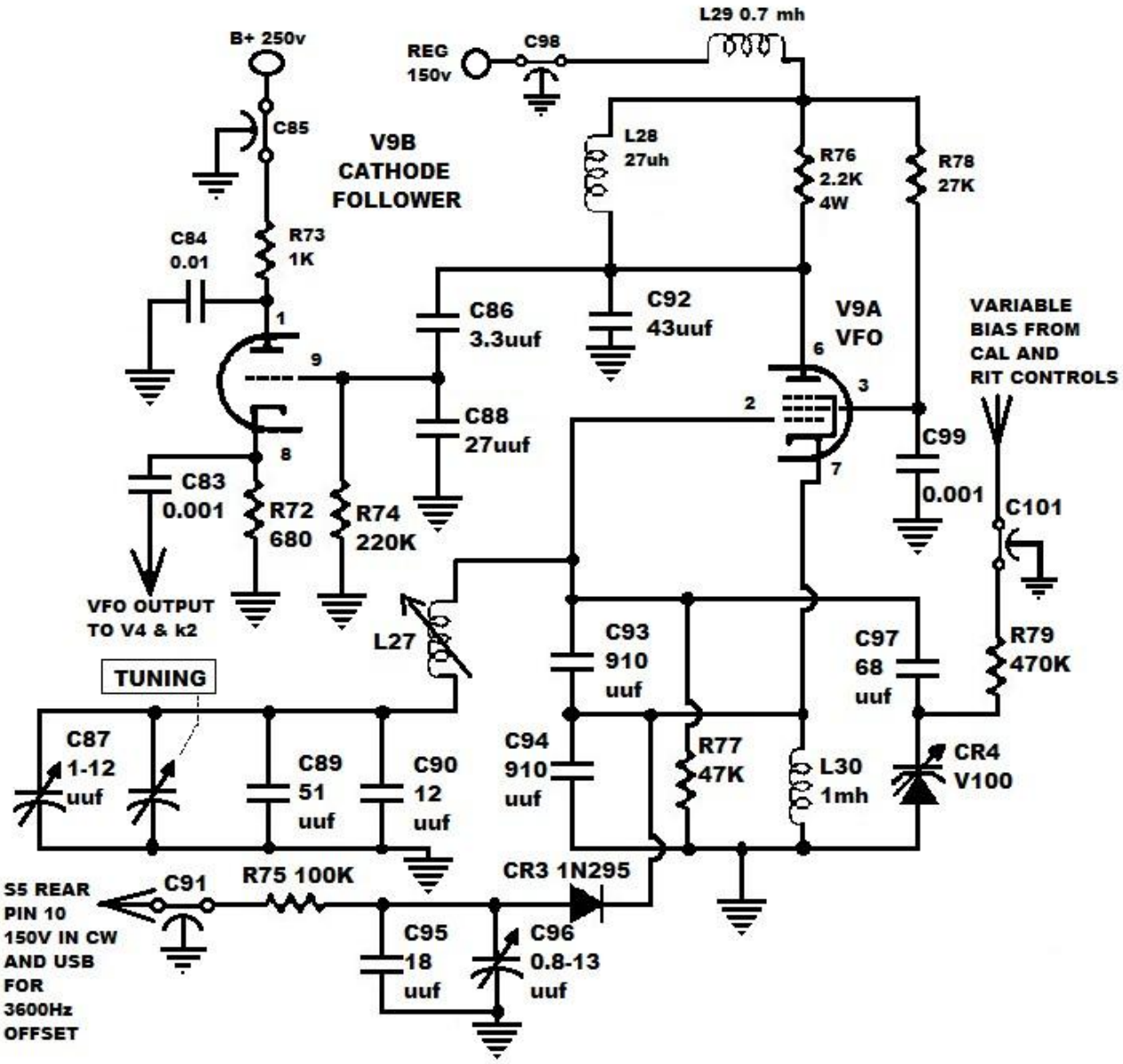
5-11, HET OSC



For static readings kill the oscillator by pulling the xtal. An RF blocking probe for the VOM or DVM will be needed for making the measurements on the grids and cathodes UNIT UNDER TEST: B+ measured 288vdc.

PIN	1	2	3	6	7	8
OSCILLATING	155	-1.8	0.05	271	67	66
STATIC	110	-0.4	0.05	265	70	79

5-12, VFO & CATHODE FOLLOWER

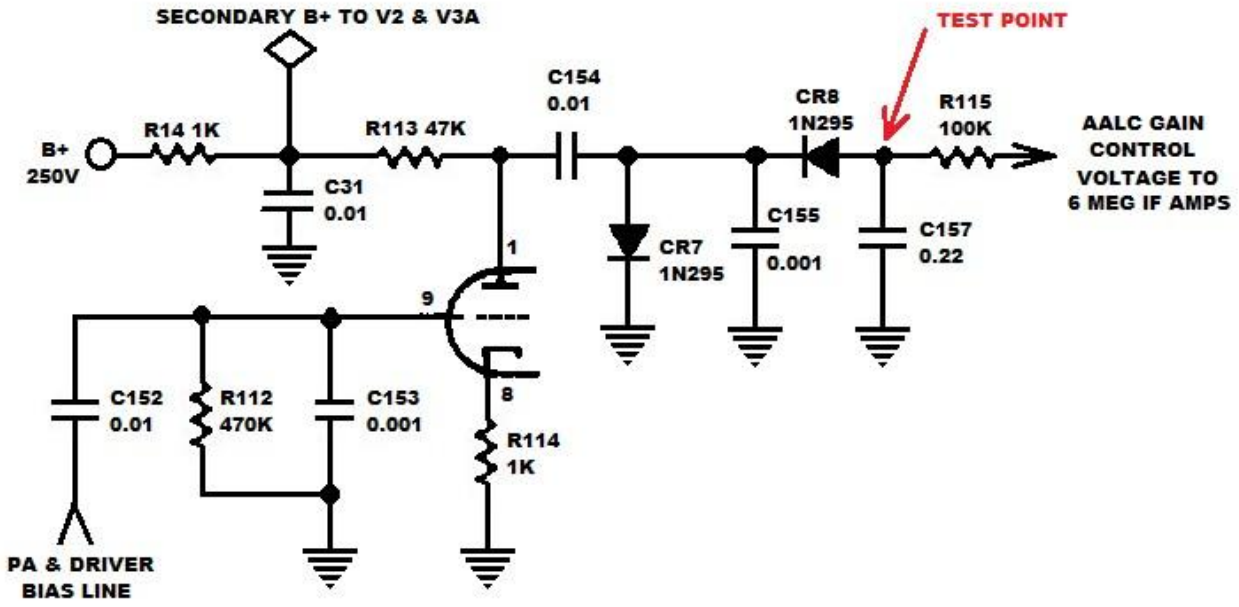


The shield can will be removed for these voltage measurements. This shield must be in place to make any frequency adjustments or alignment to the VFO.
Test unit B+ 288v, Rec voltage 155V. Use RF blocking meter lead.

PIN	1	2	3	6	7	8	9
VOLTAGE	278	-3	100	161	0.1	5.6	0

VFO output measured with a 10x scope probe, on the output side of C83 should be 0.6vpp to 1.0vpp.

5-13, AALC AMP & DETECTOR



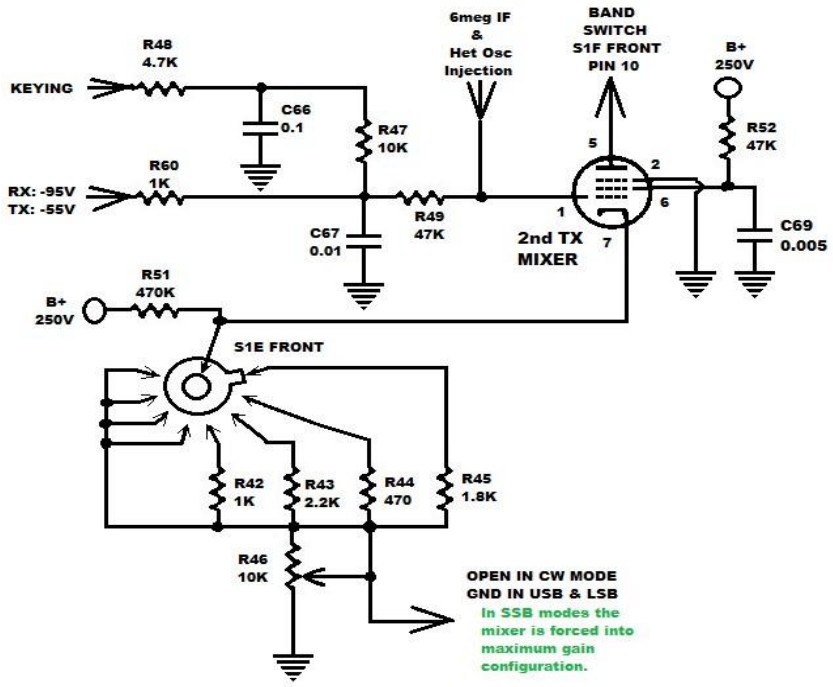
With normal operation of the PA the grid bias line is a clean DC voltage. When flat toping occurs in the PA an audio signal is induced into the bias line. A sample of that audio is fed to and amplified by V5b, rectified by CR7 and CR8. This DC voltage is fed to the 6-meg IF. This in turn reduces the 6meg portion of the drive to the 2nd TX mixer.

The AALC circuits are live at all times so testing can be done in the receive mode. Testing will be done in RX mode with AF GAIN, RF GAIN, MIC GAIN and RF LEVEL CONTROLS set to minimum (fully counterclockwise). The measurements will be made under 2 conditions, first no signal and second by injecting a 5vpp, 500Hz signal from an audio oscillator into pin 9 of V5. The no signal reading will be just that, turn it on set the controls to minimum in STANDBY mode and record the tube and test point readings. For the second set of measurements use a 1x scope probe connected to an audio oscillator to inject 500HZ into pin 9. Using a second 10x probe connected to an O'scope and pin 9, set the level of injection to 5vpp. Connect clip lead from pin 3 of T1 to chassis ground.

Test unit B+288v, Reg voltage155v.

PIN	1	8	9	TEST POINT
NO INPUT	100	3.6	0	0
5 VPP	130	3.6	0	-15.0

5-14, SECOND TX MIXER



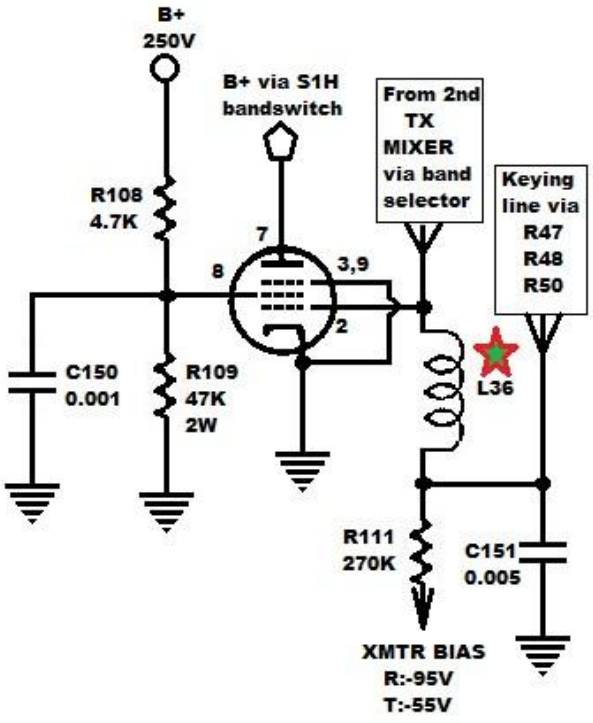
TEST UNIT B+288V, Measurements made in MOX, LSB and the RFLEVEL at max. Mis-tune the PRESELLECTOR fully clockwise for zero power out. RX MODE=MOX/LSB. TX MODE=MOX/CW.

PIN	1	5	6
RX MODE	-99	273	261
TX MODE	-2	273	198

PIN 7 MEASURMENTS

BAND	RX	TX
80	0.92	4.33
40	O.24	2.09
20	1.16	4.4
15	O.47	3.4
10	0	0

5-15, PA DRIVER



Production run 7 change. Schematics up to 089-002507C show R110 100K in place of L36. The choke can be from 270uh to 1mh.

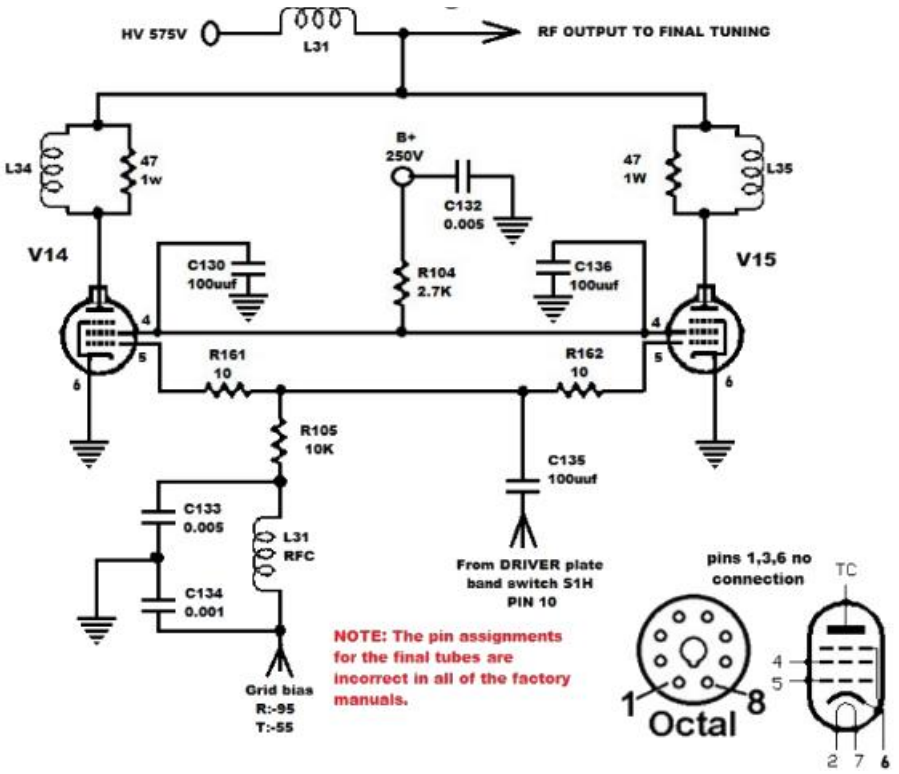
B+288V. RF LEVEL and MIC GAIN set to zero (ccw)

PIN	2	7	8
RECEIVE	-103	280	251
TRANSMIT	-2.0	266	202

See section 1-9-3 for RF signal tracing instructions in the TX mixer and driver subsystems.

5-16, TX FINAL AMP

WARNING! LETHAL VOLTAGES, IF YOU HAVE NO EXPERIENCE OR SKILLS WITH HIGH VOLTAGE CIRCUITS DO NOT PROCEED.

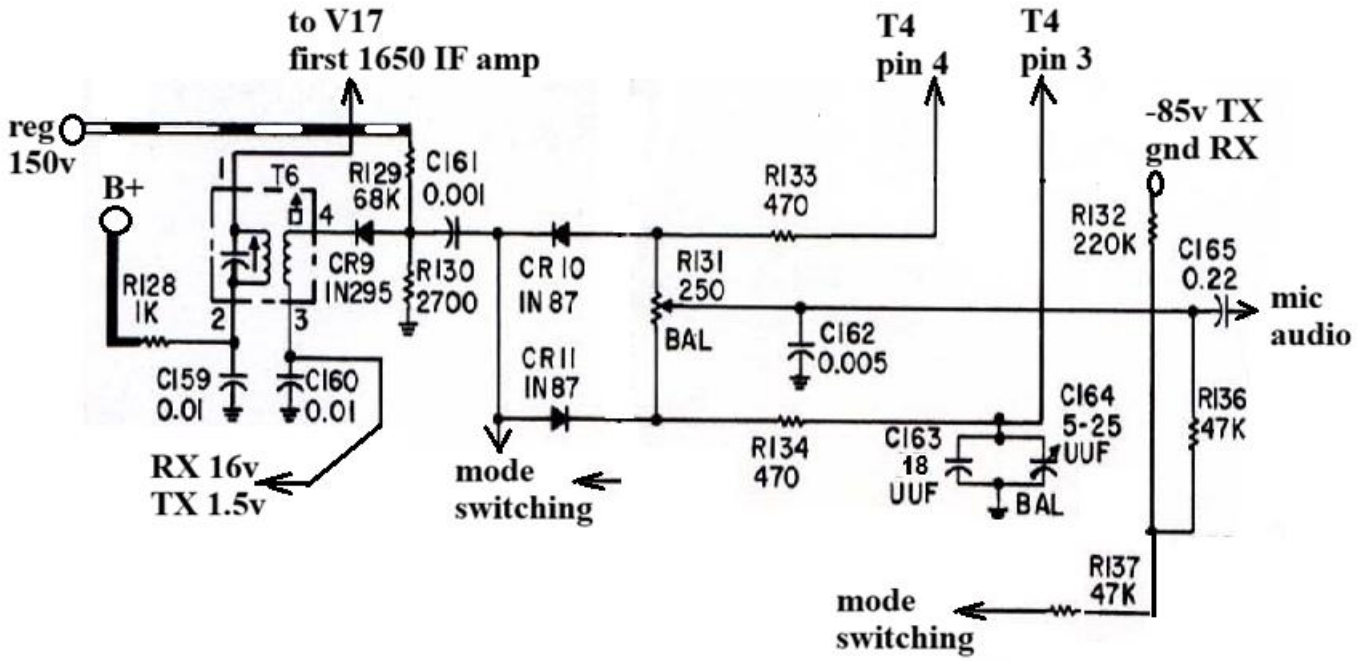


Tune up transmitter on 40-meters @ 7.260MHz. Tune up in normal manner, then back off the RF LEVEL reducing the output by 10%. If there is no power out tune receiver for max at 7.260MHz. If the receiver does not work, repair the receiver before you attempt to work on the transmitter.

Test unit HV664v, B+288.

PIN	4	5
V14 RX	280	-107
V14 TX	230	-64
V15 RX	280	-107
V15 TX	230	-64

5-17 BALANCED MIXER DRIFT



Carrier null drift in SSB mode is a common problem in all the SR's as they approach 60 years old. Due to its age the carrier balance adjustments should be made after a minimum of 15 minutes of warm up.

Inspect the solder connections of all the components mentioned below.

First thing is to monitor the carrier oscillator at pin 3 or 4 of T4, to ensure the output level is stable. Check it in both USB and LSB in transmit mode with the mic gain at zero.

If that is good next in line are the 1N87 diodes CR10 and 11. They are still available. The important thing with the diodes is, they should be matched. They cannot be checked in the circuit. You can lift one lead then check the forward and reverse resistance and leakage. Careful with the heat here. Just about any diode that meets current and voltage specs of the 1N87 will work.

Next, R133 and R134. They are 20 years past their shelf life. As a general rule, I replace them with matched 2% temp stable carbon film resistors.

R131 should be cleaned with a control cleaner/lubricant. CRC contact cleaner/lubricant in the green can is a good product and is available at Walmart.

CAREFUL HERE; Slowly rotate C164 three turns. This action will either clean it or destroy it. In either case, you have found the problem. I always save this one for last.

6 DATA SHEETS

6-1. VFO FREQUENCY CORRECTION

BLACK DIAL	SPEC MHz	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 6
0	4.8519						
100	4.7519						
200	4.6519						
300	4.5519						
400	4.4519						
500	4.3519						

6-2. RECEIVER PERFORMANCE:

Sensitivity

The receiver will produce 500 mw audio out with 1.5 uv RF signal at the antenna terminal on the 80 and 40 meter bands. All other bands will produce 500 mw with 1.0 uv or less

BAND	**TEST FREQ**	**SIG REQ FOR 500mw**
80		
40		
20		
15		
*10 opt 1		
10 std		
*10 opt 2		
*10 opt 3		

* Tests performed only if options are installed

(S+N:N)

A 1.0uv signal at the antenna terminal will produce a minimum 20db s+n:n. Factory procedure states ref. level is set with 1.0uv at the antenna, signal source is then disconnected and replaced by a 50-ohm resistive load. The resulting reduction in audio output will be 20db or greater.

BAND	**TEST FREQ**	**SIGNAL LEVEL**	**S+N:N MEASURED**
80			
40			
20			
15			
*10 opt 1			
10 std			
*10 opt 2			
*10 opt 3			

AGC Figure of merit

With a change of 5uv to 1500uv input at the antenna terminal no more than a 10 dB variation in the audio output shall occur.

MEASURED CHANGE	dB

"S" METER CAL

The S meter will read S-9 when between 25 and 100uv are injected at the antenna terminal.

SIGNAL FOR S9	uv

6-3. TRANSMITTER PERFORMANCE:

Tests performed with 50ohm resistive load. Measurements made with BIRD avg power and PEP power meter.
Hi voltage __vdc B+ __vdc Bias -__vdc

Final amplifier bias set to 70 ma SSB mode zero drive. _____

Neutralization performed @ 21.3 MHZ. _____

Carrier balance null (> 50db) _____ dB below full power output level.

Microphone input sensitivity at 1000 Hz. A signal level not more than 4mv RMS shall produce the minimum specified SSB output at specified freq. Mic gain set just below saturation.

THE "ADVERTISED" INPUT POWER IN SSB MODE IS 150 WATTS.
Flat-topping occurred at __% of mic gain rotation.

FREQ	**MIN SPEC**	**PEP @ 4mv**
3.8 MHz	75 W min	
7.3 MHz	75 W min	
14.3 MHz	70 W min	
21.3 MHz	60 W min	
28.8 MHz	50 W min	

THE "ADVERTISED" INPUT POWER IN CW MODE IS 125 WATTS.
CW power output with RF level set just to saturation level.

FREQ	**MIN SPEC**	**AVG POWER**
3.8 MHz	75 W min	
7.3 MHz	70 W min	
14.3 MHz	70 W min	
21.3 MHz	60 W min	
28.8 MHz	50 W min	

SSB TX AUDIO RESPONSE:
From 600 Hz thru 2700 Hz no more than 3 dB change in output power. _____dB
If multiple peaks occur within the pass band there will be no more than 2db from the peak to valley between. _____dB
VOX GAIN: Set for key at ____ millivolts.
VOX DELAY: Set for ____ second hold.
QT set for no key with receiver audio output at 1.5 watts and below _____.

hallicrafters

7. PERFORMANCE SPECIFICATIONS

MODEL: SR-150
LATEST REVISION: 3 OCT 62
Code ident # 26916
Specification # 093-801691

I. GENERAL

A. Power Requirements

Model PS-150-120 AC Power Supply operated from 117V 60 cps AC for all measurements. The SR-150 must function between 105v and 125v AC line input.

B. All tests marked with double asterisk (**) are for type test purposes only.

C. Using the PS-150-12 power supply the SR-150 must function between 11.5v and 16.0v DC

II. RECEIVER PERFORMANCE

A. Unless otherwise specified control settings shall apply as follows:

1. RF and AF gain set at maximum.

2. RIT at off.

3. Operation control at STANDBY.

4. Function switch at LSB.

5. Band selector as required.

6. Preselector tuned for max. audio output.

7. Transmitter RF level and AF level (mic. Gain) set at minimum.

8. FINAL TUNING control optional for receiver tests.

9. Off/Cal switch at off.

10. ANTENNA switch in separate position (use REC. ONLY input)

B. Standard audio output 500 milliwatts into 3.2-ohm load.

C. Antenna input impedance - 50 ohms (nominal). Audio output impedance 3.2 and 500 ohms.

D. Measurements made with Hewlett-Packard Model HP-606A

E. Test signal – unmodulated CW signal.

F. Frequency Data (1st I.F. = 6.0 to 6.5mc, 2nd I.F. = 1650 for all bands)

Band	Tuning Range
3.5 MC	3.5 - 4.0 MC
7.0 MC	7.0 - 7.5 MC
14.0 MC	14.0 - 14.5 MC
21.0 MC	21.0 - 21.5 MC
28.0 MC	28.0 - 28.5 MC
28.5 MC	28.5 - 29.0 MC
29.0 MC	29.0 - 29.5 MC
29.5 MC	29.5 - 30.0 MC

G. Overall Sensitivity Limits (gain check)

1. A 1.5 microvolt signal on the 3.5 and 7.0 mc bands shall produce 500mw audio output. A 1.0 microvolt signal shall produce 500 mw audio output on all other bands. (Adjust signal generator frequency for maximum recovered audio output.)

2. The gain variation on all bands except the 7.0 mc band shall not exceed 3 db. The gain variation on the 7.0 mc band shall not exceed 6 db. (Measure input variation for constant output).

H. Overall Sensitivity Limits (20 dB S/N)

A 1.0 microvolt unmodulated signal shall produce an audio output signal at least 20 dB above the internal noise level of the receiver as the receiver is tuned through the signal. (Check at least one spot on each band.)

I. The change in sensitivity between upper and lower sideband reception shall not exceed 2 dB audio output. (1 microvolt signal input and AF GAIN adjusted for 100mw.)

**J. Image and Spurious Responses

All frequencies other than the fundamental shall be down at least 55 dB on all bands (except I.F. rejection).

K. 1st I.F. Rejection Ratio (6.0 to 6.5 mc)

Band	Minimum Rejection
3.5 mc	50 dB (300 X)
7.0 mc	40 dB (100 X)
14.0 mc	66 dB (2000 X)
All other bands	70 dB (3000 X)

**L. Tweets

All "tweets" or "birdies" Within the amateur bands shall be less than 0.5 microvolt equivalent CW Signal.

M. AGC Figure of Merit Limit

1. Receiver tuned to 14.3 mc for the check.

2. Set signal generator for 5 microvolts unmodulated and tune for maximum audio output. Set receiver audio gain for 50 mw audio output.

3. Increasing signal input level 50db shall not increase audio output more than 10 db.

N. "S" Meter Calibration Limits

1. "S" meter shall be zero set before checking.

2. Receiver tuned to 14.3 mc for the check.

3. A meter reading of S-9 shall be obtained with a signal generator level between 25 and 100 microvolts.

0. Calibration Adj. Limits (RIT control at OFF)

1. The total range of each control shall be at least 3 KC.

2. Clockwise rotation shall increase frequency.

P. Dial Calibration (LSB)

1. The error between adjacent 100 KC check points shall not exceed 1.0 KC

2. With the dial calibration set to zero at the high frequency end of the dial, the error at any point shall not exceed + or - 3.0 KC.

3. Band to band calibration error shall not exceed + or – 2 KC.

Q. RIT Control (RIT control at on)

1. The RIT control shall affect receiver frequency only. Clockwise rotation shall increase receiver frequency.

2. The RIT control frequency range shall be + or – 3 kc minimum.

**R. Overall Frequency Drift Limits (Lower Sideband Reception)

1. After a 15-minute warm-up, the total drift during the first hour shall not exceed 500 cps.

2. During the next 4 hours the frequency drift shall not exceed 200cps.

S. Audio Performance

1. The hum level shall be less than 2.5 microwatts with the AF GAIN control set a minimum. (Measure at 3.2-ohm terminals.)

2. Audio distortion shall not exceed 10% at one-watt output. Receiver shall be tuned to xtal marker at 3800 kc and a 1000 cps beat note generated for the test.

T. Sideband Switching Frequency Error Limits.

1. The test shall be performed at 14.3 mc.
2. The VFO sideband corrector capacitor shall be set for no more than 15 cps change in carrier frequency between sidebands.

U. Mechanical Stability

There shall be no evidence of instability or microphonics under any condition of normal use.

III. TRANSMITTER PERFORMANCE

A. Unless otherwise specified control settings shall apply as follows:

1. Receiver RF and AF gain no requirements.
2. RIT switch at off.
3. Operation switch at manual.
4. Function switch at LSB.
5. Band selector as required.
6. Preselector adjusted for maximum drive.
7. RF level and mic gain as specified.
8. FINAL TUNING as required.
9. Calibrator switch at off.
10. ANTENNA switch position optional.

B. RF Output Impedance and Metering

50 ohm, non-reactive to 30 mc (Bird Wattmeter load or equal) and peak reading voltmeter calibrated in RMS volts (HP Model HP-410B or equal).

C. Final Amplifier Bias

The bias adjustment shall be set for zero signal, final amplifier plate current of 70 milliamps, (controls set for manual/SSB operation).

D. Neutralization and Stability Check

1. Neutralization shall be adjusted so that final amplifier plate current dip and maximum power output coincide on the 21 mc band.

2. The transmitter shall show no self-oscillation tendencies at any in band PRESELECTOR and FINAL TUNING control settings on any band with output load removed.

-150

E. Carrier Balance Limits

1. Carrier balance adjustment shall be capable of at least -50 dB below maximum output level on either sideband on any band.

**2. Carrier level shall not exceed -40 dB below maximum output level for one hour after a 15-minute warm-up from start with equipment at room temperature (25°C). Line voltage shall be held constant at 117v during the test.

**3. Carrier level shall not exceed -46 dB below maximum output level when the supply voltage is changed from 105v to 125v AC. (Balanced at 117v line).

F. Microphone Input Sensitivity

1. TEST FREQUENCY – 1000 cps

2. SSB operation, MIC GAIN control at maximum.

3. An audio level more than 4 mv or less than 1 mv shall be required to produce the minimum specified SSB output in the phone portion of any band.

G. RF Power Output Limits (SSB operation)

1. Two tone input approximately 1000 cps and 2000 cps. Each signal level 4 mv. MIC GAIN control adjusted for required level.

2. Output Limits (peak Envelope Power for a Minimum of -28 dB 3rd and 5th order distortion products.)

3.8 mc - - - - 75 W min.
7.3 mc - - - - 75 W min
14.3 mc - - - - 70 W min
21.3 mc - - - - 60 W min
28.8 mc - - - - 50 W min

3. Unwanted Sideband level shall be 50 dB or more below PEP output (600 cps to 3000 cps).

H. RF Power Output Limits (CW operation)

1. The keying envelope shall be smooth with no sharp peaks in leading edge or trailing edge transients.

2. With the RF LEVEL control set at minimum, there shall be no more than 2 watts output on any band.

3. Output Limits

3.5 mc - - - - 75 W min
7.0 mc - - - - 70 W min
14.0 mc - - - - 70 W min
21.0 mc - - - - 60 W min
28.0 mc - - - - 50 W min

I. Overall Audio Frequency Response (SSB)

1. Audio input a required. MIC GAIN control set at maximum.

2. 0 dB (reference) 1000 cps 50 volts RMS RF output.

3. Response Limits (either sideband).

-3 dB limit at 400 to 600 cps. With 100 cps max difference between usb and lsb.
-3 dB limit at 2700cps to 3200 cps
Pass band peak to valley ratio shall be less than 2 db.

J. VOX Sensitivity Limits

1. Audio input - 1000 cps

2. With VOX sensitivity at maximum and the delay control set ¼ turn from minimum delay, no more than 5 mv RMS shall be required to close the vox relay.

K. Anti-Trip Sensitivity Limits

1. Receiver adjusted to provide 250 mw 1000 cps audio output for the test.

2. The VOX sensitivity shall be reduced to 250 mv RMS to close the VOX relay or block the relay operation completely.

 L.

Operation of VOX Delay Control.

VOX relay delay shall increase with clockwise rotation of the DELAY control set at approximately ½ rotation.

M. Output Level Meter Check

1. Test at 50 watts output on any band.

2. The S meter shall indicate no less than S-8 or more than 50 dB over S-9

N. Automatic Audio Level Control Check

1. Test Conditions

SSB operation with two tone (1000 cps and 2000 cps) input level as required to produce slight flat topping of oscilloscope display.

2. Removal of AALC tube V5 (6EA8) shall produce measurable increase in envelope flat topping or excessive flat topping indicating AALC operation. **O.** Spurious Output

1. The transmitter shall be tuned and operated in SSB mode at 7 mc. Two tone input level shall be adjusted for slight flat topping to produce PEP output signal.

2. Disable the heterodyne oscillator tube (V8, 12ST7) and measure the 6.5 mc spurious signal present. (Do not remove the oscillator tube to disable.) Residual 6.5 mc spurious signal shall be 46 dB or more below PEP output.

**3. All other spurious signals shall be 50 dB or more below PEP output, except harmonics which shall be down 36 dB or more.

P. Controls and Outlets

All controls and outlets shall be tested for proper operational functions.

Q. Crystal Calibrator

The 100kc crystal oscillator shall be set to zero beat with WWV or equal frequency standard. The trimmer range shall be sufficient to permit setting the frequency to exactly zero beat.

R. The transceiver is to be supplied with the heterodyne oscillator crystal for the 28.5 mc ten-meter band segment only. The units shall be tested for proper operation on the 28 mc, 29 mc and 29.5 mc segments.

IV. MECHANICAL INSPECTION

A. On all panel control knobs the maximum play measured both in a direction perpendicular to the panel and parallel to the panel shall not exceed 1/32 inch.

B. All controls shall operate smoothly, without binding, throughout their range of adjustment.

C. All rotary switches shall have positive detent action.

D. There shall be no perceptible wobble or vertical movement in the tuning dial when viewed through the dial window.

E. Dial and meter lighting shall be uniform, without bright or dark spots.

F. There shall be no indication of backlash in the VFO tuning mechanism.

G. VFO Assembly

Two bushings (077-002851) are to be hand reamed, after staking, to 0.2945 I.D.

H. Front Panel

The holes for the FINAL TUNING and PRESELECTOR shafts are to be hand reamed to 0.587 min. I.D.

I. All cores in RF coils are to be lubricated and locked after final adjustment using a wax bearing Hallicrafters part number 034-000422 (Biwax #7022 manufactured by Biwax Corporation, Skokie, Illinois.)

V. LUBRICATION

A. VFO Assembly

1. Light oil (3 in 1 type)
- **a.** Four nyliners, 077-202301, located in bushings 077-002851.
- **b.** Two nyliners, 077-202301, located in pinion of dial disc, 026-001087.

2. Grease (093-000542)
- **a.** Spur gear, 026-001088 and 026-00089
- **b.** Gear Bushings 077-002850
- **c.** Gear pinion 026-001087

B. Chassis Assembly

1. Grease (093-000542)

a. Rear end of preselector outer shaft, 074-002791-02, and preselector inner shaft, 074-002756-03

b. Shaft, outer final tune, 074-002756-02

c. Handle knob, 030-000793, and screw machine, 003-007550

Credits and Disclaimer for test spec:
Thanks goes to Jim, K9AXN for providing me with the copy of the copy of the original document. The copy was not clear enough to reproduce so I transcribed the document. When I transcribed this document, I did not try to correct any English, punctuation or spelling. Neither did I update the mnemonics such as CPS to Hz. It is as it WAS. I hope you find it useful, 73's Walt WD*0*GOF

8, RIG CLEANING

8-1. CHASSIS CLEANING

Step 1: I have found all forms of foreign matter in rigs emerging from long term storage. My favorite of cleaning method is the bathtub, Scrubbing Bubbles bathroom cleaner, and the shower hand wand. I set the rig in the tub, back side down, front panel up. With the rig leaning against the side of the tub I spray it full of Scrubbing Bubbles and let it set 3 to 5 minutes. Then I spray it full again and after 5 minutes I rinse it using the shower hand wand. I do this on the top and bottom side of the chassis. I keep the Scrubbing Bubbles away from the front panel, dials and meters, just use common sense. All the brown residue, smoke odor and filth literally run down the drain. Very seldom is any scrubbing needed, if it is I do it with a ¾" wide paint brush with half the length of the bristles cut off. I rinse it a second time then it sets in front of a fan for a day. See following photos.

Step 2: Now that it is squeaky clean the potentiometers need the application of a suitable control cleaner/lubricant.

Step 3: Some mechanical drive trains to tuning devices require special lube so don't forget them.

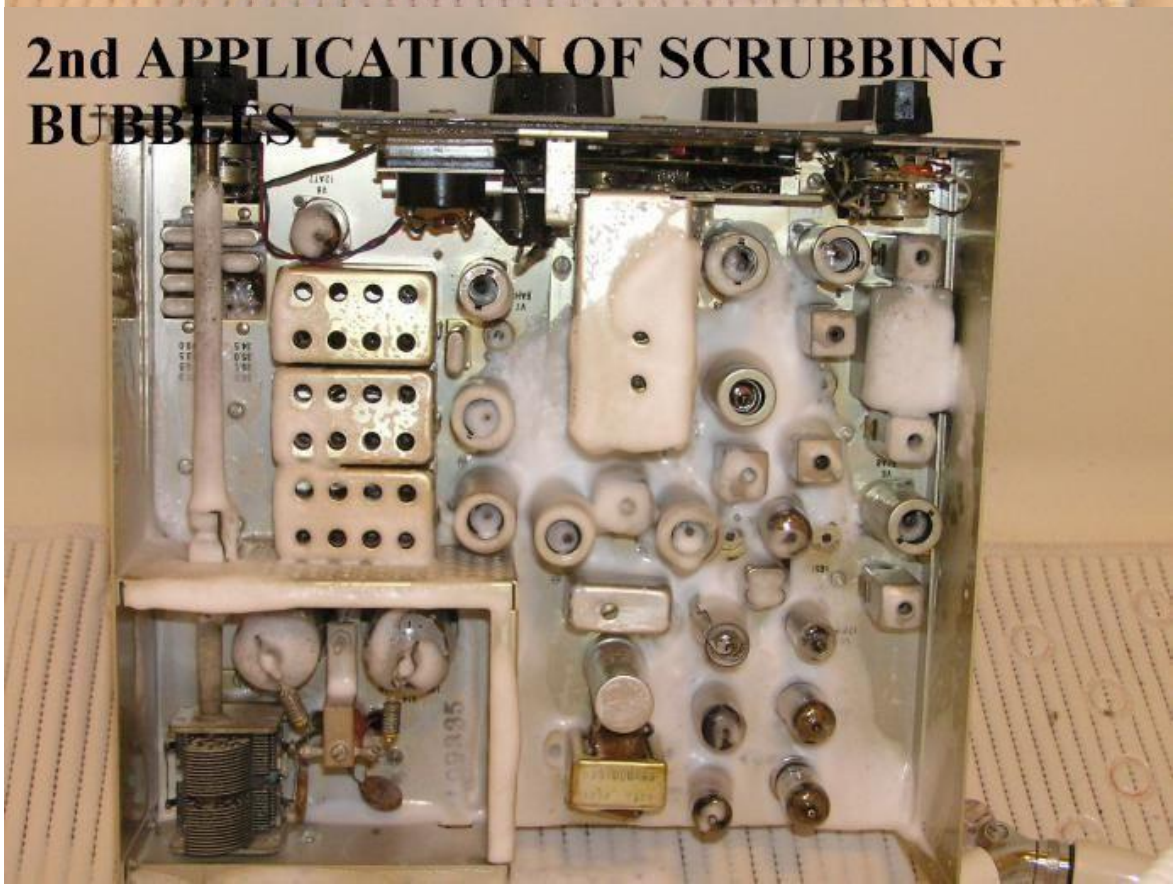
Step 4: The relays are next. I use thin strips of card paper, about 3" long and 3/16" wide. Place a drop of DeOxit on the paper and slide it back and forth between the contacts. Manually energize the relay and clean the normally open contacts as well. A pair of hemostats simplifies this step. NEVER USE SANDPAPER.

Step 5: Now for the controversy, The Wafer Switches! Every three months or so on one of the ham forums a wafer switch cleaning war breaks out. No minds are changed, no territory is conquered. Hostilities subside only to be resurrected a few months later when the "new be" asks How do I clean my wafers. There are at least 3 regulars out there that vehemently oppose my method and that is ok. It works for me and to date I have not suffered any loss due to it. First, I take a cotton swab and cut a little cotton off the tip. I spray a little DeOxit in a small glass bowl. I dip the swab in the DeOxit and clean the switch. Pretty simple and no over spray. I ***NEVER*** spray DeOxit into a rig.

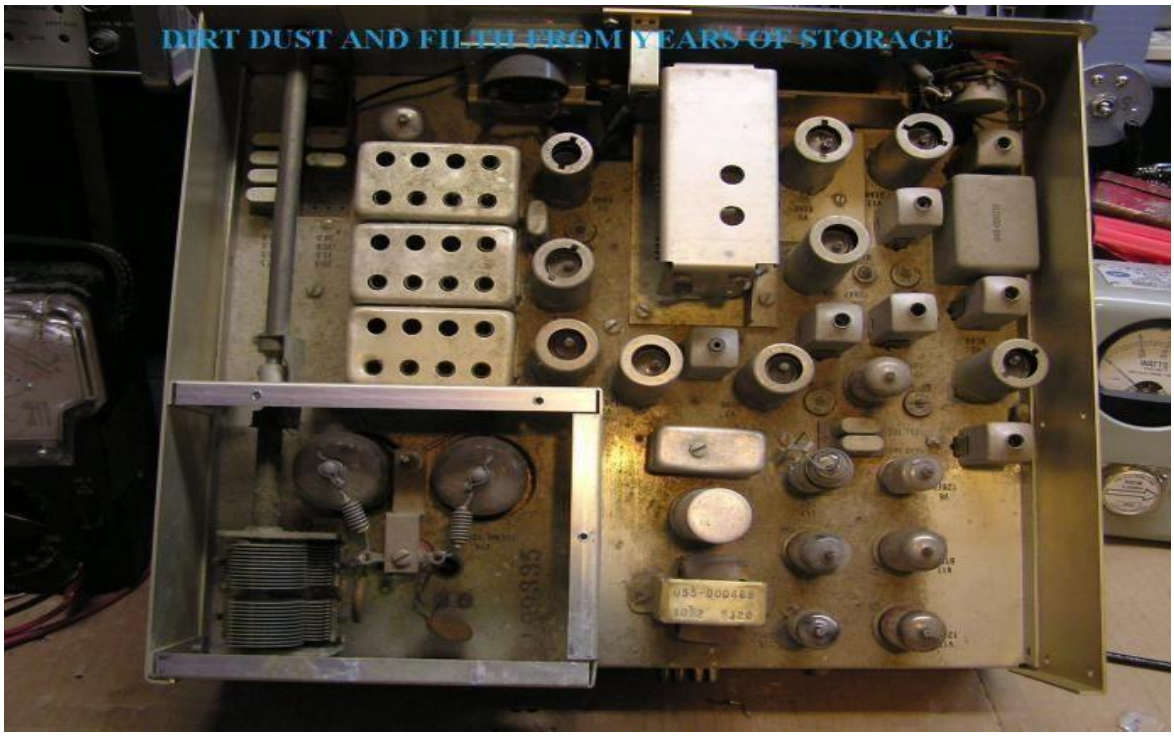
Step 6: Now to clean the tube sockets. Somewhere around the tooth brushes at your local store you will find very small round brushes used to clean between teeth. There are usually 10 or 20 to a package. Once again, I use DeOxit in the glass bowl. Dip the brush, insert the brush, spin the brush, repeat 150 times or so and you're done. See following photos.
CHASSIS CLEANING CONTINUED

You can see that as the bubbles run down the chassis it is clean and shiny


FIRST APPLICATION OF SCRUBBING
BUBBLES BATHROOM CLEANER


2nd APPLICATION OF SCRUBBING
BUBBLES

BEFORE CLEANING



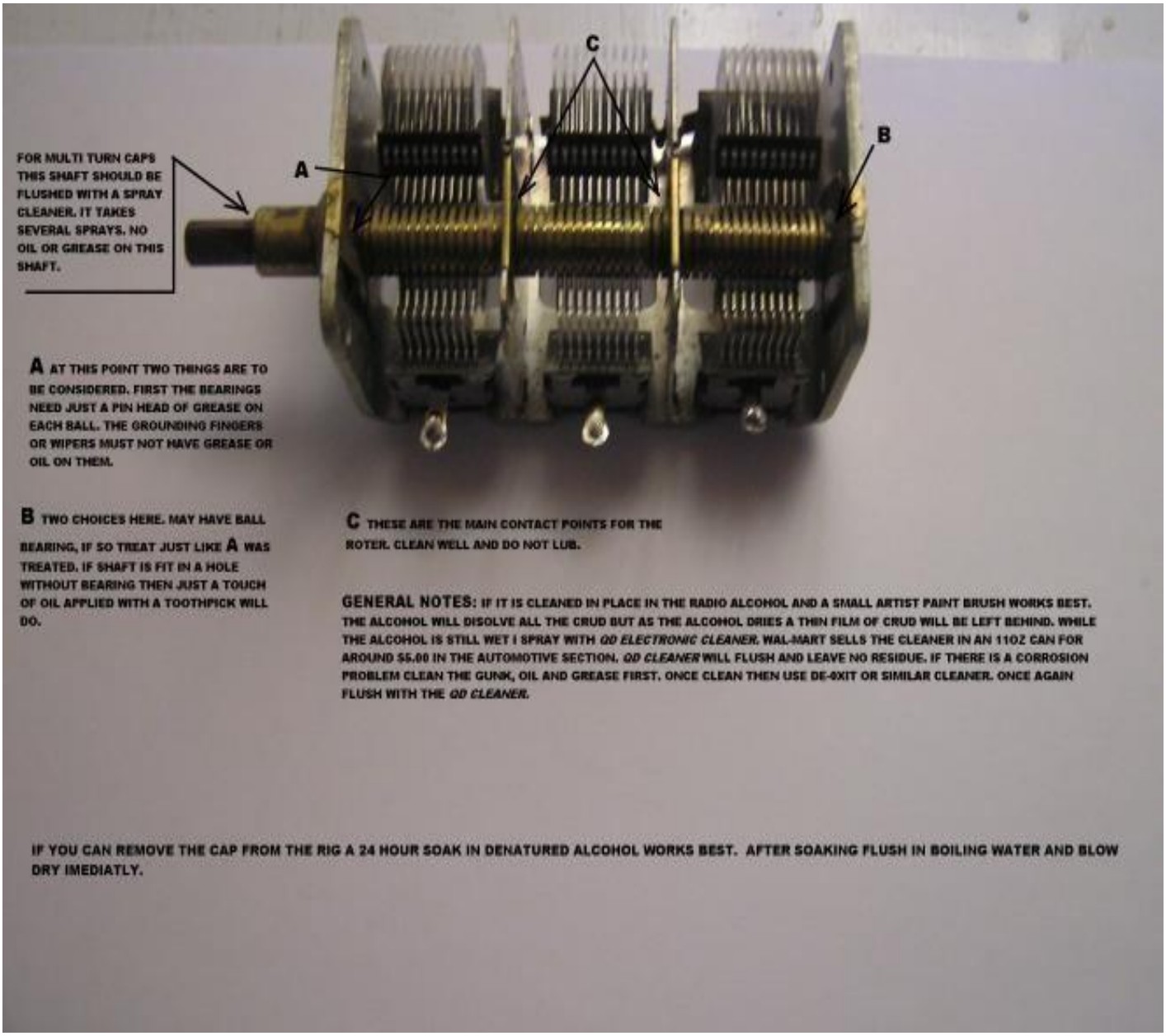
CLEAN CHASSIS



8-2. TUBE SOCKET CLEANING KIT



8-3. AIR VARIABLE CLEANING



Notes:

Notes:

Notes: