Heathkit HW-101 and SB-10x Restoration and Troubleshooting

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Revision History

2021/1/9: Added modification section regarding use of an external VFO to provide split frequency operation (within the same band).

2021/1/9: Significant cleanup work on MS Word’s handling of list numbering

2021/1/8: Added instructions for confirming bandpass filter response using sweep generator and a couple of photos of one radio’s response for reference.

2021/01/01: Added Transmit RF Signal level measurements.

2021/01/01: Added additional information to the section on the 8395 KHz to 8895 KHz bandpass filter.

2020/12/31: Added new section regarding uneven drive across the 500 KHz band and the Bandpass filter (this is still a work in progress).

Contents:

Tables:

a) History of the HW-101

By K8GNZ (8/2003)

The Heathkit HW-101 evolved out of several prior Heathkit models, namely the SB-100, SB-101, SB-102, and the HW-100. To understand the history of the HW-101, one needs to know a little about the history of these prior models and of the Heath Company in general.

The Heath Company: The Heath Company was involved in building test equipment and other devices prior to its entry into the amateur radio market. It was the entry and success of Heath in the amateur radio market that made the Heath Company very successful. After the onslaught of already-built off-shore equipment, the Heath Company's amateur business dried up and is no longer a portion of what is left of the Heath Company. The heyday for Heath was from the late 50's to the early 80's. At that time, more hams used Heath equipment than any other brand and, needless to say, since it was mostly self-constructed, Heath was instrumental in planting the technology interest seed in many future engineers and technicians.

The AT-1 transmitter of the early 50's was the first Heathkit amateur product. (I had one back then, although I didn't build it). It was followed by the hugely successful DX-100 transmitter, all 100 pounds of it! It was a plate-modulated AM/CW rig that used a pair of 6146 tube finals, just like the HW-101. Heath expanded the DX series in the late 50's with the DX-20 CW transmitter, the DX-35 CW and screen-modulated phone transmitter, and some others. (The DX-35 was the first Heathkit I built. It worked the first time I plugged it in - lucky me). Heath had many other successful amateur rigs and equipment in the late 50's and early 60's. Then, in the mid 60's, Heath came out with the SB-100.

<u>The SB-100:</u> The Heathkit SB-100 was their first attempt at a "poor man's Collins" transceiver, as it was called by the amateurs. The SB-100 looked a good bit like the Collins KWM-2 transceiver, and the circuitry had many basic similarities. Collins was, in case you don't know, regarded then (and perhaps still now) as the Cadillac of amateur radio equipment brands. It was very good, and it was very expensive! Heath wanted to compete against Collins, and the SB-100 was a good competitor since it could perform about as well as a Collins (if built correctly) at a fraction of the price.

<u>The SB-101 and SB-102:</u> These models were improvements over the SB-100, and included a 400 Hz CW filter selectable from the front panel, as well as other improvements. They were produced from the late 60's to mid 70's.

The HW-100: The Heathkit HW-100 was an attempt, and a very good one, to reduce the cost of the SB series transceivers. The circuitry and specifications were very similar, but some shortcuts were taken to reduce the cost. These were mainly in the cabinet, the VFO, and the lack of a CW filter. It was produced concurrently with some of the more expensive SB series equipment, being introduced in the late 60's. It was very successful, due in large part to it's low price and great operating capabilities.

The HW-101: Our hero, the HW-101, came along around the early 70's and stayed in production for 12 or 13 years! While production numbers are vague, it is estimated that 35,000 to 40,000 were produced by Heathkit during those years. It is still regarded as a very capable rig and has earned it's place in Heathkit and amateur radio history as the most popular radio by numbers sold, at least for tube radios. It was an improvement over the HW-100 by offering a CW filter as an option, and by using a better VFO and main tuning drive design. It also had better receive sensitivity than the HW-100. The HW-101 was so good that it was produced and sold for almost 13 years with very few changes or improvements. It sold, in kit form, for $399.95 in the fall 1980 Heathkit catalog, with the optional CW filter adding another $44.95. Heathkit ran specials over it's production life and, consequently, the HW-101 could be purchased at times for less. It has gone down in amateur radio history as one of the most beloved, respected, and successful transceivers in history.

a.1. The SB-series and HW-series (Wikipedia)

By the early 1960s, a large majority of amateurs had adopted SSB as their primary mode of voice communication on the HF bands. This led to the development of equipment that was specifically designed for transceiver operation on SSB, and also much smaller and lighter than the previous generation of ham gear.

As with other manufacturers, such as Drake and Collins, Heathkit began in 1964 by introducing a transceiver. It covered only one band and came in three models: The HW-12, -22, and -32, covering the 20m (14 MHz), 40m (7 MHz) and 75m (3.8 MHz) bands, respectively.

Influenced heavily by the *S/Line* from Collins, Heathkit designed the SB-series to become their top-line set of amateur radio equipment. Like the *S/Line*, these new products were designed to operate together in various combinations as a system. The first models appeared in the 1965 catalog, displacing the large, heavy units of the *tribes* generation (except for the Marauder and Warrior, and the 6 meter units which remained for one year).

When used together, the SB-300 receiver and SB-400 transmitter could transceive and had many other features of the *S/Line*, including crystal bandwidth filters and 1 kHz tuning dial resolution. The *S/Line* influence was easy to *see* too, in its cabinet styling, tuning mechanism and knobs. But by designing them as kits and using less expensive construction, Heathkit could offer these units at much lower prices. The pair sold for $590 that first year (equivalent to about $4100 today). The matching SB-200 linear amplifier completed the line for 1965.

The following year, two more units were added: the SB-110 transceiver for the 6 meter band, and the HA-14 “KW Compact”, a linear amplifier based on the SB-200 but with an external DC power supply, making it very small and usable in mobile service.

In a last minute, four page center insert to the 1966 catalog titled “New Product News” Heathkit announced the SB-100 five-band SSB transceiver.

Like the other transceivers of this time, the SB-100 (and later improved models SB-101 and SB-102) would become one of Heathkit’s best selling amateur radio products. This included a scaled-back, lower priced version of the SB-100 called the HW-100 (later the HW-101) introduced in 1969.

In the next three years Heathkit brought out several more SB-series accessories, including a kilowatt linear amplifier, the SB-220. The final model in the original SB-series was the SB-303 receiver, a solid state replacement for the SB-301.

The SB-series would continue to be improved and sell well until 1974 and the arrival of solid state and digital design, with the SB-104 transceiver, its accessories and a new generation of amateur radio gear. Though somewhat redesigned physically it had a similar appearance to the earlier SB-series generation.

a.2. Comparison of Various Models

a.3. SB Series vs HW series

The HW series can be thought of as a cost-reduced version of the SB series and they share a number of components and design elements.

The most noticeable differences between the two series is the difference in cabinets, front panels, and VFOs (LMOs).

The HW series uses a two part cabinet consisting of top and bottom pieces held together with a series of screws. The SB series uses a one-part cabinet with a hinged lid that permits access to the tubes and various controls, such as the VOX control, PA

Bias setting, and S Meter zero adjustment. On the HW series, these controls are accessed through openings in the right side lower cabinet.

The HW series uses a builder assembled VFO with a circular dial and frequency calibrations every 5 KHz. The dial reduction drive consists of two Jackson venier drives. The SB series used a preassembled LMO with a circular dial having calibration marks every 1 KHz. The dial reduction consists of a pinch pulley that engages a metal ring on the inner surface of the circular dial.

The HW series uses slide switches for the PTT, VOX, CAL function and metering selection. There is no provision for metering grid current or the High Voltage in the HW series, and of course the switch for frequency control using an auxiliary crystal or LMO is not present.

The HW series does not provide a CW sidetone volume adjustment nor an adjustment for the relative power meter reading. The HW series does not support the AUX XTAL control or external VFO control and components and wiring associated with these functions are not present on the associated circuit boards (although in most cases, the printed circuit traces and associated mounting holes are present).

a.3.1. RF Amp and 1st Receiver Mixer

The SB-100 and SB-101 do not use the 6HS6 tubes in the receiver's RF amplifier, V10, and receiver first mixer, V11 but rather uses 6AU6s in both stages.

The SB-102 uses the 6HS6 but ONLY in the receiver's RF amplifier, V10.

Like the SB-100 and SB-101, the HW-100 does not use 6HS6 tubes in the receiver's RF amplifier (V10) and receiver first mixer (V11) but rather 6AU6s in both stages.

The HW-101, however, used 6HS6 tubes in the receiver's RF amplifier (V10) and receiver's first mixer (V11).

At any rate, if the 6HS6 tube fails, the 6AU6 can be directly substituted without any changes in circuitry.

The circuit design the 6HS6 tubes were used in operated the 6HS6 tube at or, in some cases, exceeding the tubes ratings. This is one reason quite a number of the 6HS6 tubes failed sooner than they should. There were other tube problems that also contributed to early tube failures such as some 6AU6 EL-MENCO tubes had 4 volt filaments instead of 6 volt filaments.

I found that both V10 and V11 (receiver RF amp and receiver first mixer) would fail, short internally. The symptom was complete loss of sensitivity, no signal received, and, in many cases the shorted tube resulted in a very strong 20 over 9 meter indication "static" signal that occurred with or without the antenna attached. Replacing the defective tube(s) eliminated the problem. I experienced this problem in one of my HW-101s. Turned out both V10 and V11 were both shorted internally.

The price of a 6HS6 is a bit steep, $18 (www.vacuumtubes.net price), higher (www.vacuumtubes.net price). Both tubes are available, depends on which outlet you use and whether you are willing to pay $18+ for one tube. I personally use 6AU6s but you may think differently.

a.3.2. SB-101/SB-102 LMO Power Source

Power sources for the SB-101 and SB-102 LMO's are entirely different.

The SB-101 LMO power source is regulated 150VDC from the 300VDC source on pin 3 of the 11 pin power socket.

The SB-102 LMO power source is also regulated, "+10VDC", and the power source is from the filament supply through a #1815 dial lamp, 56 ohm resistor, zener diode (D907) and a 2N3567 transistor used as a regulator.

The wiring to the FREQ CONTROL switch is a bit different as well.

a.3.3. Sideband Bias Circuit

The sideband bias circuit is similar but different between the SB-101 and SB-102. There are series resistors with the bias voltage source in the SB-102 that are not in the SB-101.

Personally, I would not even consider using an SB-102 LMO in an SB-101. Messing around with swapping LMO's could result in instability that you didn't have before.

a.3.4. Accessory Socket

The SB-102 has a rectangular socket at the rear the permit connection of a two-meter transverter. This is not present on the SB-100 or SB-101.

There is also an accessory socket on the HW-101, but not on the HW-100

a.3.5. CW Filter

The SB-100 and HW-100 do not have the hardware and switching mechanism for the CW filter. It looks like this could be added by using parts from a junked HW-101, but I have not verified this.

a.3.6. SB-102 vs. HW-101

What's the difference between an HW-101 and an SB-102? Well, first off, the obvious is the physical appearance (front panel and both top and bottom covers).

The HW-101 can only be used with the internal LMO where the SB-102 can use both internal and external LMOs by the flick of a front panel switch. There are differences between the SB-100 and SB-101 LMOs themselves and the power source wiring when compared to the SB-102 LMO and the power source and wiring for the SB-102 LMO.

The HW-101 cannot be operated crystal control where the SB-100/101/102 can. There is a single crystal socket in the SB-100, SB-101, and SB-102 bandpass board that accepts a single crystal in the frequency range of the LMO (5.000Mhz to 5.500Mhz) that allows for crystal control receive and/or transmit depending on the front panel's FREQ CONTROL setting.

The LMO tuning assembly is entirely different in the HW-101 and the SB-100, 101, and 102. The SB-100/101/102 dials, tuning assembly, and escutcheons cannot be interchanged with the HW-101 and vice verse. However, the dial assembly in the SB-100 can be directly interchanged with the SB-102 and vice verse. The SB line of dial assemblies in the SB line of transmitters, transceivers, and receivers were all the same.

The LMOs are different between the SB-102 and the HW-101. The LMO in the HW-101 is built buy the kit builder where the LMO in the SB-100 and SB-101 were built by TRW. TRW did not build the LMO for the SB-102. The LMO in the SB-102 is the same LMO as in the SB-303 ham band only receiver and the SB-313 SWL band receiver. The solid state LMO is rather accurate at the 100Khz dial settings but not so between 100Khz dial settings.

The SB-102 has a headphone volume control that the HW-101 does not have. The SB-100 has a "600 ohm" output socket on the rear where the SB-101 does not. The only difference between the 2 is the 600 ohm socket on the rear. The rest of the circuit's the same.

The SB-102 has a CW sidetone volume control on the right rear audio board the HW-101 does not have. You can modify the HW-101 to have this feature as the audio boards in all of the HW-100, HW-101, and SB-100, 101, and 102, are the same. Simply duplicate the circuit in the HW-101 from the SB-100, 101, and 102 schematic.

There are numerous other circuit changes/differences that can be seen by comparing the two schematics.

a.3.7. Power Supply

The SB-100, 101, and 102 along with the HW-100 and HW-101, have the same basic circuitry and require the same power supply, the HP-23/PS-23 series of power supplies.

b) General Inspection and Restoration Checklist

This section describes a general guide to beginning restoration.

<u>Strong Recommendation:</u> Use a power strip to turn all vintage equipment on and off rather than the built-in on-off switch. This will help preserve the life of these hard to find switches.

b.1. Initial Inspection and Cleaning

Create a repair log notebook. Record model and serial number (if present). If no serial number, add label to chassis to identify unit.

Initial inspection: note any damage, missing parts, modifications and overall condition

Remove cabinet, clean if required (soap and water, Krud Kutter, etc), set aside for repainting if necessary.

If necessary, remove knobs, front panel, meter dials and clean chassis

1. Vacuum the chassis while gently brushing with a soft brush to remove surface dust
2. Use moistened Q-Tips and/or moistened makeup removing pads to remove more stubborn dust or grit
3. For more aggressive cleaning, spray chassis with Scrubbing Bubbles and rinse with warm water). Be sure to set the chassis aside and allow it to dry thoroughly.

Clean front panel with warm soap and water. Do not use more aggressive cleaners as they may remove the lettering. If necessary, set aside for rescreening

Inspect chassis for obvious problems such as burned resistors, bulging capacitors (especially electrolytic). Replace as required. Note any modifications or unusual components

Note: *if resistor R701 (1K on the driver grid switch board) or R940 (100 ohm running between the switch boards) is burned or open, the tab on the bandswitch closest to the bottom shield cover may be touching the lug on the bandswitch causing a short. Bend the lug on the switch away down so it doesn't contact the cover plate. This problem can also manifest itself after the cover plate has been removed and reinstalled for any reason. Problems with either resistor will show up in the resistance measurements for the V6 and V7 plate values. (see Service Bulletin HW-101-37)*

Replace the following electrolytic capacitors:

4. 20uf @ 450v capacitor on the Audio board (C304 on SB series)
5. 20uf @ 450v capacitor on the Modulator board (C12 on SB series)

6. 10uf @ 50v capacitor on the Modulator board (C2 on SB series)
7. 10uf @ 50v capacitor on the Bandpass board (C212 on SB series)
8. SB-102 only: two 500uf @ 25v (C941 and C942 located on LMO assembly)

Tighten all screws on printed the circuit boards. Replace any missing screws.

Lube controls (pots and switches) with DeOxit Fader Lube or other similar product. Rotate controls through full travel several times to distribute lube.

Check tubes on tube checker. Replace any that are very weak or indicate shorts. If all tubes are removed be sure to label their position for reinstallation in the same positions.

While tubes and relays are out, clean each socket pin using a small dental brush moistened with DeOxit D5 or other contact cleaner. If a tube seems loose in a socket, or intermittent when wiggled, tighten the socket contacts by inserting a fine sewing needle between the phenolic and contact so the contact exerts more pressure on the tube pin.

Clean contact area on TX Mixer and Driver tube shields to insure good contact with grounding tab on the socket. Failure to have good contact (or no shields installed) is almost guaranteed to cause transmit instability issues.

Clean grounding clips on Driver shield (under chassis). Make sure clip screws are tight.

Clean or replace relays as required. To clean each relay, remove the cover and slip a piece of index card moistened with contact cleaner between the contacts several times. For the normally open contacts, it will be necessary to move the actuator to the activated position to exert a slight pressure between the relay contacts and moistened index card.

Lube shaft bushings with lightweight oil

Lube SSB/CW filter switch mechanism and ensure smooth operation.

Replace rubber belts on Preselector/Driver and Load controls

Check that the LMO has full travel (5 complete revolutions). Oil the follower pawls. If LMO operation is stiff, clean grease from capacitor and reapply new grease (note: this requires removal of the LMO).

Inspect and clean main dial using water only. If there are cracks in visible area, consider replacing the dial with spare. If cracks in non-visible area, apply superglue to cracks to prevent spreading (apply only on flat side of the dial, not on spiral side and not at all on the numbered area!!). Clean spiral groove and apply Silicon Lube to groove. Inspect spiral groove follower and repair or replace as required

Clean/polish the Preselector/Driver and Final Tune/Load control shafts, if needed. An easy way to do this is to remove the shafts and chuck them in a drill while using fine sandpaper to polish the shafts

If the meter was removed from the front panel, reinstall it before reinstalling the panel (it's easier to get to the lower mounting screws while the panel is out)

If the LMO dial was removed, reinstall it before replacing the front panel

Make sure the LMO tuning shaft and bushing positioned loosely on the metal ring of the circular dial before reinstalling the front panel.

Make sure the zero set shaft and pulley are installed on the zero set dial and positioned to line up with the hole in the escutcheon.

Reinstall the main dial escutcheon on the front panel

Reinstall the front panel and all knobs except for the large tuning knob.

Reconnect the meter leads

Adjust the LMO tuning shaft/pinch roller for proper operation of the circular dial and tighten the large nut on the shaft bushing. Install the large tuning knob on the LMO shaft.

b.2. Resistance and Voltage Checks

Note: Perform the visual inspection and resistance checks before applying power for the first time.

Perform resistance check and log (on spreadsheet) measured values. Note any that resistance values that are out of tolerance (+/- 20% or more) and replace as required.

> ***Note:*** *if resistor R701 (1K on the driver grid switch board) or R940 (100 ohm running between the switch boards) is burned or open, the tab on the bandswitch closest to the bottom shield cover may be touching the lug on the bandswitch causing a short. Bend the lug on the switch away down so it doesn't contact the cover plate. This problem can also manifest itself after the cover plate has been removed and reinstalled for any reason. Problems with either resistor will show up in the resistance measurements for the V6 and V7 plate values. (see Service Bulletin HW-101-37)*

Apply power gradually using a Variac controlled supply. Watch for any unusual behavior such as smoke or burnt smells.

Check that all pilot lights function and replace as required (pilot lights may be in series with tube filaments and burned out bulbs can upset the filament voltages).

With full voltages applied, check and log (on spreadsheet) measured voltages. Note any voltages that are out of tolerance.

Check the receive function on all bands using either the built-in calibrator, antenna, or signal generator. Note any issues or anomalies.

Measure the Heterodyne Oscillator level on all bands (looking for dead crystals or gross tuning issues).

Check that both USB and LSB oscillators function and log the level (note: the plate load resistors may have drifted higher in value reducing the oscillator output level)

b.3. Receiver Alignment

Refer to the section Receiver Alignment on *page 31* for the complete receiver alignment procedure.

With no antenna connected (or switched to a dummy load), adjust the “S” meter adjustment to read “S0”.

Observe “S” Meter behavior as radio warms up. “S” meter drift is a common problem. If excessive “S” meter drift is observed check the following items:

Resistors in metering circuit, especially the 22k (or 33k) in 1st IF screen circuit, 100k from 1st IF screen to “S” meter adjust pot. The 22k (or 33k) resistor should be a 2-watt resistor for stability.

Also check AGC voltage at RF Amp, 1st RX Mixer and 1st IF amp. A positive voltage at any of these points is probably indicative of a gassy tube or one with grid emission. It is also possible that there could be a leaky coupling cap to the grid, but this does not appear to be common.

b.4. Transmit Alignment

Refer to the section Transmitter Alignment on *page 34* for the complete transmitter alignment procedure.

Measure and record RF watts out on each band using dummy load/wattmeter.

Check CW keying and sidetone oscillator. Adjust sidetone volume to a comfortable level

2-Tone IMD measurement using spectrum analyzer (optional)

b.5. Meter Checks

Verify correct meter operation in all positions

“S” Meter

High Voltage

Grid Current

Plate Current

ALC

Relative Output

b.6. Final Checks (optional)

Measure and record receiver stage gains (see Signal Level Measurements on page 41).

Measure and record receiver sensitivity on each band (spec says better than 0.35uv for 10dB S+N)/N (see)

Measure and record input level required for “S9” meter reading on each band.

On air checkout

c) General Troubleshooting Tips

This section provides some general troubleshooting tips that may be helpful if a rig is not functioning properly.

Caution: Potentially lethal voltages are present in most vacuum tube radios. Exercise extreme caution when attempting to service this type of radio. Also, vacuum tubes become very hot during operation and can cause burns.

c.1. The Unit Appears Completely Dead

If the unit appears completely dead, it may indicate a lack of power. Check the following items:

Is the unit properly connected to an HP-23 Power Supply?

Is the HP-23 Power Supply plugged into a functioning wall outlet?

Is the Power switch on the HP-23 set to the 300v position? Earlier models of the HP-23 had a three-position toggle switch 250v – OFF – 300v. Later versions of the HP-23 eliminated this switch. It is easy for the switch to be accidently bumped to the OFF position.

Is the power switch on the radio turned on? Is the power switch defective (not uncommon)?

Are any of the pilot lights on? Any of the tube filaments glowing? Are the tubes themselves hot?

c.2. Does The Unit Receive?

Many of the circuits are used for both transmit and receive. If the rig receives correctly, a considerable portion of the circuitry can be eliminated as the cause of the problem. If the rig does not receive correctly, it is easier to troubleshoot the problem in receive mode versus transmit mode.

c.2.1. Unit Does Not Receive At All

Make sure that power is on and a speaker (or headphones) is connected. Using headphones while troubleshooting is NOT recommended due to the potential shock hazard.

Make sure that all of the tubes are fully seated. It is easy for tubes to become dislodged during shipping. Try gently wiggling each tube while power is on – if you hear static or a crackling sound, it probably indicates a bad connection between the tube base and socket. If a tube is not warm to the touch, it may indicate a bad tube.

With an antenna connected, there should be a noticeable increase in background noise (hiss or static) as the preselector control is tuned. With the frequency dial set to 200, the 3.5, 7.0 and 14.0 bands should peak with the preselector pointer at approximately the 12 o'clock position. The 21 and 28/29 frequency bands should peak with the pointer around the 2 o'clock position. Depending on band conditions, you should also be able to hear signals.

c.2.2. Unit Receives On Some Bands But Not Others

If the unit receives on some bands, but not others (particularly if not on one or more 10 meter bands) check that the heterodyne oscillator for that band is running.

It is possible that one or more sections of the bandswitch are dirty and not making connection. See if rocking the bandswitch from side to side has any effect.

It is possible that the driver grid or plate slug-tuned coil is bad for a specific band

c.3. Transmitter Troubleshooting

Perform the Transmit Tuning procedure described on page 27. If the Transmit tuning procedure does not work, here are some tips that might help.

Does the unit receive properly? If so, the Driver Grid and Plate tuned circuits, heterodyne and carrier oscillators and LMO, and IF circuits are working. Assuming the receiver is working, check that the following tubes are fully seated:

V5, the 1st Transmit mixer tube (6EA8)

The 6CB6 (2^{nd} Transmit mixer) and 6CL6 (Driver) tubes on the driver board (these are the ones with the shields)

d) Transmit Tuning and Operation

d.1. Initial Transmit Tune-Up

The steps of this procedure must be performed for all modes of operation.

Set the BAND switch and Main Tuning dial for the desired frequency.

Place the METER switch in the PLATE position.

Turn the MIC/CW LEVEL control fully counterclockwise.

With the RF load connected to the ANTENNA jack, set the MODE switch to TUNE. The meter should read 50 mA (at the • mark on the HW-101). If the meter needle indicates other than 50 mA, perform the BIAS adjustment.

CAUTION: Do not turn on full output power continuously for more than 30 seconds at one time, or the final amplifier tubes or power supply may be damaged. Each time full output power is turned off, allow the tubes to cool for at least a minute.

Set the METER switch to PLATE and adjust the LOAD lever to the three o'clock position.

Set the FINAL TUNE knob to the position corresponding to the band in use.

Turn the MIC/CW LEVEL control clockwise to obtain a small up-scale indication on the meter.

Adjust the PRESELECTOR for maximum PLATE current

Adjust the FINAL TUNE knob to “dip” the PLATE current

While doing these adjustments, you may turn the MIC/CW LEVEL control clockwise slightly if necessary to provide a measurable PLATE current

Perform the following step for the appropriate model.

SB Series: Set the METER switch to the GRID position. Turn the MIC/CW LEVEL control clockwise until the meter just barely begins to show GRID current.

HW Series: Slowly turn the MIC/CW LEVEL control clockwise until the meter reading no longer increases with knob rotation. Do not increase the MIC/CW LEVEL beyond this point.

Repeat the following two steps until the correct PLATE current is obtained

Adjust the FINAL TUNE knob to “dip” the PLATE current

Move the LOAD control clockwise to increase the amount of plate current at the “dip”. The meter needle should read approximately 40 on the scale (HW-101), or a plate current of 225-250 mA (SB series).

Important: Before you put the transmitter into operation for the first time, and any time you change the final amplifier tubes, make the following check: Tune the transmitter as outlined in the steps above. Then operate the METER switch between REL PWR and PLATE. The maximum power output (REL PWR) should occur at approximately the same point on the FINAL TUNE knob as the maximum dip in PLATE current. If it does not occur at the same point, DO NOT operate the transmitter until you have re-neutralized the unit as outlined (starting in the left column) in the manual.

Return the MIC/CW LEVEL control to its full counterclockwise position.

CAUTION: The Transceiver should be retuned if the frequency is changed by any great amount. Be sure to readjust the FINAL TUNE controls. It may also be necessary to re-peak the DRIVER PRESELECTOR control.

This completes the Initial Tune Up. Before placing the Transceiver in operation, complete either the following CW or Single Sideband adjustments.

d.2. Single Sideband Operation

Be sure steps 1 through 10 have been satisfactorily completed before proceeding with the following adjustments.

1. Set the MODE switch to either the USB or LSB position.
2. Connect a microphone to the MIC connector.
3. Set the METER switch to ALC (the meter needle may "rest" below zero in the Transmit mode).
4. Place the FUNCTION switch in the PTT position. (If your microphone does not have push·to-talk capabilities, make the VOX Adjustments and disregard PTT Adjustments).

d.2.1. PTT Adjustments

Actuate the transmitter and, while speaking into the microphone, turn the MIC/CW LEVEL control clockwise until the peak deflections register at about S3 on the meter. Keep the meter deflection below the S3 point on voice peaks for the most linear output.

d.2.2. VOX Adjustments

Turn the MIC/CW LEVEL control fully counterclockwise. Leave this control in this position for the following adjustments.

Set the FUNCTION switch to VOX.

NOTE: Close-talk into the microphone when using VOX operation to prevent background noise from tripping the Transceiver into transmit operation.

1. While speaking into the microphone, turn the VOX SENS control to just beyond a setting that will energize the relays. Be sure this control is not set so high that it will allow background noise to trip the relays.
2. Tune the receiver to a fairly strong signal and adjust the AF GAIN control for a comfortable listening level.
3. Place the microphone where it will normally be used. Advance the ANTI-TRIP gain control to Just beyond a setting that will keep the speaker signal from tripping the VOX circuits. Be sure this control is not set so high that it completely disables the relay closing action.
4. Speak into the microphone and turn the VOX DELAY control to a setting that will hold the relays energized during the slight pauses between words. This prevents the relays from tripping at the beginning and end of each word.

NOTE: There will be a slight interaction between the VOX SENS, ANTI-TRIP, and VOX DELAY controls. Consequently, it may be necessary to readjust these controls to achieve the desired results.

The Transceiver is now ready for operation in the SSB mode. Speaking into the microphone (VOX) or using the microphone push-to-talk switch (PTT) will change the Transceiver from receive to transmit operation.

d.3. CW Operation

For CW operation, the FUNCTION switch can be set to either the PTT or VOX positions. Even though CW operation is possible in the Calibrate position, it is not recommended because of possible spurious outputs from calibrator signals being present at the grid of the driver stage.

For 400 Hz CW selectivity, the Heath SBA-301-2 CW crystal filter may be installed in addition to the SSB crystal filter supplied with the Transceiver. The filter switch will then select the SSB or the CW filter.

Be sure steps 1 through 10 have been satisfactorily completed before proceeding with the following adjustments.

1. Place the MODE switch in the CW position.
2. Plug a key into the CW KEY jack.
3. While sending a series of "V's", adjust the VOX DELAY control so the relays stay energized between groups of characters. Clockwise rotation of this control will increase the holding time of the relays. The final setting of the VOX DELAY control will be determined by the sending speed of the operator. The slower the sending speed, the higher the setting of this control.

4. **NOTE:** Be sure the VOX DELAY control is adjusted so the relays do not open after each character is sent.

Set the MIC/CW LEVEL control to the minimum position that produces full output (Plate current should be 225-250 ma).

e) Alignment

The coils and transformers in your Transceiver have been preset at the factory. Only slight readjustments should be necessary during the following alignment procedure.

The following equipment is necessary for alignment of the Transceiver.

- An 11 megohm input VTVM, such as the Heath Model IM-11 , (a 20 KΩ/V VOM may also be used).
- A 50 Ω nonreactive dummy load that is capable of 100 watts dissipation, such as the Heathkit Model HN-31. Do not use light bulbs as a dummy load, as their resistance varies radically with voltage.
- A receiver capable of receiving WWV, such as the Heath Model GR-54, at 2.5, 5, 10, or 15 MHz. If this type of receiver is not available, a receiver tunable to a standard broadcast station that is operating at an even multiple of 100 kHz (such as 600 kHz, 1000 kHz, etc.) can be used.

For the alignment of the transmitter section it is recommended that you use an oscilloscope, such as the Heathkit Model SB-610 Monitor Scope to observe the output RF envelope.

WARNING: Do not place the Transceiver in the transmit mode of operation until directed to do so or the Transceiver may be seriously damaged.

1. Set the ANTENNA switch (located on rear of chassis) to the COM position (SB-101 only?).

Connect a 50 Ω dummy load, capable of 100 watts dissipation, to the RF OUT jack on the rear of the chassis. CAUTION: Do not use light bulbs as a dummy load.

Be sure an 8 Ω speaker is connected to the 8 Ω jack on the rear of the chassis.

Preset the CAL XTAL trimmer so its notch is towards the 100 kHz crystal as shown in Figure 1-1 (fold-out from Page 82).

Preset the front panel controls as follows:

f) DRIVER PRESELECTOR - 12 o'clock position (3.7,7.2,14.2).
g) MIC/CW LEVEL - fully counter clockwise.
h) MODE - LSB
i) BAND - 3.5
j) Main tuning dial (LMO) - 3.7 MHz (upper dial pointer at 2, and the circular dial at 0).
k) FUNCTION - PTT.

l) FREQ CONTROL - LOCKED NORMAL.
m) RF GAIN - fully clockwise.
n) FILTER - SSB.
o) METER - ALC.
p) AF GAIN - 9 o'clock position.

p.1. S-Meter Adjustment

After a few minutes warmup, adjust the METER ZERO control (on the IF circuit board directly behind the FREQ CONTROL switch) for a zero reading on the panel meter.

p.2. Receiver Alignment

Set the VTVM switches so the meter will indicate a negative (-) DC voltage.

Connect the common lead of the VTVM to the chassis and the other lead to the circuit board foil at TP on the screened side of the bandpass circuit board near tube V19.

The heterodyne oscillator output will be checked at each position of the BAND switch in the following steps. If necessary, the heterodyne oscillator coils will be adjusted to obtain a preliminary output voltage reading. Final adjustment will be made later.

p.2.1. Preliminary Heterodyne Oscillator Alignment

With the BAND switch· at 3.5, the VTVM should indicate about -0.5 to -2 volts DC. If necessary, adjust coil 3.5 (near tube V11 on the top side of the RF -driver circuit board) for the proper VTVM reading. NOTE: When adjusting this coil in one direction, the oscillator output voltage will change rapidly; when adjusting the coil in the opposite direction from the peak, the output voltage will change slowly. Adjust the coil in the direction that gives the slower change in output voltage.

Similarly, check the heterodyne oscillator output voltage at all positions of the BAND switch. **If necessary, adjust the correct heterodyne oscillator coil for any BAND switch position that** does not give an indication of about -0.5 to -2 volts DC on the VTVM. The heterodyne oscillator coils for bands 3.5, 14, and 28.5 are marked, and adjusted at the top side of the RF –driver circuit board; the coils for the other bands are marked on the shield cover, and are adjusted from the bottom of the chassis:

> ***Note:*** *If adjusting from the bottom side of the chassis, the 3.5 MHz core is also the core on the 7 MHz coil that is closest to the chassis, the 14 MHz core is also the core on the 21 Mhz coil that is closest to the chassis and the 28.5 MHz core is also the core that is closest to the chassis on the 29.0 MHz coil.*

Set the FUNCTION switch to CAL and the BAND switch to 3.5, then turn the Main Tuning dial back and forth around 3.7 MHz to get the loudest signal. Check for the calibrate Signal by turning the FUNCTION switch to VOX and back to CAL; the signal should stop and then start again and should peak with the DRIVER PRESELECTOR.

Reset the DRIVER PRESELECTOR to the 12 o'clock position.

Disconnect the VTVM leads from the Transceiver.

p.2.2. IF Alignment

The S-Meter will be used as an output indicator during the remaining alignment of the Transceiver, and the 100 kHz calibrator will be used as a signal source.

a) Adjust transformer T201 for maximum volume.
q) Adjust the top and bottom slugs of transformer T102 for a maximum volume or S Meter indication.
r) Adjust the slug of transformer TI03 for a maximum S-Meter indication.
s) Repeat the adjustments of transformers T201, TI02, and TI03 for a maximum S-Meter indication.

s.1.1. Preliminary Driver Grid and Plate Coil Alignment

Important: Due to the way the coils are switched, they coils **must** be adjusted in the order listed. The 3.5 coil is in the circuit all the time – the 29, 21, 14, and 7 coils in series and are progressively switched in parallel with the 3.5 coil. That is, for 21 MHz, the 29 and 21 coil (in series) are switched into parallel with the 3.5 coil.

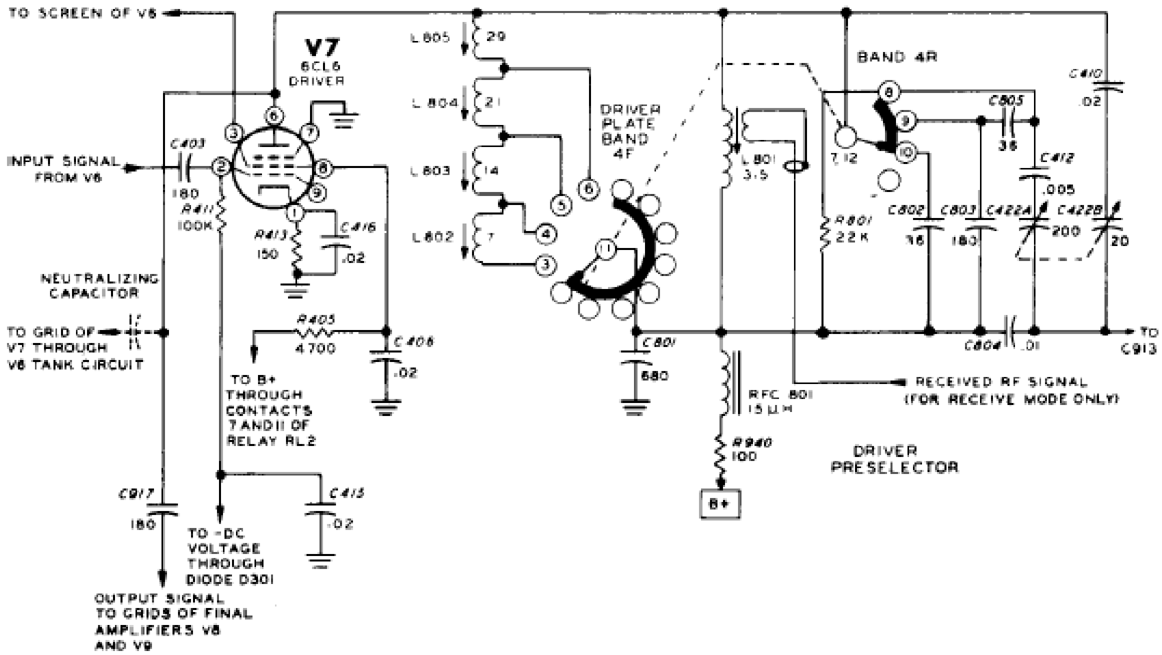


Figure 2-16

Figure 1. Driver Grid and Plate Coil Configuration

The driver grid and driver plate coils will be adjusted in the following steps. The coil locations are marked on the shield cover at the bottom of the chassis. These coils must be adjusted in the proper sequence as follows:

1. Adjust driver grid coil 3.5 and driver plate coil 3.5 for a maximum S-Meter indication. The S-Meter will move slowly during the adjustment of these two coils

Change the setting of the front panel controls as follows:

DRIVER PRESELECTOR - 29.2 position (see Error: Reference source not found on page 33).

BAND - 29.0

Main Tuning dial (LMO) - 29.2 MHz

Turn the Main tuning dial back and forth around 29.2 MHz to get the loudest Signal.

Check for the calibrate signal by turning the DRIVER PRESELECTOR to see if there is any variation in volume. Return the DRIVER PRESELECTOR to the 29.2 position.

Adjust driver grid coil 29 and driver plate coil 29 for a maximum S-Meter indication.

Change the setting of the front panel controls as follows:

DRIVER PRESELECTOR - 21.2 position (see Error: Reference source not found on page 33).

BAND - 21.0

Main tuning dial: 21.2 MHz.

Turn the Main tuning dial back and forth around 21.2 MHz for the loudest signal.

Check for the calibrate Signal by turning the FUNCTION switch to VOX and back to CAL again.

Adjust driver grid coil 21 and driver plate coil 21 for a maximum S-Meter indication.

Turn the BAND switch to 14.0, the Main tuning dial to 14.2 MHz, and the DRIVER PRESELECTOR to the 14.2 position (See Error: Reference source not found on page 33).

Tune the Main tuning dial for the loudest signal and check for the calibrate signal.

Adjust driver grid coil 14 and driver plate coil 14 for a maximum S-Meter indication.

Set the BAND switch at 7.0, the Main tuning dial at 7.2 MHz, and the DRIVER-PRESELECTOR to the 7.2 position.

Note: A Heathkit service bulletin HW-101-48 recommended setting the Driver-Preselector knob to the 1 o'clock position rather than the 2 o'clock position shown to ensure that the Driver-Preselector could be peaked at both ends of the band.

Tune the Main tuning dial for the loudest signal.

Adjust driver grid coil 7 and driver plate coil 7 for a maximum S-Meter indication.

Turn the FUNCTION switch to PTT

Proper receiver operation will be indicated by calibrator signals of S9 +20 db at 3700 kHz and decreasing to S6 at 29.2 MHz.

s.2. Transmitter Alignment

See the "Reading the Meter" section on Page (tbd) before making any more adjustments.

NOTE: The coil cover must be in place for transmitter operation.

1. Connect a push-to-talk microphone to the MIC connector on the front panel.

If an oscilloscope is available, connect the oscilloscope between the RF OUT jack and the dummy load. Be sure the dummy load is capable of 100 watts dissipation.

Set the NEUTRALIZING CAPACITOR (on the RF cage) at the 1/2 meshed position. The slot in the shaft should be vertical.

Set the front panel controls as follows:

DRIVER PRESELECTOR - 12 o'clock position.

MIC/CW LEVEL - fully counter clockwise.

FINAL (round knob) - to 80.

FINAL (lever knob) - over the 50 Ω marking.

MODE - LSB.

BAND - 3.5

Main tuning dial - 3.7 MHz.

FUNCTION - PTT.

FILTER - SSB.

FREQ CONTROL - LOCKED NORMAL

METER - PLATE.

Press the PTT microphone button and turn the BIAS ADJUST control in the Transceiver for a plate current reading of 50 ma If the meter reads more than 100 ma, do not press the microphone button more than a few seconds at one time, until the plate current has been properly adjusted.

If an oscilloscope is not used, preset the RELATIVE POWER control to the center of its range and turn the METER switch to REL PWR.

With the MODE switch set at the TUNE position, slowly turn the MIC/CW LEVEL control in a clockwise direction until there is an indication of RF output on the meter or oscilloscope.

Turn the MIC/CW LEVEL control for a low level of RF output, then adjust the DRIVER PRESELECTOR control for maximum RF output.

Adjust the FINAL tune (round knob) control for maximum RF output.

Turn the MIC/CW LEVEL control counterclockwise to obtain approximately 1/4 maximum output.

Adjust transformer T1 for maximum RF output. It should not be necessary to adjust this transformer more than one complete turn.

Turn the MIC/CW LEVEL control and DRIVER PRESELECTOR control to obtain maximum RF output on the meter or oscilloscope. Then turn the METER switch to GRID (grid current); the meter should indicate full scale.

Turn the METER switch to the PLATE position.

Adjust the FINAL tune control for minimum plate current. Turn the METER switch to REL PWR or observe the output on an oscilloscope. Adjust the FINAL tune control for maximum meter indication and note the position of the FINAL tune control. (If necessary, readjust the RELATIVE POWER control so the meter does not indicate beyond full scale.) If maximum relative power and minimum plate current do not occur at the same point of tuning, then turn the neutralizing capacitor a small amount.

Check the position of the FINAL tune control at minimum plate current and also at the maximum relative power indication.

The neutralizing capacitor should be adjusted a small amount at a time until minimum plate current and maximum relative power occur at the same point of tuning the FINAL tune control.

Turn the MIC/CW LEVEL control fully counterclockwise.

Turn the MODE switch to LSB, push the PTT switch on the microphone, then adjust the CARRIER NULL control for minimum RF output.

NOTE: Readjust the RELATIVE POWER control for more sensitivity if the panel meter is used to indicate relative power.

Adjust the CARRIER NULL capacitor for minimum RF output. ( ) If necessary, repeat the adjustments of the CARRIER NULL control, and the CARRIER NULL capacitor until the RF output or null reading is about the same on both the LSB and USB positions of the MODE switch. (The output should null down to a quarter of a volt or less, if an RF volt-meter is available.)

CAUTION: The 6.8 MHz trap coil is sealed, and should not be turned.

Turn the MODE switch to TUNE. Tune for maximum output, and adjust the RELATIVE POWER control for a 6 to 8 meter reading.

Leave the BAND switch at 3.5, and adjust for a maximum output. Then set the MIC/CW LEVEL control for a grid current reading of about 0.3 ma

s.2.1. Final Heterodyne Oscillator Alignment

> ***Note:*** *If adjusting from the bottom side of the chassis, the 3.5 MHz core is also the core on the 7 MHz coil that is closest to the chassis, the 14 MHz core is also the core on the 21 Mhz coil that is closest to the chassis and the 28.5 MHz core is also the core that is closest to the chassis on the 29.0 MHz coil.*

1. Adjust heterodyne oscillator coil 3.5 for maximum grid current, with the tuning on the "slow" side of the peak.
2. At each position of the BAND switch, adjust the heterodyne oscillator coil for maximum grid current. Adjust the coil that has the same number as the BAND switch position.
3. Check the grid current at each position of the BAND switch. The maximum grid current reading should be near or over full scale on each band.

s.2.2. Driver Neutralization Adjustment

1. Set the BAND switch at 21.0 and turn the Main tuning dial to read 21.2 MHz.
2. Position the free end of the driver neutralizing wire into hole W in the RF –driver circuit board as shown in Figure 1-1 (foldout from Page tbd).
3. Adjust the DRIVER PRESELECTOR control for maximum RF output; then turn the control back and forth to see if this produces a smooth peaking in RF output.
4. If the turning of the DRIVER PRESELECTOR control causes ragged changes in the RF output, readjust the position of, or bend, the driver neutralizing wire to produce a smooth peaking in RF output.
5. Check the final neutralizing again at 14.2 Hz as in the last step on Page 95.
6. Rezero the S-Meter while receiving, with the BAND switch at 29.5. Then check to be sure the meter reads zero in each Band switch position. If the S-Meter does not read zero on any band, readjust the heterodyne oscillator coil for that band, as directed in previous steps.

s.3. LMO Shifter Adjustment

1. Adjust the Main tuning dial to 3.7 MHz (BAND switch to 3.5, the upper dial at 2, and the circular dial to 0).
2. Set the FUNCTION switch to CAL.
3. Turn the MODE switch to USB.
4. Carefully zero beat the calibrator Signal (using the Main Tuning dial) and peak the DRIVER PRESELECTOR control.
5. Set the MODE switch to LSB. Be careful not to touch the Main Tuning dial. Note that the calibrator signal mayor may not be exactly at zero beat in the LSB position.
6. Turn the frequency shifter adjustment on the LMO for an exact zero beat in the LSB mode. See Figure 1-1 (fold-out from Page 82).
7. Recheck the zero beat in the USB mode to be certain of the adjustment. Repeat the procedure if necessary.

t) Uneven Response Across the Band / Bandpass Filter

It has been observed that in some rigs the power output is uneven across the band, or drops off at the high or low end of the band. This is not specific to the band in use and assuming a proper alignment has been performed, this may be due to one or more of the following:

1. The two Pre-selector/Driver caps are not tracking together. This can occur as a result of the rubber “O” rings slipping. Ensure that they are both fully meshed and fully open at the same time.
2. Confirm that the LMO output is constant across the band. The LMO output can be measured using either an oscilloscope or a VTVM with an RF probe connected to the RCA jack on the rear of the LMO. It is normal to see some difference between the high and low ends of the range.
3. The frequency response of the 8395 KHz to 8895 KHz bandpass circuit is uneven.

t.1. 8395 to 8895 KHz Bandpass Filter

The frequency response of the 8395 KHz to 8895 KHz bandpass circuit and filter can result in a variation in drive from the low end to the high end on all bands. The frequency response of this circuitry is determined by the Bandpass Filter (T202). T202 is factory aligned and sealed and there is no procedure defined for adjustment should the response change due to component variation or aging.

T202 is a traditional LC bandpass filter configured as a pi network. L2, C2 and C5 form a series-resonant circuit that is tuned to the center of the pass band (8645 KHz) and the two end sections form parallel resonant circuits to boost the low and high endpoints to provide a broader response.

If alignment is found to be necessary, it can be done without removing T202 from the radio by removing the top screw and unsoldering the two tabs that hold the case to the circuit board. It is not necessary to unsolder the five signal leads. Removing the case provides access to the three trimmer caps.

When reinstalling the case ensure that the inside with the tape is positioned over the trimmer cap adjustment screws to prevent shorting the adjustment screws to the case.

NOTE: *Heathkit Service Bulletin HW-101-56 discusses this problem and describes a method to perform a sweep alignment of the Bandpass Filter T202. I have not found a copy of this service bulletin that contains the figures it references.*

t.1.1. Measuring the Bandpass Filter Response (Simple Method)

The simplest approach to measuring the response of the bandpass filter is as follows:

Test Setup SB-102: Measure RF Signal at Driver Output jack on the rear panel. Remove the 6146 Screen voltage by removing MOLEX plug on rear. This makes it easier on the finals while performing the measurements. Switch to TUNE mode and Peak the DRIVER/PRESELECTOR for maximum signal level at each measurement point.

Test Setup SB-101 & HW-101: Measure RF Signal at CR-201 (located near 100 KHz XTAL) Anode (non-banded end). It is recommended to remove 6146 Screen voltage by disconnecting R920 (100 ohm to Pin 3 on 6146s). This makes it easier on the finals while performing the measurements. Switch to TUNE mode, Peak the DRIVER/PRESELECTOR for maximum signal level at each measurement point.

Connect an oscilloscope or VTVM with an RF probe to the Driver Output connector on the rear panel and measure the level as the LMO is tuned from end to end. It is necessary to peak the Pre-Selector/Driver control for each measurement.

By recording the signal value at multiple points (e.g., every 50 KHz), it is possible to construct a graph of the frequency response.

t.1.2. Measuring the Bandpass Filter Response (Sweep Analysis)

If a sweep generator and oscilloscope with an RF demodulator probe or spectrum analyzer with tracking generator is available, the bandpass circuitry can be swept to visually determine the frequency response.

Two different setups are required, one for receive mode and a second for transmit mode.

Receive Mode Bandpass Response

With power off, connect the output of the sweep (tracking) generator to V11 pin 1 through a suitable DC blocking capacitor. Connect the demodulator probe or spectrum analyzer input to V12 pin 2 also through a suitable DC blocking capacitor. Set the center frequency to 8645 KHz with a sweep width of 2 MHz.

With power applied, you should see a response that looks like the following example (Marker 1 is at 8395 KHz, Marker 2 is at 8645 KHz, and Marker 3 is at 8895 KHz). Observe that the pass band is within +/- 3dB over the desired span.

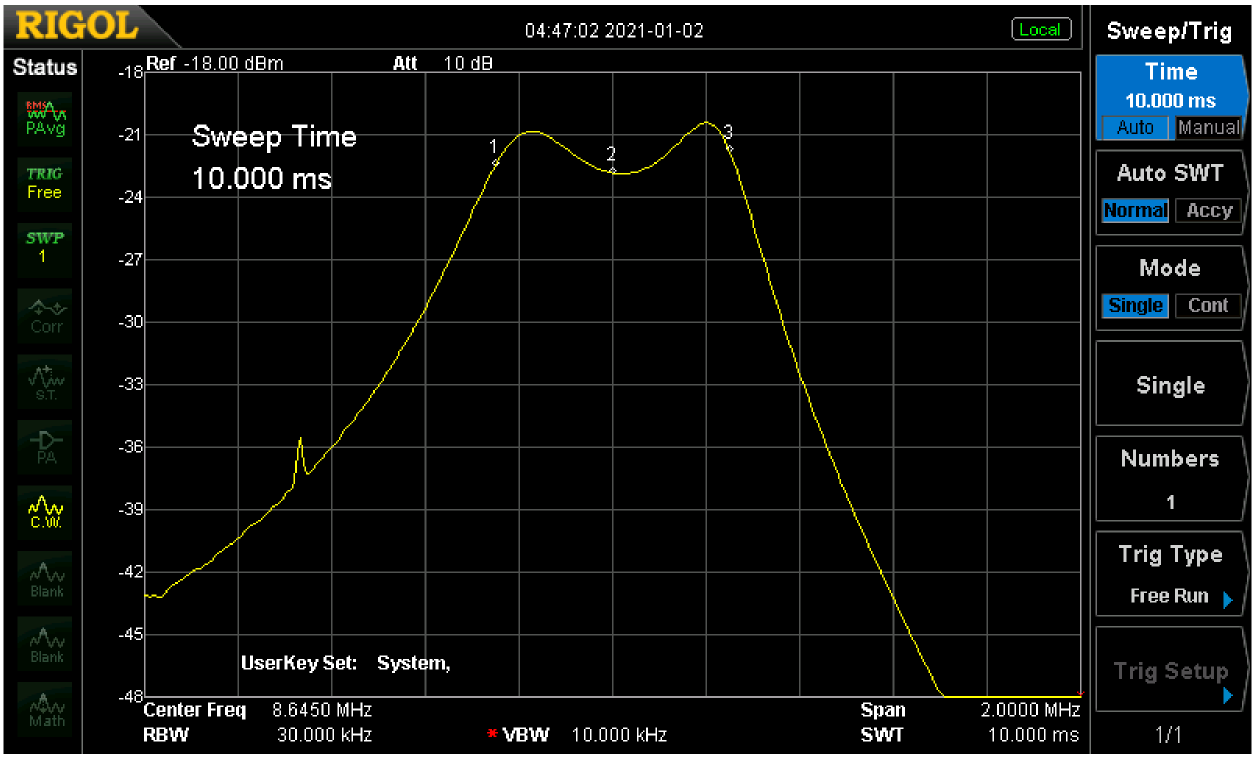


Figure 2. Bandpass Response (Receive Mode)

To tune the transmit response, tune the middle trimmer cap for peak signal at 8645 KHz (Marker 2, center of the bandpass) and the bottom trimmer cap to provide a symmetrical frequency response between the upper and lower ends of the pass band (Markers 1 and 3).

Note: need to verify that it is indeed the bottom trimmer cap.

Transmit Mode Bandpass Response

With power off, connect the output of the sweep or tracking generator to V5 pin 2 through a suitable DC blocking capacitor. Connect the demodulator probe or spectrum analyzer input to V6 pin 1 also through a suitable DC blocking capacitor. Set the center frequency to 8645 KHz with a sweep width of 2 MHz.

With power applied, you should see a response that looks like the following (Marker 1 is at 8395 KHz, Marker 2 is at 8645 KHz, and Marker 3 is at 8895 KHz). Observe that the pass band is within +/- 3dB over the desired span.

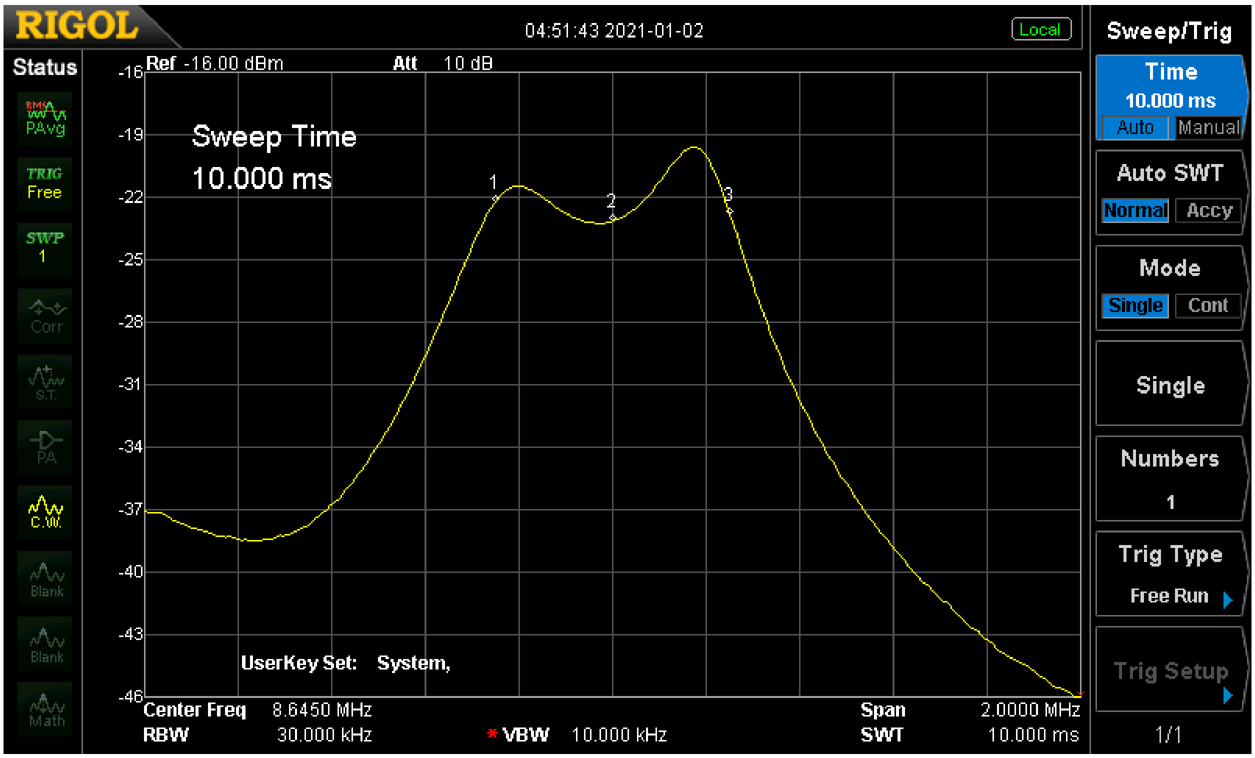


Figure 3. Transmit Mode Bandpass Response

To tune the transmit response, tune the middle trimmer cap for peak signal at 8645 KHz (Marker 2) and the top trimmer cap to provide a symmetrical frequency response between the upper and lower ends of the pass band (Markers 1 and 3).

Note: need to verify that it is indeed the top trimmer cap.

u) Signal Level Measurements

The purpose of these measurements is to determine the receiver gain through various stages. This can help isolate problems due to insufficient gain in a particular stage in the signal path. I have not found any published values, so the expected values are based on the average measurements from a number of different rigs.

Measurements start at the audio output stage and progressively work back towards the RF amp stage. By following this progression, each step builds upon results of previous steps.

Differences between the expected and measured signal levels are normal due to component tolerances, aging and vacuum tube condition. These differences should only be of concern when the actual value differs significantly from the expected value.

The following figure shows the receive signal path and test points used by this procedure.

Figure 4. Receive Signal Path Test Points

u.1. Receive Signal Levels

This section describes a procedure to measure the signal levels required to produce a given output level on a stage-by-stage basis. It is broken into two parts which are independent of one another. The reason for this is that the measurement procedure is different for the audio stages versus the RF/IF stages. It also removes the AF gain control as a variable factor.

u.1.1. Carrier and Heterodyne Oscillator Levels

Before making any signal level measurements, check for correct operation of the carrier (BFO), LMO, and heterodyne (HFO) oscillator frequencies and levels.

Connect a scope or RF probe to the carrier null pot center lug test point (or pin 3 or 8 of V16) and switch between sideband modes, checking for equality in level. If need be, adjust the value of R6 or R7 to achieve equality. The level should be at least 1 volt RMS, or 3 volts P-P.

Ensure that the heterodyne oscillator level is -2.0 VDC for all positions of the band switch *(see* Preliminary Heterodyne Oscillator Alignment *on page 31).* Values less than -1.5 VDC will result in reduced conversion gain through the 1st RX Mixer.

u.1.2. Receive Audio Signal Levels

The purpose of these two measurements is to determine the gain of the receive audio stages associated with V14. This is done by measuring the audio input levels needed to produce 500 mw audio output into audio level meter or dummy load (500 mw = 2 VAC across an 8Ω resistor). Input and output levels can be measured using an AC voltmeter.

a) Disconnect speaker and connect an Audio Level meter to the speaker jack (alternatively, an 8Ω load resistor and AC voltmeter can be used to measure the levels)
v) Using an audio signal generator at 1 KHz, connect the generator to the top of the AF Gain control and adjust the AF Gain control to provide 500 mw audio output.

Note: In lieu of an audio generator, you can use the built-in calibrator by tuning for a 1 KHz audio beat note (tone) and adjusting the AF Gain control to provide 500 mw audio output.

Audio Stages: Expected Signal Levels for 500 mw Audio Output				
TP	**Input Signal Injection Point**	**Frequency**	**Expected Level**	**Actual Input**
AF Power Amp	Top of AF Gain Control Adjust for AF Gain Control to provide 500 mw audio output	1 KHz	3.2 - 3.6 VAC @ V14 pin 8	
Audio Amp	Top of AF Gain Control Adjust for AF Gain Control to provide 500 mw audio output	1 KHz	0.1 VAC @ V14 pin 1	

Table 1. Receive Audio Levels

v.1.1. Receive RF and IF Signal Levels

This procedure measures the nominal signal levels required to produce 2 VAC (audio) at the top end of the AF Gain control. It requires an AC voltmeter, a signal source with a calibrated output and a probe with a blocking capacitor. The following figure shows one possible setup using a calibrated RF source feeding a step attenuator that is used to set the injection signal level.

By using a 50Ω test setup, the effects of the circuit related to the signal injection point are largely swamped out by the test setup.

During this procedure, it is necessary to disable the AVC circuitry to prevent the AVC circuitry from affecting the gain of the stages being measured.

Initial Test Setup:

RF Gain control fully clockwise

AF Gain control set to a comfortable listening level

AC Voltmeter connected to top of AF Gain control

Band Switch set to 3.5 (80 meters)

Frequency dial set to 3700 KHz.

Disable the AVC by Disconnect the two yellow wires from pad 13 on the IF board (rear left as viewed from the bottom of the chassis) and connect them to ground with a jumper wire.

Note 1: *The 1st RX Mixer tube may develop a small negative grid leak bias between 0 VDC and -0.5 VDC (as measured at V11 pin 1). This should have minimal effect on the measurement.*

Note 2: *Don't forget to restore the AVC wiring upon completion of the measurement process.*

All signal levels are specified in dB relative to 1 milliwatt as measured into a 50Ω load (dBm). If preferred, this can be converted into microvolts using Table 3. dBm to Microvolt Conversion Chart on *page 45*.

TP	Injection Test Point	Input Signal Injection Point	Injection Frequency	Expected Input for 2 VAC at top of AF Gain Pot	Measured Input for 2 VAC at top of AF Gain Pot
②	Product Detector Input	V13 pin 8	3,395 KHz	-8 dBm	
③	2nd IF Amp Input	V4 pin 1	3,395 KHz	-26 dBm	
④	1st IF Amp Input	V3 pin 1	3,395 KHz	-61 dBm	
⑤	2nd RX Mixer Input	V12 pin 2	3,395 KHz	-66 dBm	
			8,695 KHz (1)	-64 dBm	
⑥	1st RX Mixer Input	V11 pin 1	8,695 KHz (1)	-65 dBm	
			3,700 KHz (1)	-57 dBm	
⑦	RF Amplifier Input	V10 pin 1	3,700 KHz (2)	-78 dBm	
⑧	Antenna	Antenna Jack	3,700 KHz (2)	-85 dBm	
			7,200 KHz (2)	-80 dBm	
			14,200 KHz (2)	-87 dBm	
			21,200 KHz (2)	-87 dBm	
			28,200 KHz (2)	-82 dBm	
			28,700 KHz (2)	-82 dBm	
			29,200 KHz (2)	-83 dBm	
			29,700 KHz (2)	-82 dBm	

Table 2. RF and IF Stages Expected Signal Levels

Notes:

1. Adjust the Frequency dial for maximum signal
2. Adjust the Frequency dial **and** Preselector control for maximum signal
3. Expected values are simply a guide based on the average values observed in several rigs and are not based on any published specification

dBm TO MICROVOLTS CONVERSION CHART (For 50 Ω System)

dBm	uV	dBm	uV	dBm	uV
0	224,000	-47	1,000	-94	4.47
-1	200,000	-48	891	-95	3.99
-2	178,000	-49	795	-96	3.55
-3	159,000	-50	709	-97	3.17
-4	141,000	-51	633	-98	2.82
-5	126,000	-52	563	-99	2.52
-6	112,000	-53	501	-100	2.24
-7	100,000	-54	447	-101	2.00
-8	89,100	-55	399	-102	1.78
-9	79,500	-56	355	-103	1.59
-10	70,900	-57	317	-104	1.41
-11	63,300	-58	282	-105	1.26
-12	56,300	-59	252	-106	1.12
-13	50,100	-60	224	-107	1.00
-14	44,700	-61	200	-108	0.891
-15	39,900	-62	178	-109	0.795
-16	35,500	-63	159	-110	0.709
-17	31,700	-64	141	-111	0.633
-18	28,200	-65	126	-112	0.563
-19	25,200	-66	112	-113	0.501
-20	22,400	-67	100	-114	0.447
-21	20,000	-68	89.1	-115	0.399
-22	17,800	-69	79.5	-116	0.355
-23	15,900	-70	70.9	-117	0.317
-24	14,100	-71	63.3	-118	0.282
-25	12,600	-72	56.3	-119	0.252
-26	11,200	-73	50.1	-120	0.224
-27	10,000	-74	44.7	-121	0.200
-28	8,900	-75	39.9	-122	0.178
-29	7,950	-76	35.5	-123	0.159
-30	7,090	-77	31.7	-124	0.141
-31	6,330	-78	28.2	-125	0.126
-32	5,630	-79	25.2	-126	0.112
-33	5,010	-80	22.4	-127	0.100
-34	4,470	-81	20.0	-128	0.0891
-35	3,990	-82	17.8	-129	0.0795
-36	3,550	-83	15.9	-130	0.0709
-37	3,170	-84	14.1	-131	0.0633
-38	2,820	-85	12.6	-132	0.0563
-39	2,520	-86	11.2	-133	0.0501
-40	2,240	-87	10.0	-134	0.0447
-41	2,000	-88	8.91	-135	0.0399
-42	1,780	-89	7.95	-136	0.0355
-43	1,590	-90	7.09	-137	0.0317
-44	1,410	-91	6.33	-138	0.0282
-45	1,260	-92	5.63	-139	0.0252
-46	1.120	-93	5.01	-140	0:0224

Table 3. dBm to Microvolt Conversion Chart

v.2. Transmit Signal Levels

v.2.1. Transmit and VOX Audio Level Troubleshooting Guide

Source: Heathkit Service Bulletin HW-101-6

It is assumed that the basic steps such as making DC voltage measurement, checking tubes & reviewing the soldering have been completed.

The following information was compiled from the above transceivers in the 80M LSB position. The mike level control was at the 9:00 o'clock position.

AC signal voltages are listed below. These voltages were measured from the microphone connector through the VOX circuit. All measurements were made with a VTVM. A microphone or audio generator for 0.1V @ 1KHZ can be used as the signal source.

Test Point	Expected Level	Measured Level
Mike Connector Lug 1 (set input level to)	0.1VAC	
Pin 2 of V1 (note **)	0.02VAC	
Pin 6 of V1	10-15VAC	
Pin 5 Level Control (adjust mike level control for)	0.5VAC	
Pin 9 of V1 (note **)	0.2VAC	
Pin 8 of V1 (must be in VOX mode and not CW)	0.1 - 0.3VAC	
Center Arm of VOX Sensitivity Control	5-15VAC	
Pin 7 of V17	5-10VAC	
Pin 6 of V17	40-50VAC	
Junction of C211-D201	40-50VAC	
Pin 9 of V12 (note this is VDC)	9-15VAC	
note (*) value depends on setting of VOX sensitivity control note (**) The expected values appear to be pulled down by loading of the voltmeter. I did not see this drop in my measurements		

Table 4. Transmit Audio & VOX Signal Levels

By tracing the AC signal from stage to stage the point of trouble can be isolated & steps taken to correct it. The following are some possible trouble areas:

Check each of the shielded cables for a possible open or poorly grounded shield.

Check for continuity through each of the shielded cables.

Check for a proper ground at the mike control level.

If the frequency response of the audio stage is not within specifications check the values & installation of C1, C2, C3 & C9.

A change in VOX delay after operating for a period of time can be caused by leakage in diode D201. The other possibility is a change in value of capacitor C213. Either component could experience a change in operation characteristics due to heat.

v.2.2. Transmit RF Signal Levels

The transmit levels listed are based on measurements taken on two SB-102 radios and are intended to provide a general ball-park figure rather than any kind of specification.

Test Setup SB-102
Remove 6146 Screen voltage by removing MOLEX plug on rear - easier on finals. TUNE mode, Peak the DRIVER/PRESELECTOR for maximum drive.
Test Setup SB-101 & HW-101
Remove 6146 Screen voltage by disconnecting R920 (100 ohm to Pin 3 on 6146s) - easier on finals. TUNE mode, Peak the DRIVER/PRESELECTOR for maximum drive.
RF Volts measured with Heathkit VTVM & RF Probe. Scope measured with wideband scope using 10x probe

Oscillators		Volts (RF Probe)		Volts (Scope, Peak-to-Peak)	
		Reference	Actual	Reference	Actual
V16 Pin 3 or 8 (Carrier Oscillator) LSB		2.00		5.66	
V16 Pin 3 or 8 (Carrier Oscillator) USB		2.00		5.66	
Carrier Balance Pot. (center)		1.50		4.24	
V19 Pin 2 (Het Osc. Cathode Follower Grid)		5.00		14.14	
V19 Pin 3 (Het Osc. Cathode Follower)		2.00		5.66	
V5 Pin 7 or V12 Pin 7 (VFO)/LMO)		2.00		5.66	
V5 Pin 2 (1st TX Mixer Grid)		2.20		6.22	
V6 Pin 1 (2nd TX Mixer Grid)		1.20		3.39	
V7 Pin 1 (Driver Grid) - Peak Driver/Preselector control for maximum voltage					
3.5	3,700 KHz	3.00		8.48	
7.0	7,200 KHz	2.60		7.35	
14.0	14,200 KHz	3.30		9.33	
21.0	21,200 KHz	3.50		9.90	
28.0	28,200 KHz	2.40		6.79	
28.5	28,700 KHz	2.40		6.79	
29.0	29,200 KHz	2.40		6.79	
29.5	29,700 KHz	2.40		6.79	
Driver Out Jack on Rear Panel (SB-102 only) - Peak Driver/Preselector control for maximum voltage					
3.5	3,700 KHz	3.5		9.90	
7.0	7,200 KHz	3.75		10.61	
14.0	14,200 KHz	3.80		10.75	

21.0	21,200 KHz	3.90		11.03	
28.0	28,200 KHz	4.20		11.88	
28.5	28,700 KHz	4.20		11.88	
29.0	29,200 KHz	4.20		11.88	
29.5	29,700 KHz	4.20		11.88	

w) Signal to Noise Ratio (SNR)

w.1. Signal to Noise Ratio (Theory)

The noise performance and hence the signal to noise ratio is a key parameter for any radio receiver. The signal to noise ratio, or SNR as it is often termed is a measure of the sensitivity performance of a receiver. This is of prime importance in all applications from simple broadcast receivers to those used in cellular or wireless communications as well as in fixed or mobile radio communications, two way radio communications systems, satellite radio and more.

There are a number of ways in which the noise performance, and hence the sensitivity of a radio receiver can be measured. The most obvious method is to compare the signal and noise levels for a known signal level, i.e. the signal to noise (S/N) ratio or SNR. Obviously the greater the difference between the signal and the unwanted noise, i.e. the greater the S/N ratio or SNR, the better the radio receiver sensitivity performance.

As with any sensitivity measurement, the performance of the overall radio receiver is determined by the performance of the front end RF amplifier stage. Any noise introduced by the first RF amplifier will be added to the signal and amplified by subsequent amplifiers in the receiver. As the noise introduced by the first RF amplifier will be amplified the most, this RF amplifier becomes the most critical in terms of radio receiver sensitivity performance. Thus the first amplifier of any radio receiver should be a low noise amplifier.

w.1.1. Concept of signal to noise ratio SNR

Although there are many ways of measuring the sensitivity performance of a radio receiver, the S/N ratio or SNR is one of the most straightforward and it is used in a variety of applications. However it has a number of limitations, and although it is widely used, other methods including noise figure are often used as well. Nevertheless the S/N ratio or SNR is an important specification, and is widely used as a measure of receiver sensitivity.

w.1.2. Signal to noise ratio

The signal to noise ratio is the ratio between the wanted signal and the unwanted background noise.

The difference is normally shown as a ratio between the signal and the noise (S/N) and it is normally expressed in decibels. As the signal input level obviously has an effect on this ratio, the input signal level must be given. This is usually expressed in microvolts. Typically a certain input level required to give a 10 dB signal to noise ratio is specified.

$$SNR = \frac{P_{signal}}{P_{noise}}$$

It is more usual to see a signal to noise ratio expressed in a logarithmic basis using decibels:

$$SNR_{dB} = 10 \log_{10}\left(\frac{P_{signal}}{P_{noise}}\right)$$

If all levels are expressed in decibels, then the formula can be simplified to:

$$SNR_{dB} = P_{signal_{dB}} - P_{noise_{dB}}$$

The power levels may be expressed in levels such as dBm (decibels relative to a milliwatt, or to some other standard by which the levels can be compared.

w.1.3. Effect of bandwidth on SNR

A number of other factors apart from the basic performance of the set can affect the signal to noise ratio, SNR specification. The first is the actual bandwidth of the receiver. As the noise spreads out over all frequencies, it is found that the wider the bandwidth of the receiver, the greater the level of the noise. Accordingly the receiver bandwidth needs to be stated.

Additionally it is found that when using AM the level of modulation has an effect. The greater the level of modulation, the higher the audio output from the receiver. When measuring the noise performance the audio output from the receiver is measured and accordingly the modulation level of the AM has an effect. Usually a modulation level of 30% is chosen for this measurement.

w.1.4. Signal to noise ratio specifications

This method of measuring the performance is most commonly used for HF communications receivers. Typically one might expect to see a figure in the region of 0.5 microvolts for a 10 dB S/N in a 3 kHz bandwidth for SSB or Morse. For AM a figure of 1.5 microvolts for a 10 dB S/N in a 6 kHz bandwidth at 30% modulation for AM might be seen.

Points to note when measuring signal to noise ratio:

> SNR is a very convenient method of quantifying the sensitivity of a receiver, but there are some points to note when interpreting and measuring signal to noise ratio. To investigate these it is necessary to look at the way the measurements of signal to

noise ratio, SNR are made. A calibrated RF signal generator is used as a signal source for the receiver. It must have an accurate method of setting the output level down to very low signal levels. Then at the output of the receiver a true RMS AC voltmeter is used to measure the output level.

S/N and (S+N)/N: When measuring signal to noise ratio there are two basic elements to the measurement. One is the noise level and the other is the signal. As a result of the way measurements are made, often the signal measurement also includes noise as well, i.e. it is a signal plus noise measurement. This is not normally too much of a problem because the signal level is assumed to be much larger than the noise. In view of this some receiver manufacturers will specify a slightly different ratio: namely signal plus noise to noise (S+N/N). In practice the difference is not large, but the S+N/N ratio is more correct.

PD and EMF: Occasionally the signal generator level in the specification will mention that it is either PD or EMF. This is actually very important because there is a factor of 2:1 between the two levels. For example, 1 microvolt EMF and 0.5 microvolt PD are the same. The EMF (electro-motive force) is the open circuit voltage, whereas the PD (potential difference) is measured when the generator is loaded. As a result of the way in which the generator level circuitry works it assumes that a correct (50Ω) load has been applied. If the load is not this value then there will be an error. Despite this most equipment will assume values in PD unless otherwise stated.

While there are many parameters that are used for specifying the sensitivity performance of radio receivers, the signal to noise ratio is one of the most basic and easy to comprehend. It is therefore widely used for many radio receivers used in applications ranging from broadcast reception to fixed or mobile radio communications.

w.2. Measuring Signal to Noise Ratio (SNR)

We will make a very simple measurement--how much signal is required for a specified signal-to-noise ratio at the headphone output. More precisely, we will measure the required signal for a specified (Signal+Noise)/Noise ratio, but with a target of 10 or 20 dB, the difference between S/N and (S+N)/N isn't too great and we will call the result the sensitivity.

w.2.1. Required Equipment

The required equipment is:

A signal generator with a calibrated, variable output covering the frequency range of interest (I used the tracking generator on a Rigol 815 Spectrum Analyzer and a step attenuator).

A multimeter (analog or digital) capable of reading audio output of your receiver. I used a Fluke digital voltmeter, but in fact a good analog meter is preferable as you have to do some "eyeball averaging" when reading the noise level.

Connecting cables.

w.2.2. Test Setup

The illustration below shows the test setup. The headphones let you listen to the receiver audio at the same time you measure the level.

Caution: Before you connect your transceiver to the signal generator, render your transceiver unable to transmit by disconnecting the MIC and KEY. You will be irked, to say the least, if the attenuators in your signal generator are smoked by a brief burst of power out of your transceiver.

w.2.3. Test Methodology

If your signal generator is not synthesized or phase locked, let it warm up thoroughly.

Make the connections in the test setup shown above.

For each band you wish to measure (and each mode), repeat the following steps:

1. Set the receiver to the desired mode. Set the RF gain control to maximum.
2. Set the signal generator for a test frequency in the band and set the receiver to the desired mode. The signal generator should be in CW mode, i.e., no modulation. Assume we start in the 40 meter band. I set my signal generator for 7250.00 KHz. The signal generator output level should be at approximately -100 dBm. (2 uV if your signal generator is calibrated in microvolts) Tune the receiver to the signal generator frequency and verify that you can hear it.
3. Tune the receiver away from the signal generator 10 or 15 KHz. You should not hear the signal generator in your receiver; to test this, unplug the coax cable connecting the generator to your receiver. You should see no significant change in the voltmeter and you should hear no significant difference in audio output. (connect the cable back, of course.)
4. Keeping the receiver's RF gain at maximum adjust the AF gain to provide a low but comfortable listening level (e.g., .01 VAC). Record the voltmeter reading.
5. Tune the receiver to the generator frequency, adjusting the receiver frequency so that the audio output as read on the voltmeter is maximized. Do not adjust the receiver audio level!
6. If your voltmeter reads in dB, vary the signal generator's output level (should need to be reduced if you started at the recommended -100 dBm level) until the audio level is:

   10dB above the noise reading (equals 3.15x voltage)
   20 dB above than the noise reading (equals 10x voltage)
7. Record the signal generator output level.

Band	Frequency	Signal Gen Output (dBm)	Signal Gen Output (μ volts)
80	3,750		
40	7,250		
20	14,250		
15	21,250		
10	28,750		

Table 5. Signal to Noise Ratio (S+N/N)

If the CW Filter is installed, as a bonus measurement, you might wish to switch to CW mode, and tune to the signal generator (if the CS Filter is not installed, you can do this in SSB mode). Keep reducing the generator's output until you think that the signal represents the weakest signal you could copy. Record the signal generator level. This can be considered the "minimum discernible signal."

Since there is some difference between the signal level that you consider readable and my assessment, there is more room for operator-to-operator variance here. (We could make this more quantifiable by saying that the MDS is 6 dB (S+N)/N but in truth, it is whatever your ears tell you it is.)

Band	Frequency	Signal Gen Output (dBm)	Signal Gen Output (μ volts)
80	3,750		
40	7,250		
20	14,250		
15	21,250		
10	28,750		

Table 6. Minimum Discernible Signal (MDS)

x) Testing Gain, S+N/N, AGC Threshold and Figure Of Merit

By Walt Cates, WD0GOF

Note: *While this article uses the Hallicrafters SR-400 transceiver as an example, the concepts should apply equally well to other transceivers and receivers (other than specific numbers).*

Receiver gain, signal + noise to noise ratio ((S+N)/N), AGC linearity and AGC figure of merit are the prime indicators of receiver performance. These four items can be very difficult to determine accurately without the proper equipment. But it doesn't take much and it is not expensive. First you need a reliable, calibrated signal source. I use a 65-year-old URM-25D. It needs to cover the HF bands and all the IF frequencies. It should have metered output and built in step attenuator. In addition to a calibrated signal source, 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. Just about everything you need to “test to spec” a receiver is covered with these two test instruments.

Figure 5. General Radio 1840A Audio Output Meter

For my bench setup I have a standard ¼ inch phone plug which goes to a switch. The switch selects either a speaker or the audio power meter. Most of the equipment I work on (Hallicrafters SR series) has a front panel phone jack that disconnects internal speakers. I have an adaptor phone jack with clip leads for working on various other radios. A side benefit of using an audio power meter with built in load is you do not have to listen to the constant drone of the receiver. Switching in the speaker allows you to quickly find the signal when you change frequencies.

Note: *Unless it has been modified, the headphone jack on the Heathkit transceivers is designed for high-impedance headphones and should not be used for audio output measurements. Instead, use the speaker jack on the rear of the chassis.*

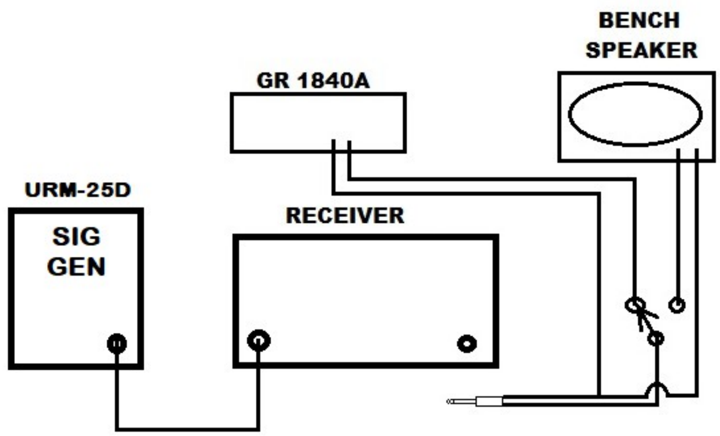


Figure 6. Receiver Test Setup

x.1. Testing

I'll give you the processes as they relate to the Hallicrafters SR series receivers. You can figure out the math and apply the process to whatever receiver you wish. ALSO NOTE THE FOLLOWING APPLIES TO HF BAND RECIEVERS.

x.1.1. Receiver Gain

This is pretty straight forward. The gain of the SR-400A for example, is stated: *With the audio and RF gain set to max, a signal at the antenna of 1uv will produce a minimum of 500mw audio output.* You can do the math for 1uv into a 50-ohm load producing 500mw across 3.5ohms and it comes out to 123db gain. This is the minimum acceptable for the SR-400. With the AF and RF gain both at max the typical gain for the 400A is 139.6db. If your unit under test states the gain in DB then you have some math you must sort out and there are many on line calculators that will help you.

x.1.2. (S+N)/N Testing

Once again, I will use the SR-400A. The spec states: Sensitivity -- *1uv or less for 20dB signal to noise ratio.* With 1uv input at the antenna and the receiver properly tuned up, RF gain at max, AF gain set for 500mw audio output. Disconnect the signal generator and the noise level should decrease by at least 20 dm. To be totally correct the receiver should be terminated in 50 ohms when the signal generator is disconnected. I have found it doesn't make much difference.

x.1.3. AGC Threshold

The AGC threshold is that point of minimum signal at the antenna where AGC starts to maintain a constant audio signal level to the speaker. I start at 5uv for all 60's or later receivers. Peak the receiver, set the RF gain to max, Set the AF gain to 500mw out. Decrease the input signal until the audio power out drops 1dB (down to 400mw or decrease of 20%). That is the AGC threshold point.

Some receivers like the SR-400A have an adjustment for setting the threshold. There are differing opinions on where the threshold should be set. In most cases I use 3uv. I want max gain for weak signals and I also want the AGC to be in the linear range of AGC action by 5uv. This is an arbitrary set point. Each manufacturer, engineer and tech have their own opinion. If the manufacturer specifies a set point it is best to use that point for assessing their products performance. When comparing receivers from different manufacturers use whatever set point works best for you.

x.1.4. AGC Figure of Merit

The AGC figure of merit is the span of the input signal where the audio output power remains within a specified limit. In the case of the SR series of receivers that specified limit is *10dB audio change over a signal input range of 60dB.*

If, the receiver gain, the (S+N)/N, and the AGC threshold are all in spec figure of merit will meet spec. If any of the three of those are at fault then the figure of merit will most likely not meet spec. So, the figure of merit is a good way to test the overall performance of a receiver.

For the SR series and most other receivers the spec is: *No more than 10 dB of audio output change from 5uv to 5000uv.*

x.2. Summation

Understanding the relationships between the different specifications is key to determining or comparing the overall performance of receivers. Always keep in mind that early receivers, 1950's and before were not built to the established standards of today. One important thing to remember is there was no standard for input Z_o of the receiver and could vary from 20 to 6000 ohms. So, determining the input power to compute the overall gain can get complicated. From the 60's on "MOST" receivers' input Z_o has been 50 or 300 ohms. First and foremost, you need to determine what you have and how to properly interface your test instruments to it. Sometimes you just got to do the math.

y) Heathkit “S” Meter Circuit

Refer to the following diagram for the “S” meter circuitry. R104 and R105 provide a small positive reference voltage for the “S” meter based on the cathode current of V3. As the AVC voltage goes more negative in response to a received signal, the negative bias on the grid increases reducing the current flow (gain) through V3, the 1st IF amp. As this happens, the screen and cathode current go down causing the screen voltage to go up while the cathode voltage goes down.

The screen current is reduced and the voltage at the junction of R106 and R107 increases while the voltage at the junction of R104 and R105 decreases causing the meter to read higher (the “S” meter is measuring the difference between the screen voltage and cathode voltage of V3).

Figure 7. "S" Meter Circuit

When the rig is first turned on (or if V3 is removed), V3 is drawing no current, the screen voltage is at its maximum and the meter should deflect to full scale (S9+60). If this is not the case, then the values of R106, R107, R110, and R105 should be checked and any that are off by more than 10% should be replaced. Carbon composition resistors will often drift higher in value as they age.

R106 (*) determines the screen voltage seen by V3. In early models, this resistor was 22k, but was later increased to 33k to reduce the failure rate of V3 due to excessive screen dissipation. If a 22k resistor is present, it should be replaced with a 30k or 33k 2w resistor.

R107 (**) determines the ‘sensitivity’ of the “S” meter. Ideally, it would be chosen to provide an S9 reading with a 50μv input signal. Because the AVC voltage controlling V3 is a function of the gain of all of the RF and IF stages, there will be considerable variation from one radio to another so the value of R107 is somewhat a compromise. There was a (factory?) mod to reduce the value of R107 to 82k to increase the sensitivity of the “S” meter. This will often cure the case where the “S” meter readings seem abnormally low. This can be accomplished by replacing R107 or adding a 470k resistor in parallel with the existing R107.

Note: Is the above paragraph actually correct? Need to verify that the screen voltage does indeed vary with the AVC voltage and that R107 affects the sensitivity.

R110 (***) raises the lower end of the “S” meter zero potentiometer slightly above ground potential to permit zeroing of the “S” meter in the absence of an input signal. Ideally, the value would be chosen such that the “S” meter is at S0 in the middle of the potentiometer travel. If the meter reads above zero and cannot be zeroed, the value of R110 needs to be reduced, lowering the voltage at the bottom of the potentiometer. If the meter reads below zero, the value of R11- should be increased.

y.1. “S” Meter vs. AVC Voltage

The “S” Meter reading is controlled by the AVC voltage present at the grid of V3, the 1st IF amplifier. As the AVC voltage goes more negative, the “S” meter reading increases. The following table provides some measured data regarding the relationship between the AVC voltage and “S” meter reading.

The measurement of the AVC voltage is taken on the RF Driver board at the end of R415 (1 megohm) that is furthest toward the rear of the chassis. The other end of R415 connects to a 3.3 megohm resistor that comprises a voltage divider that supplies the AVC voltage to the IF amplifier stages.

In this measurement, the AVC voltage is varied by using the RF Gain control to control the AVC voltage.

“S” Meter Reading	AVC Voltage (measured at R415)	AVC Voltage (measured at V3 pin 1)	V3 Screen Voltage (measured at V3 pin 6)
S0	-1.26 vdc	-0.88 vdc	
S3	-2.43 vdc	-1.85 vdc	
S6	-3.7 vdc	-2.75 vdc	
S9	-5.0 vdc	-3.7 vdc	
S9+20	-6.67 vdc	-5.3 vdc	
S9+40	-8.88 vdc	-7.0 vdc	

Table 7. "S" Meter vs. AVC Voltage

The above values can vary from radio to radio and should be viewed only as a guide. The AVC voltage at V3 pin 1 is provided by a voltage divider on the raw AVC line and should by approximately 75% on the value measured at R415. If this is not the case, it may be that one, or both, of the IF amplifier tubes is gassy creating a positive voltage that bucks the AVC voltage.

y.2. AVC and "S" Meter Calibration

Using the same setup as used for measuring SNR, you can also measure AVC and "S" meter readings. With the signal peaked, vary the attenuator to identify the "S3", "S6", and "S9" values for each band. Traditionally, "S9" is taken as 50 uv (-73dBm) although actual values can vary widely from radio to radio.

	Freq =>	**3,700**	**7,200**	**14,200**	**21,200**	**28,700**
S3	Input dBm					
	μ volts					
	AVC Voltage					
S6	Input dBm					
	μ volts					
	AVC Voltage					
S9	Input dBm					
	μ volts					
	AVC Voltage					
S9+20	Input dBm					
	μ volts					
	AVC Voltage					

Table 8. "S" Meter Calibration

z) Servicing Procedures

This section documents remove and replace procedures for several non-obvious components.

z.1. Front Panel Remove and Replace

The following steps list the procedure to remove and replace the front panel on an SB series radio.

z.1.1. Front Panel Removal

1. Remove all of the front panel knobs, including the small knob on the zero setting shaft.
2. Remove the nut, lock washer, and large flat washer from the main frequency tuning shaft
3. Remove the tuning dial escutcheon
4. Disconnect the wires going to the microphone connector and remove the microphone connector (transmitters and transceivers only)
5. Disconnect the meter leads (leave the meter attached to the panel)
6. Loosen the nuts on the Preselector and PA Tune shafts until they are clear of the bushings (the nuts are located on the back side of the panel)
7. Remove all of the nuts and washers on the front panel
8. Remove the two screws at the top corners of the panel that attach the panel to the side braces
9. The front panel should now be free and can be removed taking extra caution to prevent pulling on the zero set shaft.

Note: I wonder if it is necessary to remove the escutcheon? It seems like you should be able to loosen the nut on the main tuning shaft and lift the shaft and gently pull it forward to clear the tuning dial

z.1.2. Front Panel Installation

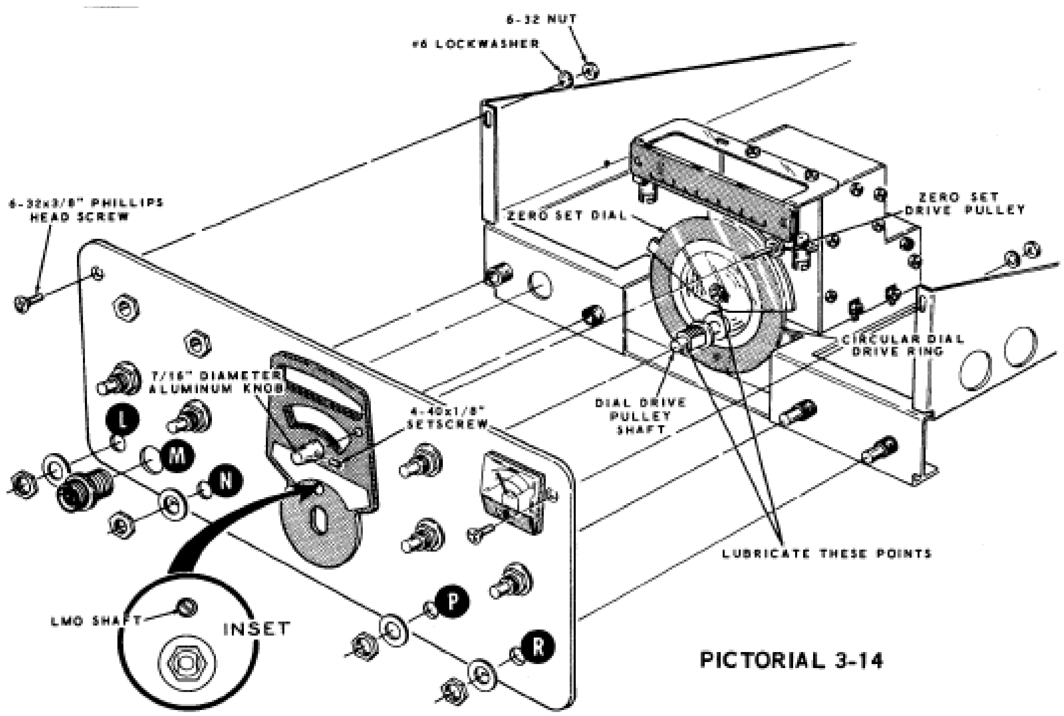


Figure 8. Front Panel Installation

1. Mount the meter to the front panel, if it is not already installed.
2. Make sure that the internal lock washers and nuts are positioned on the Preselector and PA Tune shafts
   a) Make sure that the preselector shaft has these items installed in the following order facing back from the panel: a flat washer, a lock washer, the nut and two rubber "O" rings. The bushing for the Preselector shaft is installed from the front after the panel is installed.
   b) Make sure that the PA Tune shaft has these items installed in the following order facing back from the panel: a flat washer, a lock washer, the shaft bushing and a large "O" ring. The front flat washer and nut are installed from the front after the panel is in place.

Mount the tuning dial escutcheon to the front panel, if it is not already installed.

Position the main tuning shaft and beveled washer pulley on the metal ring on the circular frequency dial. The mounting nut, large washer, and lock washer will be installed after the front panel is installed.

Make sure the zero set shaft and pulley are installed and located in their approximate final position in order to slide through the corresponding hole in the tuning dial escutcheon

Warnings:

a) During this procedure, be especially careful not to place too much pressure on the main tuning dial.
b) During this procedure, be especially careful not to place too much pressure on the zero set shaft.

Gently slide the front panel over all of the control shafts, paying particular attention to the Preselector and PA Tune shafts as they will tend to be pulled down by the rubber “O” rings.

When all of the front panel control are through to corresponding holes in the front panel, gently slide the panel all the way on paying particular attention to the zero set shaft and main tuning shaft

Loosely install the flat washer and nut on the Headphone Jack and AF Gain controls (this will help hold the front panel in position).

Make sure the locating tab on the Band Switch is correctly located in the hole in the chassis. Loosely install the flat washer and nut on the Band Switch.

Install the microphone connector with the two sockets located horizontally. Pin number 2 (the PTT Line) should be positioned closest to the headphone jack

At this point, the flat washers and nuts can be installed on the remaining controls.

Install the bushings for the Preselector and PA tune shafts. Once the nuts are started, leave them loose temporarily, install the sub-panel with the VOX controls and then tighten the nuts.

Install the two screws holding the front panel to the side supports

Reconnect the two black wires to pin 2 of the microphone jack and the 22kΩ resistor to pin 1 of the microphone jack

Reconnect the meter leads

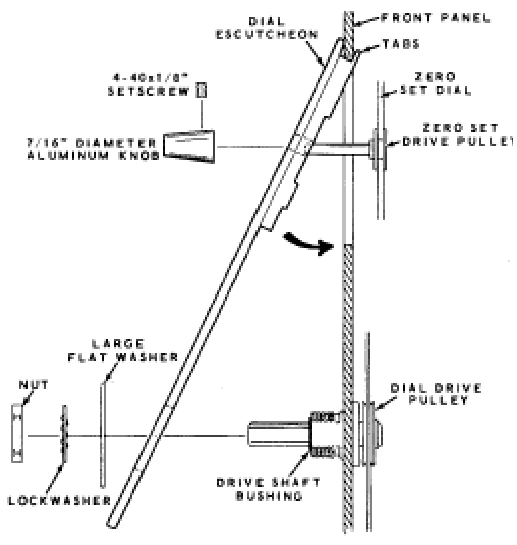
z.2. Front Panel Escutcheon Mounting

The following procedure was taken from SB-101 Assembly Manual but should apply equally to any SB-series product using the same dial mechanism.

> <u>NOTE:</u> *If the front panel is not installed, it may be easier to mount the escutcheon to the front panel before installing the front panel.*

> <u>NOTE:</u> *If the front panel has been repainted, the paint may have added enough thickness that the tabs on the escutcheon may no longer fit over the panel. Removing a slight amount of material on the rear side of the panel may allow the escutcheon to be installed.*

Refer to Detail 3-14A for the following steps.



Detail 3-14A

Figure 9. Front Panel Escutcheon Installation

1. Place the drive' shaft bushing assembly (#455-42) over the dial drive pulley.
2. Carefully lubricate the shaft of the dial drive pulley and the center bearing of the Zero set dial with a small amount of silicone grease.
3. Push the dial drive bushing down into the keyhole slot so the dial drive pulley engages with the circular drive ring.
4. Snap the zero set drive pulley (small pulley) onto the zero set dial. Position the pulley and dial as shown.
5. Mount the dial escutcheon as follows:

   Start the shaft of the zero set pulley through the small hole in the escutcheon. Position the tabs at the top of the escutcheon inside the front panel. Slide the escutcheon in place with the dial drive bushing and shaft through the lower hole. Secure the dial drive bushing with the large flat washer, lock washer, and nut.

NOTE: The amount of torque required to turn the circular dial can be adjusted by moving the dial drive bushing up or down.

6. Push the zero set drive pulley flush with the inside of the dial escutcheon; then install the 7/16" diameter aluminum knob on the shaft of the zero set drive pulley with a 4-40 x 1/8" setscrew. Be sure the zero set dial does not rub against the circular dial plate. They must be separated by at least 1/64".

NOTE: *The following adjustment of the front panel is critical and must be done carefully to obtain smooth operation of the dial mechanism.*

7. Align the small hole in the center of the escutcheon with the end of the LMO shaft by carefully moving the front panel. See the inset drawing on Pictorial 3-14. Tighten the control nuts at L, P, and R with the bottom edge of the front panel parallel with the bottom edge of the chassis. Also, tighten the hardware at the upper corners of the front panel.

z.3. SB Series Dial Mechanism

The following section is taken from the SB-101 Assembly Manual and describes installation, adjustment and calibration of the dial mechanism.

z.3.1. Installation of the Spiral Groove Follower Mechanism

1. Refer to Detail 3-7A and install the nylon spiral follower on the dial pointer drive arm. Use a 3-48 x 1/8" screw. Be careful not to over tighten the screw.
2. Mount the dial pointer drive arm on the chassis. Use 6-32 x 3/8" hardware. Position the screws in the center of the chassis and dial pointer drive arm slots.
3. Refer to Pictorial 3-8 for the following steps.
4. Mount the plastic dial window (#464-30-1), two pilot lamp sockets (#434-44) and the dial pointer assembly (#100-443), to the dial mounting bracket (#204-553). Use 3-48 x 3/8" flat head hardware. Be sure to position the plastic dial window and dial pointer assembly as shown.
5. Mount the dial mounting bracket on the LMO. Use the two top front screws of the LMO. Position the stud on the rear of the dial pointer into the slot of the dial pointer drive arm.
6. Refer to Detail 3-8A for the following steps.
7. Twist together a 6-1/2" brown wire and a 6-1/2" white wire to form a twisted pair with approximately 2 turns per inch.
8. At one end of this twisted pair of wires, connect the brown wire to lug 1 (S-1) and the white wire to lug 2 (S-1) of pilot lamp socket DF.
9. Position the other end of this twisted pair of wires between the dial pointer drive arm and the front of the LMO. Connect the brown wire to lug 1 (NS) and the white wire to lug 2 (NS) of pilot lamp socket DG.
10. Twist together an 8" brown wire and a 6-1/2" white wire to form a twisted pair. At the end where the wire ends are even, connect the brown wire to lug 1 (S-2) and the white wire to lug 2 (S-2) of pilot lamp socket DG. Bend down lugs 1 and 2 of socket DG so it clears the/ dial painter. The other ends of these wires will be connected later. Install pilot lamps and pilot lamp shields in pilot lamp sockets DF and DG. Position the shields as shown. Be sure none of the lugs of the pilot lamp sockets touch any other metal parts.

z.3.2. Installation of Circular Dial on LMO Shaft

Refer to Detail 3-8B for the following steps.

1. Turn the shaft of the LMO fully counterclockwise, against the stop.
2. Start an 8- 32 x 1/4" setscrew in the tapped hole in the hub of the circular dial (#100- 449).

3. Position the circular dial on the LMO shaft with the "90" marking straight up, and position the nylon spiral follower in the first groove (nearest the hub) of the circular dial; then tighten the setscrew.

   NOTE: If the nylon follower will not fit into the first groove of the circular dial, loosen the hardware that secures the dial pointer drive arm to the chassis. Then move the dial pointer drive arm as required. Retighten the hardware.

4. Check to see that the front of the plastic dial window is flush with the zero set dial on the circular dial. If not, loosen the two screws in the top of the LMO and adjust the dial mounting bracket as required. Retighten the screws. See the inset drawing on Pictorial 3-8.

   NOTE: If the zero set dial does not rotate freely under the plastic dial window, bend the dial mounting bracket up to obtain sufficient clearance.

5. Check to see that the "90" marking on the circular dial is directly under the "2-1/2" mark on the plastic dial window when the shaft of the LMO is turned fully counterclockwise. If not, loosen the circular dial setscrew and make the necessary adjustment. Retighten the setscrew.

   NOTE: The pointer on the 0 to 5 linear dial will be near the 0 position.

   Refer to the left-hand drawing in Pictorial 3-9 for the following steps.

6. Rotate the circular dial clockwise from the fully counterclockwise position ("90" marking) to the first zero marking. The dial pointer should be at the zero marking on the plastic dial window. If not, perform one of the following two steps. Use the open-end wrench supplied.

   a) If the dial pointer is to the right of the zero marking, loosen the dial pointer drive arm mounting screws, and move the dial pointer drive arm base to the right until the dial pointer is at zero. Do not move the dial pointer drive arm base up or down. Retighten the screws.

   aa) If the dial pointer is to the left of the zero marking, loosen the dial pointer drive arm base- to the left until the dial pointer is at zero. Do not move the dial pointer drive arm base up or down. Retighten the screws.

Refer to the right-hand drawing of Pictorial 3-9 for the following steps.

1. Rotate the circular dial in a clockwise direction one revolution (zero to zero); this should move the dial pointer to the "1" marking on the plastic dial window. Each time the circular dial is rotated one more revolution clockwise, the dial pointer should advance one more number on the plastic dial window. After five complete revolutions the dial pointer should be at or very close to the "5" marking on the plastic dial window. If not, perform one of the following two steps.

   CAUTION: When performing either of the two following steps, be very careful not to move the dial pointer drive arm base to the left or right, as this will disrupt the zero end dial pointer adjustment.

a) If the dial pointer is to the left of the "5" marking, loosen the dial pointer drive arm mounting screws and move the dial pointer drive arm base up until the dial pointer is at the "5" marking. Retighten the screws.

ab) If the dial pointer is to the right of the "5" marking, loosen the dial pointer drive arm mounting screws and move the dial pointer drive arm base down until the dial pointer is at the "5" marking. Retighten the screws.

The preceding adjustment may affect the dial pointer setting at the zero marking. Repeat the entire dial adjustment procedure as many times as necessary to obtain proper dial pointer calibration.

Because the dial pointer is only a turns counter, it need not be exactly at a number when the circular dial is at one of its five possible zero settings; however, the preceding steps should permit fairly close calibration. Rotating the circular dial from a fully counterclockwise position to a fully clockwise position will cause the dial pointer to go to the left of the zero marking and to the right of the "5" marking on the plastic dial window. These adjustments in no way affect frequency calibration, which depends only on the circular dial reading.

ab.1.1. Dial Calibration

1. Zero beat the Main Tuning dial at 3.7 MHz.
2. Check for the calibrate signal and set the Zero Set dial. If the hairline is not close to the window center, proceed with the following steps.
3. Remove the knob from the Main Tuning shaft without disturbing the zero beat setting.
4. Place a screwdriver through the hole in the dial escutcheon (directly above the main tuning shaft) and into the LMO dial drive shaft.
5. Hold the LMO dial drive shaft on zero beat and loosen the setscrew in the circular dial. Turn the circular dial until the 0 is directly behind the line on the zero set dial. Now retighten the setscrew in the circular dial. Wrap tape around the Allen wrench so you do not short circuit the pilot lamp socket with the Allen wrench.
6. Make sure the circular dial turns freely and the nylon spiral follower is properly engaged in the spiral groove before proceeding.
7. Replace the knob on the Main Tuning shaft.

ab.1.2. Re-engaging the Main Tuning Pulley

The main tuning shaft may have become mispositioned as a result of removing the front panel escutcheon, panel replacement, or adjustment attempts.

The pulley on the inner end of the main tuning shaft has a pair of beveled washers that grip a metal ring on the inside of the circular dial. Turning the main tuning shaft causes the beveled pulley to turn the metal ring on main tuning shaft.

If the dial mechanism slips while tuning, it may be that the beveled pulley is not gripping the metal ring sufficiently. To remedy this, loosen the nut on the front of the shaft slightly and move the bushing and shaft down very slightly.

If the pulley on the end of the main tuning shaft is positioned to the front of the metal ring, the dial will not move unless the main tuning shaft is pushed in slightly. On the other hand, if the pulley is positioned behind the metal ring, the dial will only move when the main tuning shaft is pulled forward slightly so that the pulley is pressing on the back of the metal ring.

In either case, the pulley can be positioned correctly by removing the large knob on the tuning shaft and loosening the nut enough so that the bushing can be moved up and down. When this has been done, the bushing can be moved up enough to permit the main tuning shaft to be moved in and out. While doing this, the pulley can be repositioned on the metal ring. This has to be done by “feel” as it is not possible to see when the pulley is correctly positioned. When the pulley is correctly positioned, the main tuning shaft and bushing can be moved down enough to provide smooth operation of the dial, the nut tightened and the knob replaced.

Note that it is not necessary to remove either the escutcheon or front panel to perform this operation.

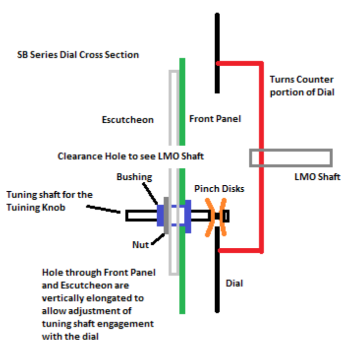


Figure 10. Main Tuning Shaft Beveled Pulley

ab.1.3. Drag When Rotating Main Tuning Knob

Sometimes when turning the main tuning knob, it may be noticed that there is an excessive amount of drag, or a periodic increase in the amount of force required to turn the knob. Assuming that the problem is not in the LMO itself, here are a couple of things to check.

One possible cause is that the circular dial is binding on the cable bundle that is located towards the bottom left of the circular dial. The cable bundle is held in place with a plastic cable clamp which may have loosened with time allowing the cable to shift forward and rub against the back side of the dial. Replacing the cable clamp and/or pushing the cable further back may eliminate the drag. Alternatively, moving the circular dial forward slightly may allow the dial to clear the cables.

Another possible cause is that the circular dial has a slight amount of ‘wobble’ as described in the following section. This can result in a change in the force required as the main tuning knob is rotated if the circular dial is binding on the nylon follower that operates the slide rule dial. The small tip of the follower should track the groove on the back of the circular dial, but should not bottom out in the groove. Moving the circular dial outward (toward the front panel) slightly may eliminate the drag. Moving the circular dial outward too far can result in the nylon follower coming out of the groove in the back of the circular dial altogether.

ab.1.4. Circular Dial Wobble

It may be noticed that the main tuning mechanism exhibits an uneven drag or resistance as the LMO is tuned through its range. This drag may become more pronounced as the tuning approaches the 5 end of the slide rule dial. If so, here is one possible cause.

Upon investigation, it was determined that the circular dial had a “wobble” or “eccentricity” as the LMO shaft was rotated. This wobble causes the spiral groove on the back of the dial to move in and out as the dial is rotated and can result in the spiral groove follower either coming out of the groove or bottoming out in the groove causing uneven drag.

Initially, two possibilities were considered: the hub in the circular dial was not perpendicular to the face of the dial, or the LMO shaft was eccentric or wobbling as it was rotated. However, neither of these proved to be the case and the actual cause was more subtle.

It was noted that when the circular dial was placed on the LMO shaft but the set screw was not tightened, one could wiggle the dial from side to side slightly due to the clearance between the LMO Shaft and the inside of the hub on the circular dial. When the set screw was tightened, it pushed the rear of the bushing away from the LMO shaft resulting in the dial being slightly “cocked” relative to the LMO shaft. This was the ultimate cause of the observed wobble.

Some clearance is necessary in order to be able to slip the circular dial on the LMO shaft, but too much clearance results in excessive wobble. Probably when everything was new, the fit was near perfect and any wobble was minimal, but this may have changed with time, especially if the LMO shaft has been filed or burnished to remove burrs or scarring left by the set screw.

The amount of ‘wobble’ was measured by placing a dial indicator on the outer edge of the dial and rotating the dial through one complete revolution. As shown in the figure, the dial was furthest forward at the position of the set screw and furthest back directly opposite the set screw. In the worst case seen, the amount of dial wobble was nearly 0.100” versus another radio where the wobble was approximately 0.020”. If the wobble is excessive, the nylon spiral groove follower may bind on the back of the dial (causing drag) or come out of the track (causing the slide rule dial to skip).

It may be possible to insert a very thin shim (.001” or .002”) between the shaft and dial bushing directly opposite the set screw. It does not matter if the dial runs slightly eccentric (up and down a bit) as a small amount of up and down motion of the circular scale is probably not noticeable.

ab.1.5. Spiral Groove Nylon Follower Replacement

In several instances, the small tip on the nylon follower that rides in the spiral groove of the circular dial may have been damaged. When this occurs, the follower mechanism and slide rule dial no longer function.

It is possible to fashion a replacement using a threaded nylon standoff insulator designed for mounting printed circuit boards. In this example, the nylon standoff was part of an assortment that was purchased via ebay *(M2 Nylon Screw White Hex Nut PCB Standoff Assortment Kit 140Pcs)*.

The smallest of the standoffs (M2 x 5mm) was a good match for the size of the original nylon follower and was used to fashion a replacement.

The diameter of the threaded portion of the standoff was too large to fit into the spiral groove and was reduced by putting the standoff in a drill and using a small file, or sandpaper, to reduce the diameter of the threaded portion enough so it would fit comfortably in the spiral groove of the circular dial. A wire cutter was used to snip off a small portion of the (now reduced) threaded portion of the standoff to obtain the desired length.

The original nylon follower was removed and replaced with the modified standoff using the screw provided in the kit.

ab.1.6. Zero Set Dial Mechanism and Pulley

It may be found that the rear washer of the zero set pulley has broken off and it is no longer possible to move the plastic window with the dial cursor. The pulley consists of a front washer, spacer, and rear washer. Originally, the shaft holding the rear washer was peened to hold the washer in place.

If the washer has come off, but is still available, it may be possible to reattach it by replacing the spacer and pulley on the shaft and soldering the washer to the end of the shaft, or dimpling the end of the shaft using a center punch. If soldering, be sure to clean and tin both the end of the shaft and washer before soldering.

If the spacer has been lost, it may be possible to replace it with one salvaged from a rotary switch.

If the rear washer is missing is may be possible to replace it with a brass washer of about the same size (1/8” hole, 0.375” diameter, and 0.012” thick) and solder it to the end of the shaft.

If the zero set mechanism is intact, but the operation is erratic due to slippage of the pulley, it may be possible to improve the operation by cleaning the pulley with a q-tip moistened in alcohol. If this is ineffective, you might try using a thin coating of a ‘non-slip’ liquid to the inside of the pulley.

Zero Set (part 2)

If the "zero set" dial window (with the vertical line) is "floppy", the clip holding it to the tuning dial hub has probably come off (the clip is available at hardware stores). If the the "zero set" dial slips, the pinch roller, made up of two spring washers, is loose. It could be just wear over time but the problem I've seen here is that someone pulled the front bezel/panel off, not knowing that the pinch wheel is supposed to stay with the dial.

As the aluminum shaft oxidizes and increases in size, it tends to stick in the plastic bezel (easy mistake to make - personal experience). This stresses the rear spring disk and bends it and/or pops it off the shaft.

To fix, flatten the spring disk if necessary. Place a nut on the shaft, against the front shoulder to distribute the force, and insert the shaft loosely into a vice, small socket, hole in a metal plate, etc. Put the rear spring disk on and make sure it's flat against the shoulder on the rear of the shaft. Center punch the shaft to expand it slightly and hold the rear spring washer. It would also be prudent to find out where the old part(s) went if anything is missing.

If the pinch roller was just slipping due to age the fix is to add some "grip" material like silicon to the inner surface of the pinch roller or to the outer surface of the dial window. The dial window tracks in approx 2/3 of the depth of the pinch roller.

ab.1.7. Repairing the Center Hub

Source: Unknown

For those with ailing SB-series tuning dials, I hope this will be of some use:

The following is my best attempt at describing how I restored the broken tuning dial on an otherwise nice Heathkit SB-101. The end result was a super-smooth operating dial mechanism, that's robust enough to outlive the rest of the radio.

My dial had the aluminum hub completely broken/stripped out of the center of the plastic dial (the "pocket"), with many pieces of the plastic floating loosely in the dial pocket. And there were several radial cracks thru the plastic, running from the hub area to the outer edge of the dial.

I first applied a little gorilla super glue along the cracks (front side on the central transparent area, rear side on the black outer area with the graduations), then tightened a 4" stainless hose clamp around the outer edge, closing the cracks where the super glue had been applied. Let it set for a couple of hours.

I left the hose clamp tightened around the dial circumference, and fit the aluminum hub back into the center of the dial, adjusted the hose clamp so when the dial and clamp were laid front-side up on a horizontal surface, the hub was correctly positioned so the plastic index cursor piece just cleared the steel ring on the dial that's driven by the pinch drive wheel. The hub should be rotated to a position such that the hex pocket of the set-screw on the hub is pointing at about "95" on the dial before filling with the J-B Weld, so you can position/index the dial per the Heathkit instructions, and can tighten the setscrew with a long hex wrench from the topside of the radio. Make sure that the hose clamp and the rear of the aluminum hub are supported to maintain their correct relative positions when laid on the flat surface (front-side "up"). I then removed the transparent plastic index cursor piece from the aluminum hub (removed snap ring), and carefully removed the steel ring from the dial (4 "thru" locking tabs).

With the clamp tightened in the correct position and the hub installed in the center of the dial in the correct axial (in-out), and rotational position previously determined (when the plastic dial cursor was still installed), and the dial/hub together and placed outer side "up", I filled the entire dial "cup" surrounding the hub and out to the outer edge of the "cup" with J-B Weld. Careful not to get that fill so deep that it is higher than the bearing surface on the hub that supports the plastic index cursor. After letting the J-B Weld cure for 24 hours, I machined out a 3/4" wide band of the fill around the outer edge of the fill (dial pocket) just deep enough to allow for clearance for the pinch roller drive wheel.

I did the complete fill of the pocket because I wanted the area with cracks in the transparent pocket to be reinforced by the J-B Weld. You could avoid the need to machine out the fill for the pinch roller drive wheel by just using a round cylinder form around the hub that leaves at least 3/4"-wide clearance band at the outer edge of the pocket, and just fill the area between the hub and the inner side of the cylinder form with J-B Weld. Just be sure the fill doesn't extend beyond the hub bearing surface for the plastic index cursor. A plastic or metal cylinder form would be OK, and you wouldn't need to use a form release compound if the outer diameter of the cylinder gives you the needed 3/4"-wide clear band at the outer edge of the pocket. ALSO.......if you use this technique of a partial fill with the cylinder form, YOU WOULDN'T NEED TO REMOVE THE STEEL RING FROM THE DIAL (secured by the 4 thru tabs).

Sorry, but I couldn't figure out how to include a picture of the filled dial pocket. Depending on how badly the dial has been damaged (cracks in the transparent pocket area), you may want to smooth any rough edges on the backside of the pocket which has the spirally grooved tracks, so the nylon stylus pin tracks smoothly (without hanging up) in the spiral groove on the backside of the dial. I used 800 grit cloth to very lightly smooth the outer surface of that area, and the spiral grooves themselves.

The finished dial works smoother than ANY of the many SB's that I've had, and will outlast the rest of the radio many times over. The procedure sounds complicated and difficult, but it isn't really. It's just harder to explain than actually doing it.

BTW......forgot to mention:

DO NOT use the J-B KWIK (quick setting), since it sets up in under 4 minutes, which is way too fast for a task like this, and doesn't fill all the voids as well as the normal slow-setting epoxy or J-B Weld. And, of course, all surfaces to be bonded by the J-B Weld or epoxy should be prepared by thorough cleaning/degreasing, and "roughed up" for best adhesion.

ab.2. Knob Inlays

- The small knob spun aluminum inlay is 9/16" diameter
- The large knob spun aluminum inlay is 1½" diameter (HW and SB series)

Occasionally, someone produces inlays that show up online.

ab.3. PA Load Capacitor Remove and Replace

1. Remove the top and rear covers to the PA cage
2. Remove the load cap "O" ring and pulley (the pulley uses the same 5/64” Allen wrench as the knobs)
3. Under the chassis, disconnect the leads to the old load cap (at three different places).
4. Disconnect the silver mica cap that goes from the neutralizing capacitor from the PA Tune cap
5. Disconnect the plate blocking capacitor from the PA Tune cap
6. Disconnect the 10 Meter coil
7. Remove the 4 screws that hold the PA Tune cap bracket and remove the bracket and PA Tune cap (and anything still attached to it)
8. Remove the 3 screws under the chassis that hold the PA Load cap. Do not lose the fiber washers that are on the top side and keep these screws separate as they are shorter than the 4 removed in step 7 (the washers and shorter screws ensure that they won't touch the plates of the load cap)
9. At this point, the load cap should be free and can be removed.

To replace the load cap, simply reverse the above steps.

ab.4. Function Switch (A.C. Switch)

It is not unusual for the AC portion of the Function switch to fail with the result that the radio cannot be turned on or off with the switch. Unfortunately, it is usually not possible to find a replacement for the AC switch portion.

Note: *it is highly recommended that power be controlled with an external power strip or AC control panel to avoid stressing the A.C. switch.*

ab.4.1. Finding a Replacement AC Switch

While the ideal solution is to locate a replacement switch (from a parts unit), this may not always be possible. In addition, a replacement switch is subject to the same potential failure as the original switch given the age and usage of a replacement.

ab.4.2. Replacing the AF Gain with a Control Having an AC Switch

While a non-standard fix, it is possible to replace the AF Gain control with a new potentiometer that has an AC switch. The pot should be 500k ohms with an audio taper and the switch should be capable of switching at least 5 amps.

ab.4.3. Modifying the Failed Switch with a Microswitch

Another option is to modify the function switch by replacing the original AC switch with a micro-switch that is activated by the existing tab. To do this, it is necessary to

1. Disconnect the power cable from the radio.

Disconnect the two wires that go to the AC switch portion of the function switch.

Remove the existing switch from the panel by removing the knob and mounting nut and washer. It is not necessary to disconnect the wires that go to the wafer portion of the switch.

Remove the original AC switch by removing the two nuts on the ends of the screws that hold the switch together. Keep the switch positioned so that the screws remain in place.

Remove the switch mounting plate and then remove the switch from the mounting plate by bending the three tabs up and removing the switch

Reinstall the mounting plate using the existing screw closest to the grounding lug.

Replace the screw opposite the grounding lug with a 4-40 x ???” . Do not install the nut yet

Bend the actuating lever on the micro switch so that it will engage the tab on the switch mounting plate (see photo). Cut off any excess of the actuating lever to prevent binding.

Install the nut on the screw holding the micro-switch, adjust the position of the micro-switch and actuator lever so that the micro switch switches on-off as the function switch shaft is rotated.

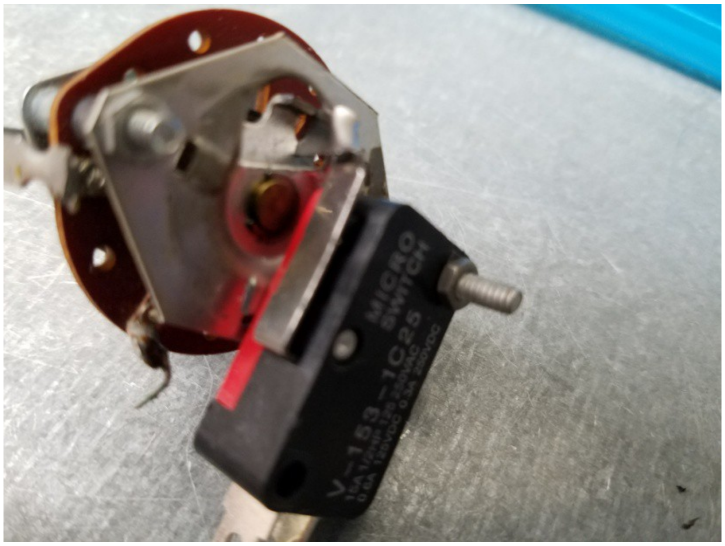


Figure 11. Modified Function Switch

ac) Modifications

While many of the modifications in this section are oriented toward the HW-101, they should apply equally well to the SB series. As with all vintage radios, one should consider whether a certain modification is desirable, or not.

Many thanks to Lenny WB8JCJ for his help in editing, image scanning, input, and implementation of these changes into his HW-101. His help was indispensable.

Mark WB8JKR

ac.1. Conversion to Low-Z Headphones:

These rigs are designed to be used with Hi-Z headphones, but if low-Z phones are used the outboard speaker will not mute completely with the phones connected. To convert to low-Z phones, make the following wiring changes referring to (Figure 12. Modification for Low Z Headphones) of this document, and pictorial 8-4 (foldout from page 53), and pictorial 8-5 (foldout from page 67) of the HW-101 manual:

1. Remove the black wire from terminal strip BA lug 2 and reconnect it to lug 3 (ground).
2. Remove the green wire and the 100Ω resistor from jack AB (speaker).
3. Connect the green wire to terminal strip BA lug 2.
4. Connect the 100Ω resistor removed in step 2 to lugs 2 and 3 of terminal strip BA.
5. Remove the jumper wire from lugs 1 and 2 of headphone jack L.
6. Run a NEW wire along the wiring harness from speaker jack AB lug 1 to the headphone jack lug 2.

Now the external speaker should mute completely when low-Z phones are used.

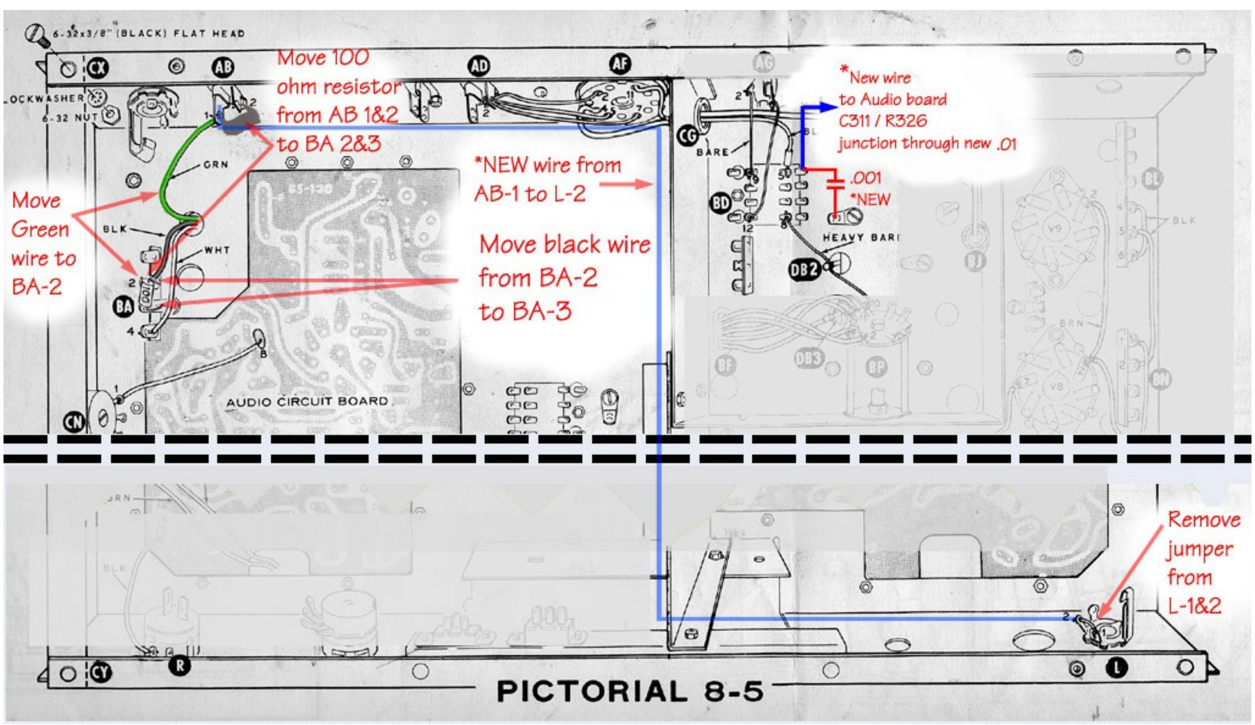


Figure 12. Modification for Low Z Headphones

ac.2. Improved CW Operation:

In the CW mode the rig's relays are energized by the CW sidetone amplifier's sidetone output driving the VOX relay amplifier. The audio (sidetone) drive to the VOX amp is a bit on the low side for fast relay action, and at speeds approaching 20 wpm the first dot sent is heard in the sidetone but isn't transmitted due to the slow relay response time.

Correcting this is a very simple modification – simply replace the 470KΩ resistor R328 on the audio board with a 1KΩ resistor ***(Figure 2)***. This increases the drive to the VOX amp enough to cause the relays to pull in quicker. Now the rig will key reliably at 20 wpm. The first dot tends to become shortened at 25 wpm but the rig is useable at this speed.

Another annoying problem with these rigs is the fact the sidetone can be heard when the rig is in the CW mode without the key actually being pressed. Although the sidetone amplifier is in deep cutoff, there is enough coupling through the inter-electrode capacitance of the tube to allow the output of the sidetone oscillator to be heard at a constant low level even when the key isn't being pressed. Fortunately this is also fairly easy to correct:

1. Connect a .001 μfd disk capacitor (DO NOT use a higher value) from relay RL1 pin 1, to ground *(see* Figure 12. Modification for Low Z Headphones***).***
2. Connect a piece of wire about 8" long from pin 1 of RL1 and run this wire through the same opening in the shield as the wiring harness.
3. On the audio circuit board, replace 1MΩ resistor R326 with a 2.2MΩ resistor ***(Figure 2).***
4. At the circuit board junction of R326 and C311, connect one side of a .005 μfd 500v disk capacitor, and connect the other side of this capacitor to the wire from RL1 pin 1.

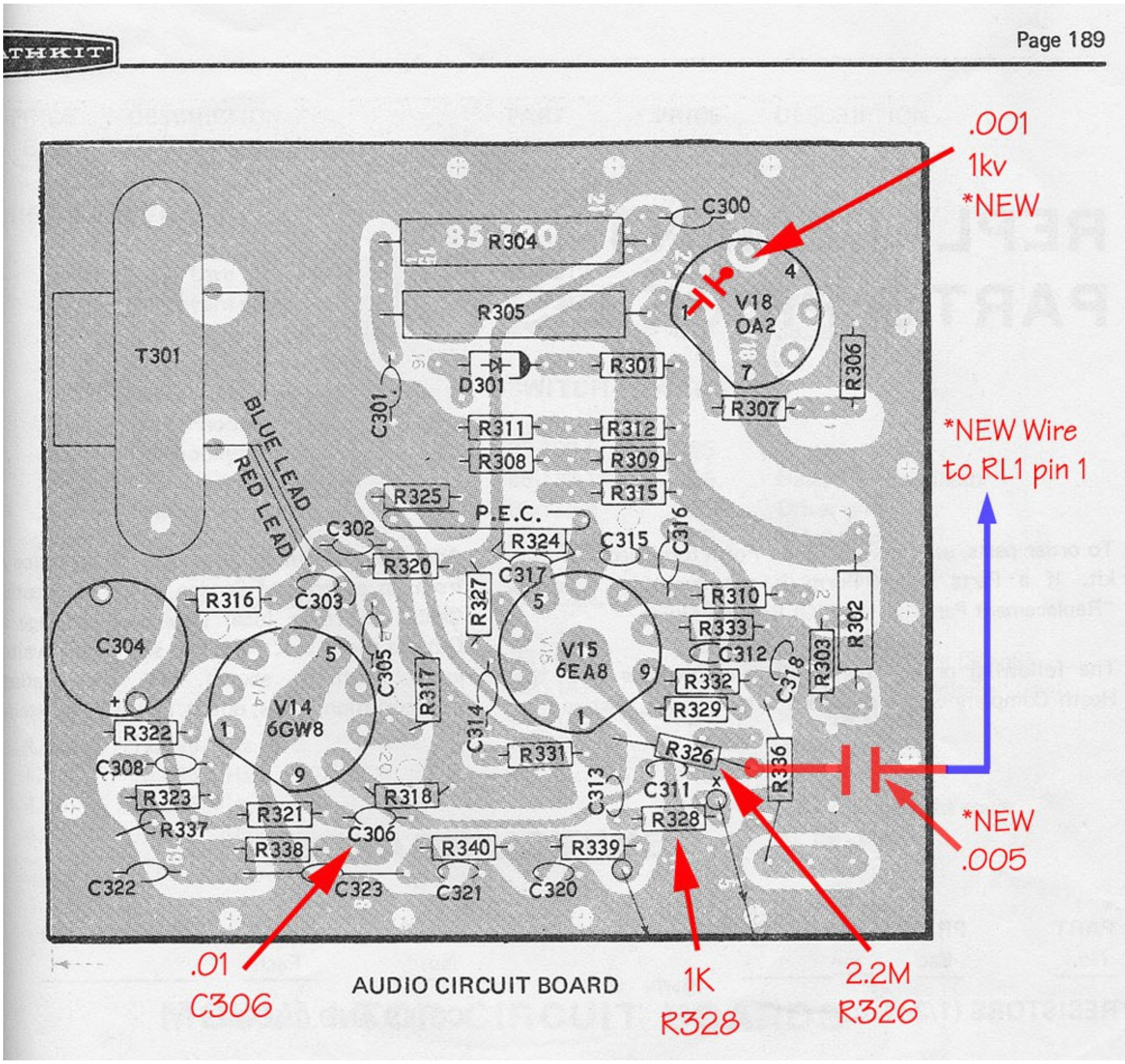


Figure 13. Audio Circuit Board Modifications

Now during receive, the sidetone will be bypassed to ground by the normally closed contact on RL1. During transmit, RL1 opens and the sidetone works normally.

ac.3. Transmit Improvements

The transmitter audio quality can be improved by changing the value of coupling capacitor C11 on the modulator board from .001 µfd to .01 µfd *(see* Figure 15. Modulator Circuit Board *on page 86)*. This will increase the low frequency response and give the transmit audio a little more “body”.

If 10KΩ resistor R202 is present between the I.F. circuit board (L101 pin 4) and the bandpass circuit board (V5 pin 2), remove and replace it with a piece of insulated hook up wire ***(Figure 3)***. This will increase drive to the 1st transmit mixer. This change is already incorporated in later model HW-101s.

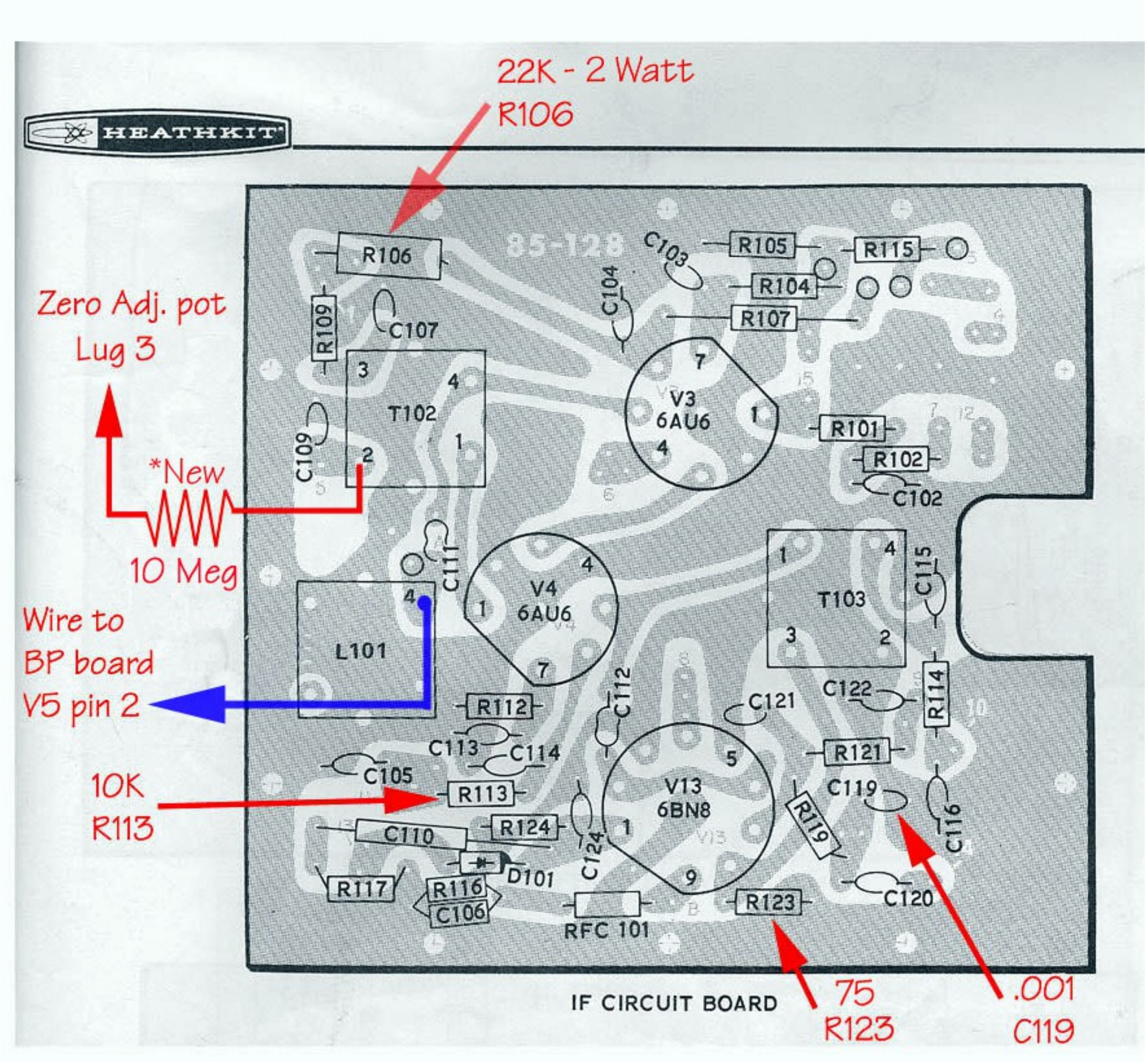


Figure 14. IF Circuit Board Modifications

ac.4. Receive Improvements

The receiver's strong signal-handling capability and audio quality can be vastly improved by the following changes:

During alignment check to see if, while adjusting T-102 *(see* Figure 14. IF Circuit Board Modifications *on page 84)*, there are two points where the transformer can be peaked -- one spot for transmit and a slightly different setting for receive. If so, peak the transformer for maximum transmit drive instead of maximum receive gain. The receiver has an abundance of gain, however the transmitter could use a little extra. This will get rid of some of the receiver gain but WILL NOT affect receiver sensitivity.

Also change the value of the screen dropping resistor R113 in the second I.F. amplifier V4 from 1KΩ to 10KΩ *(see* Figure 14. IF Circuit Board Modifications *on page 84)*. This will reduce the gain of this stage a bit and improve gain distribution.

ac.5. BFO Level to Product Detector

The next step in receive improvements is to increase the BFO drive to the product detector. The BFO (carrier oscillator) injection to the product detector should be about five times the level of the I.F. signal for low distortion. On these rigs, the I.F. signal can equal the BFO injection level under strong signal conditions resulting in a very raspy, distorted audio quality. I have even noted at times some pulling of the BFO oscillator frequency. The major problem is that during receive, the BFO signal is coupled to the product detector cathode through C17, a 12pf silver mica capacitor which is connected to a piece of coax running to the product detector cathode. The capacitance of the coax cable exceeds the value of coupling capacitor C17, and the combination of the two acts as a voltage divider, greatly reducing BFO drive level to the product detector V13C.

Correcting this involves increasing BFO drive and decreasing the I.F. drive to V13C.

To increase BFO drive, simply replace coupling capacitor C17 on the modulator board with a 100pf silver mica, and replace the 33KΩ resistors R6 and R7 on the modulator board with 27KΩ resistors *(see* Figure 15. Modulator Circuit Board *on page 86)*. To reduce the I.F. drive, change resistor R123 on the I.F. board from 470Ω to 75Ω *(see* Figure 14. IF Circuit Board Modifications *on page 84)*.

Note: *Rather than replacing C17, it may be simpler to add a 47pf silver mica cap in parallel with C17. The added capacitor can be soldered on the foil side of the Modulator board.*

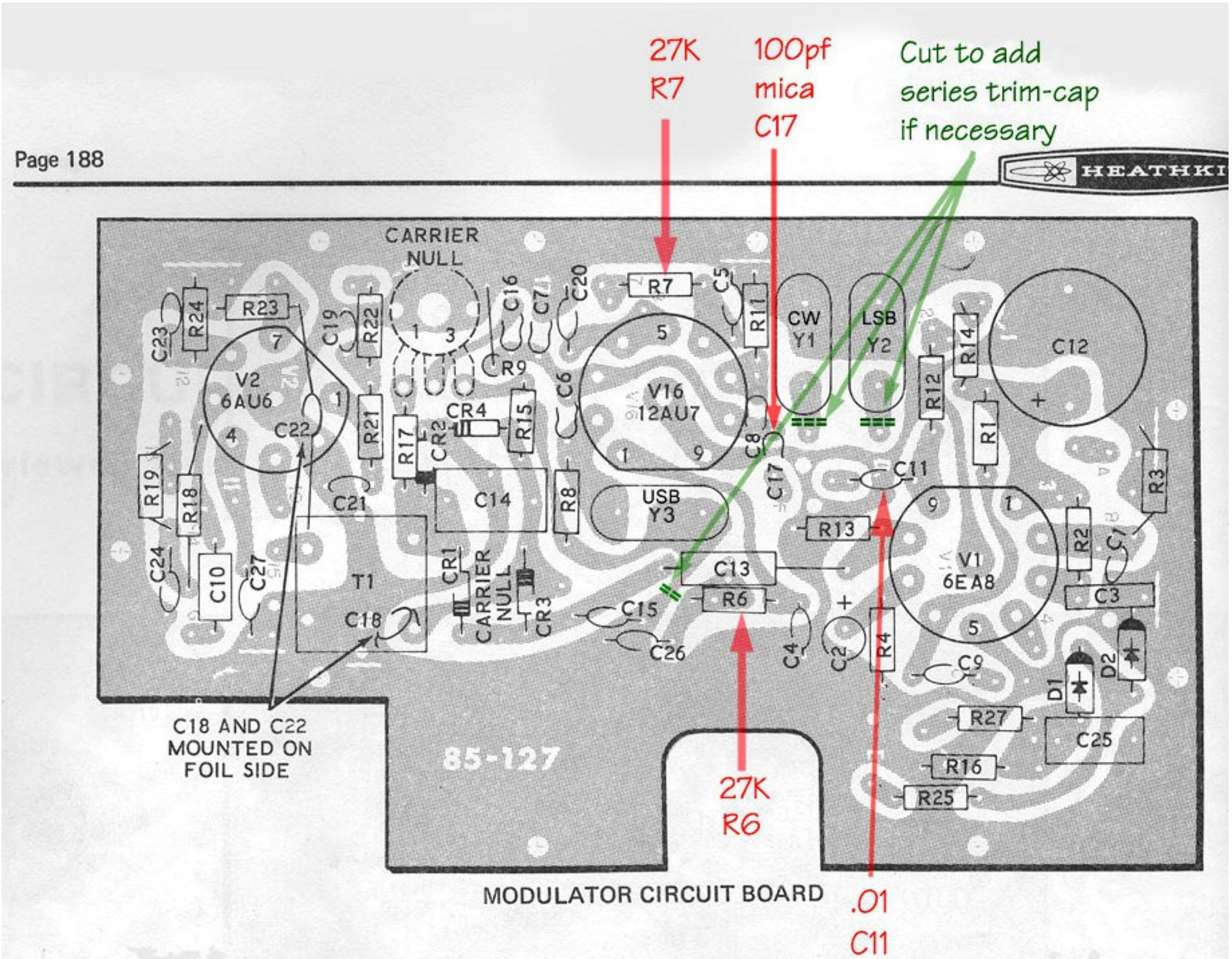


Figure 15. Modulator Circuit Board Modifications

Additional rolloff of the high frequency response will remove the raspy nature of the receive audio, and this is accomplished by changing the value of capacitor C119 on the I.F. board from 500pf to .001 µfd *(see* Figure 14. IF Circuit Board Modifications *on page 84)*. The low-end audio response of the audio amplifier increases slightly by replacing coupling capacitor C306 on the audio board with a .01 µfd disk capacitor *(see* Figure 13. Audio Circuit Board Modifications *on page 82)*.

Any possibility of voltage regulator hash being generated by V18 is reduced by connecting a .001 µfd 500V disk capacitor from V18 pin 1 to the ground foil on the audio board.

Some of the 'birdies' and other internally-generated signals heard in the tuning range of the receiver are reduced considerably by bypassing the filament string to ground with a . 01 µfd capacitor connected from the common filament point on the bandpass circuit board to ground. This is the point where the four brown wires connect about an inch below pin 1 of V19 *(see* Figure 16. Bandpass Board Modifications *on page 87)*.

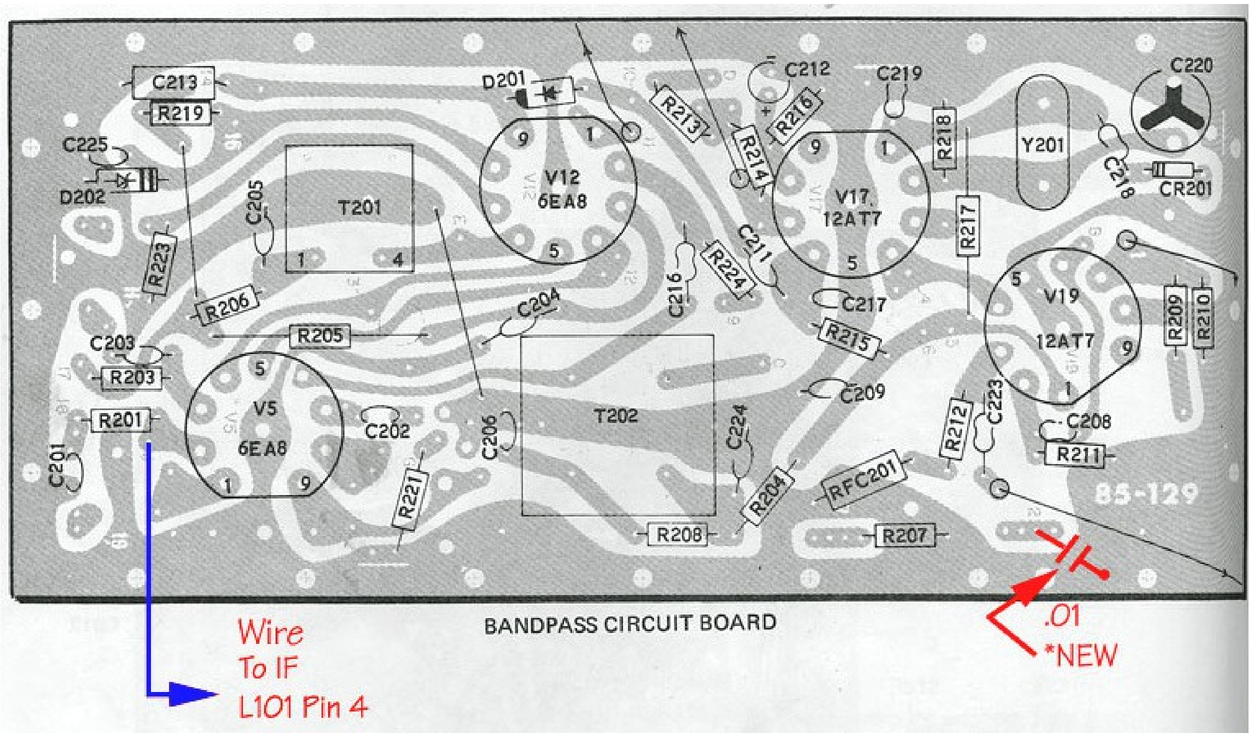


Figure 16. Bandpass Board Modifications

ac.6. I.F. Filter Passband Improvements

I believe the crystals that Heath supplied for the carrier oscillator were of fairly wide tolerance, thus the frequencies of the LSB/USB/CW carrier injection may not be properly positioned on the slope of the I.F. filter. This can affect both the receive and transmit audio response to a great degree. Telltale signs of this are not having the same audio response on USB and LSB, and reduced CW power output when using the CW filter.

It is relatively easy to tell if the USB/LSB carrier insertion points aren't placed equidistant from the center of the I.F. filter passband. After the rig reaches a stable operating temperature (1/2 hour) disconnect any antenna and peak the preselector for maximum receiver gain. Next turn up the volume control to a slightly higher than normal level and listen closely to the hiss coming from the speaker. Then switch to the opposite sideband. The pitch of the receiver background noise should be the same if the USB & LSB carriers are both placed equidistant from the filter center frequency.

If the carrier oscillator frequency is placed too far from the filter passband, the receive and transmit signals will lack "lows" but the opposite sideband rejection will be high. If the carrier oscillator frequency is placed too close to the filter center frequency, the receive and transmit signals will have excessive "lows" and the opposite sideband rejection and carrier suppression will suffer. Balance is the key.

On my particular HW-101, the actual measured carrier oscillator frequencies were 3393.8 kHz LSB, 3395.9 kHz USB, and 3395.17 kHz for CW. This resulted in a "tinny" sounding audio response in LSB compared to USB, and a very "bassy" sounding USB.

The CW power output while using the SSB filter was 110 watts, but since the CW carrier oscillator injection was so far from the CW filter center-frequency of 3395.4 kHz, the CW power output was 50 watts while using the CW filter!

Heath's intended frequencies for the carrier oscillator were 3393.6 kHz LSB, 3396.6 kHz USB, and 3395.4 kHz for CW. With the specified filter center-frequency of 3395.0 kHz the USB & LSB carrier positions would be 1.6 kHz each side of the filter center frequency.

Unfortunately, the filter center-frequency may not be exactly 3395.0 kHz, so simply placing the carrier injection points equally-spaced from 3395 kHz may not have the intended result. In order to determine the filter center-frequency one must balance the audio response between both sidebands, measure the USB and LSB carrier frequencies, and finally subtract ½ the difference between the USB & LSB frequencies from the USB carrier frequency. The result will be the I.F. filter center-frequency as it exists within your particular rig. For example, if the audio response is exactly the same between USB/LSB, and the measured USB carrier frequency is 3396.31 kHz while the LSB carrier frequency measures 3393.51 kHz, then the difference is 3396.31 - 3393.51 = 2.8 kHz. One-half the difference is 2.8 ÷ 2, or 1.4 kHz. Then the USB frequency of 3396.31 kHz - 1.4 kHz = 3394.91 kHz, which in this example is the actual SSB filter center frequency.

I like audio with a tad bit more bottom end response, so I placed my carrier points just a little closer to the filter center frequency than the Heath spec., i.e., rather than 1.6 kHz off center I went with 1.4 kHz.

The frequency of the oscillator is lowered by placing a small amount of capacitance in parallel with the crystal, and the frequency is raised by putting capacitance in series with the crystal. To put a capacitor in series with the crystal simply cut one circuit board trace just before the crystal pin as indicated, and solder the capacitor across the opened trace *(see* Figure 15. Modulator Circuit Board Modifications *on page 86)*.

A 100 pf capacitor in series will move the crystal frequency up about 100 Hz, but the same frequency change in the downward direction would only require about 10 pf connected in parallel with the crystal.

Note: *Series capacitor values versus frequency shift: 100pf up about 100 Hz, 47pf up about 330Hz, 33pf up about 450 Hz, 22pf up about 600 Hz. If the series capacitor is too small, the oscillator may fail to start.*

On my HW-101 I put the capacitors (silver mica's) directly on the circuit board foils. I got one sideband to sound the way I liked, and then simply adjusted the other sideband to match it in audio response. I wound up using a 10pf cap in parallel with the LSB crystal, 100pf in series with the USB crystal, and 80pf in series with the CW carrier crystal.

Following these changes, the new carrier oscillator frequencies for my rig are 3393.51 kHz LSB, 3396.31 kHz USB, and 3395.38 for CW. The audio is perfectly balanced when switching between sidebands, indicating a true I.F. filter center frequency of Heathkit Crystal Filters of 3394.91 kHz. The CW power output while using the CW filter went from 50 watts to 110 watts.

I also soldered a short loop of wire to the center lug of the carrier null pot to serve as a test point to measure the carrier oscillator frequency. Be sure that once you have determined the filter center-frequency, you place the oscillator frequencies no closer than about 1.4 kHz and no further than 1.6 kHz from the filter center-frequency.

To recap, we are actually matching the response between USB & LSB by ear, then verifying with a frequency counter that the carriers are no closer to the filter passband than 1.4 kHz, and no further than 1.6 kHz. Even though we can match the pitch between USB and LSB with our ear, we can't tell exactly WHERE they are -- only that they are at the same point on the filter slope.

When the carrier oscillator frequencies are changed, the signal level of the oscillator outputs may consequently change and therefore should be adjusted to be equal. Connect a scope or RF probe to the carrier null pot center lug test point and switch between sideband modes, checking for equality in level. If need be, adjust the value of R6 or R7 to achieve equality. The level should be at least 1 volt RMS, or 3 volts P-P.

ac.7. Stabilizing Meter Zero Settings

S-meter zero setting instability is mainly caused by heat-related resistance changes in the R106 22KΩ 1-watt resistor on the I.F. board. Replace R106 with a 22KΩ 2-watt wirewound resistor.

Also, change R107 from 100KΩ ½ watt to 100KΩ 1 or 2 watt.

Note: *R106 was changed to 33kΩ on revision level 5 of the IF board to improve the life of V3. Changing to this value may also require changing the 330Ω resistor to 510Ω to allow zeroing of the "S" Meter. This resistor does not have to be wirewound as stated, it just should not be a carbon composition resistor for stability reasons.*

The problem of the meter reading below zero during transmit while in the ALC position is corrected by connecting a 10MΩ resistor from the meter Zero-Adjust pot pin 3, to pin 2 of T-102 on the I.F. board (hints from N4NRW).

ac.8. Antenna Connector

For a number of reasons, you may want to replace the original RCA style antenna connector with a different style. There are two common replacements.

ac.8.1. BNC Connector

Some may want to replace the "Ant" RCA phono plug with a round "bulkhead" mount BNC connector. They fit nicely and provide an excellent, solid, 50 ohm antenna connection. The RCA is also an excellent 50 ohm connector system at 100 watts (better electrically than the old PL-259 UHF connector system) but after many years the ceramic insert starts to chip and deteriorate through use (compare it to the other RCA connectors). RCA connectors are not real good for mechanical retention, especially where the cables are stressed as they exit the unit.

The BNC connector system is an excellent, low power, 50 ohm system ....both electrically AND mechanically (and convenient). If you look at the airgaps, insulator thicknesses, insulator material, and plating materials used, you will find them superior to the RCA connectors. I've never had a problem with around 100 watts, although I would not use them at 1KW. A BULKHEAD mount BNC connector does NOT modify the chassis. Remove the RCA connector and install a bulkhead BNC, which has a small threaded barrel on the back. The diameter of the threaded portion is actually smaller than the RCA connector and it mounts in the hole with plenty of room to spare.

ac.8.2. SO-239 Connector

It is also possible to replace the RCA connector with an SO-239 style connector. An advantage of using this connector is that is probably more commonly used for ham antenna connections than the BNC connector.

SO-239 bulkhead connectors that mount with a large nut on the threaded portion of the barrel are readily available on ebay or through other sources. In this case, you only need to remove the original RCA style connector and enlarge the mounting hole to 5/8” to accept the new connector. I use a 5/8” Greenlee socket punch as it avoids the debris associated with drilling a larger hole.

You can also use a standard flange-mount SO-239 connector. This requires enlarging the hole and drilling additional holes for the mounting screws.

ac.8.3. SO-239 to RCA Male Adapter

Should you decide to leave the original connector installed while still using cables with the familiar PL-259 connector, adapters are available from Amazon.com, ebay, or other sources.

ac.9. SB-100 CW Filter Modification

As pointer out by Mike (W5RKL), the SB-100 can be modified to incorporate the CW/SSB filter switching mechanism that was added to the SB-101 and SB-102 transceivers. While the SB-100 originally used a larger sized filter than the later transceivers

To do this, it is necessary to secure the following items (perhaps from a SB-101 or SB-102 parts chassis (filters and filter mounting bracket not shown in the figure):

- SSB and CW filters (must be the smaller form-factor filters)
- Filter mounting bracket
- RF Gain Control (with lever mechanism to operate the filter switch)
- Switch mounting bracket with two slide switches
- SSB/CW Filter lever knob and bushing to adapt the new, smaller shaft to the RF Gain knob

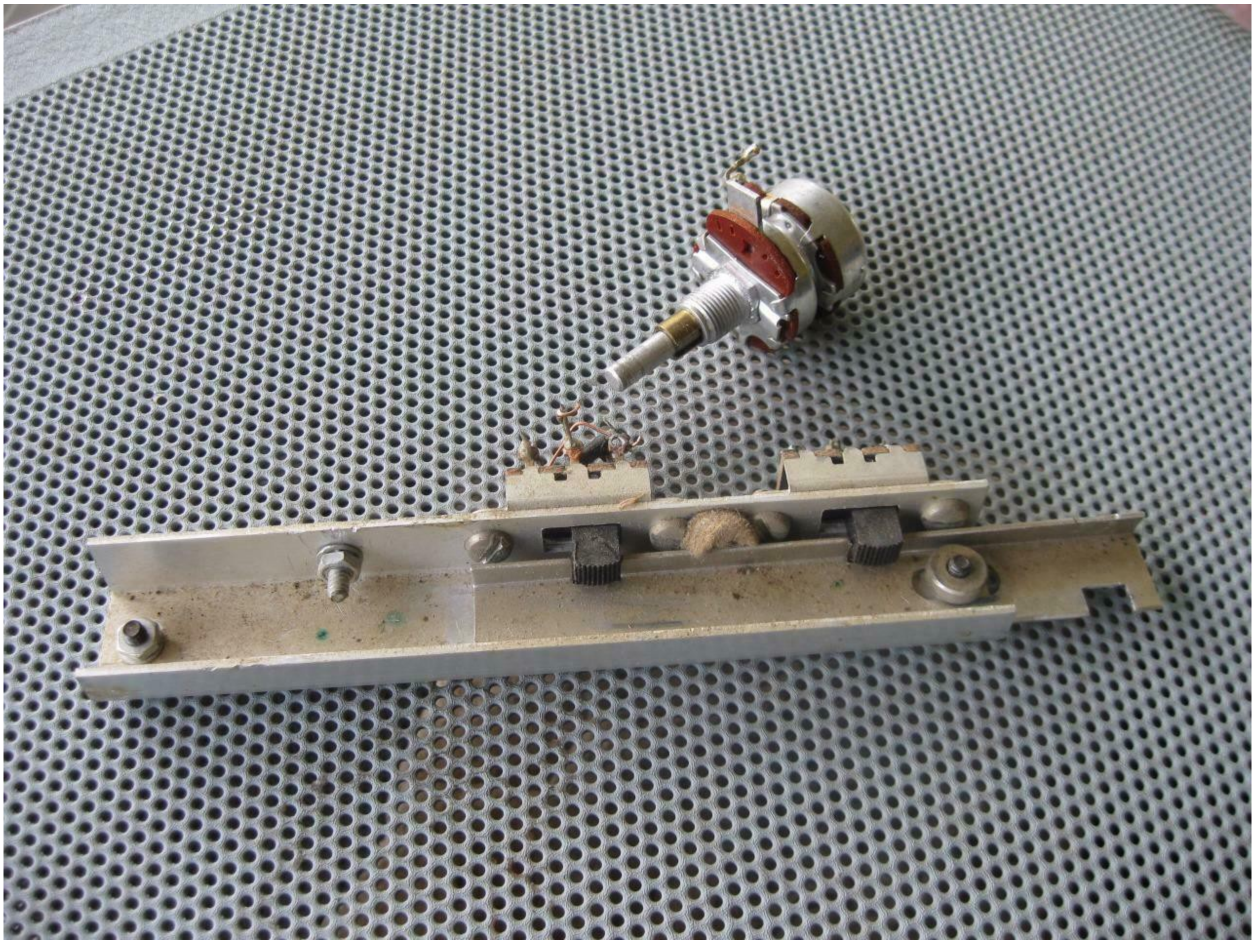


Figure 17. CW/SSB Filter Switch Assembly

ac.10. Using an External VFO for Split Frequency Operation

With the SB-series split frequency operation is very easy, because there is a front panel switch that selects either the internal VFO or an internal crystal oscillator to control the transmit frequency. The following modification essentially duplicates the changes made to accommodate the SB-640 External LMO. However, one is not limited to just use of the SB-640, but rather could use any oscillator providing the necessary signal level over the 5.0 MHz to 5.5 MHz range.

To perform this modification:

1. Remove the miniature RG-174 coax cable from the crystal oscillator as shown in the figure and replace it with an RG-174 cable having enough length to reach an unused back panel RCA phono jack and mark it ‘EXT VFO IN’.
2. Remove R220 (1K) to remove plate voltage from V5B
3. The Heathkit modification also calls for removal of L202 (36uH) and C222 (100pF) although it is unclear why this would be necessary.

Figure 18. Using an External Transmit VFO

Mode	SB-100 Setting	SB-101/SB-102 Setting
Transceive using internal LMO	LMO	LOCKED NORMAL
Transceive using external LMO (or internal crystal oscillator)	XTAL	LOCKED AUX.
Receive uses internal LMO Transmit uses external VFO (or internal crystal oscillator)	AUX. 1	UNLOCKED AUX.

ad) Heathkit Filters

Heathkit used two different physical sizes for the filters in the SB/HW transceivers, receiver/transmitter pairs, and SWL receivers.

Part no.	Model no.	Type	Bandpass at -6dB	Bandpass at -60dB	Used in
Larger Sized Filters					
404-200		SSB	2.1 kHz.	5 kHz.	SB-100, 300, 400
404-201		AM	3.5 kHz	14 kHz	
404-202		CW	400 Hz	2.5 kHz	
Smaller Sized Filters					
404-283	SBA-310-2	SSB	2.1 kHz.	5 kHz.	SB-301, 310, 401, 101
404-284-1	SBA-301-2	CW	400 Hz	2 kHz.	
404-285-1	SBA-301-1	AM	3.75 kHz	10 KHz.	
404-314		AM	5 KHz.	15 kHz@50db	SB-310, 313 only
404-328	SBA-310-1	SSB	2.1 kHz	7 kHz.	SB-310, HW-100, 101 only
404-548		CW	400 Hz	2 kHz	SB-104, 104A only

Table 9. Heathkit Filters

Be careful of the last one, the 404-548 CW filter. It will ONLY work in the SB-104, 104A because its center frequency is different, 3395.700 Khz, from all the other CW filters.

ad.1. Heathkit Filter Measurements

This section contains a series of measurements made on one example of each type of Heathkit SB-line crystal filters at 3.395MHz.

	AM (wide) 404-314		SSB 404-200		CW 404-284-1	
Attenuation dB	Low Side	High Side	Low Side	High Side	Low Side	High Side
-1	3.39418	3.39489	3.39407	3.39602	3.39525	3.39545
-3	3.394	3.39889	3.39397	3.39610	3.39522	3.3955
-10	3.39352	3.39946	3.39385	3.39622	3.39518	3.39564
-20	3.39281	3.40012	3.39369	3.39640	3.3951	3.39576
-30	3.39182	3.40095	3.39348	3.39660	3.395	3.39588
-40	3.39032	3.40203	3.39325	3.39684	3.39486	3.39604
-50	3.38785	3.40315	3.39298	3.39711	3.39468	3.39621
-60	-56dB @ 3.38376	3.40425	3.39266	3.39750	3.39442	3.39635
-70	-	3.40532	3.39246	3.39763	3.39402	3.39646
-80	-	-	3.39229	3.39785	-76dB @ 3.39289	3.39652
Average stopband	-60dB		-75dB		-70dB	
Notes	Four crystals. Significant spurious responses at 3.54MHz, 3.575MHz and 3.688MHz.		Six crystals. Slight spurious responses on the HF side. None worse than -70dB.		Four crystals. Spurious responses on the HF side. None worse than -50dB.	

Table 10. Heathkit Crystal Filter Table

a) All filters were terminated with 2000Ω and showed ripple values of not more than 2dB.

b) All frequencies in MHz.

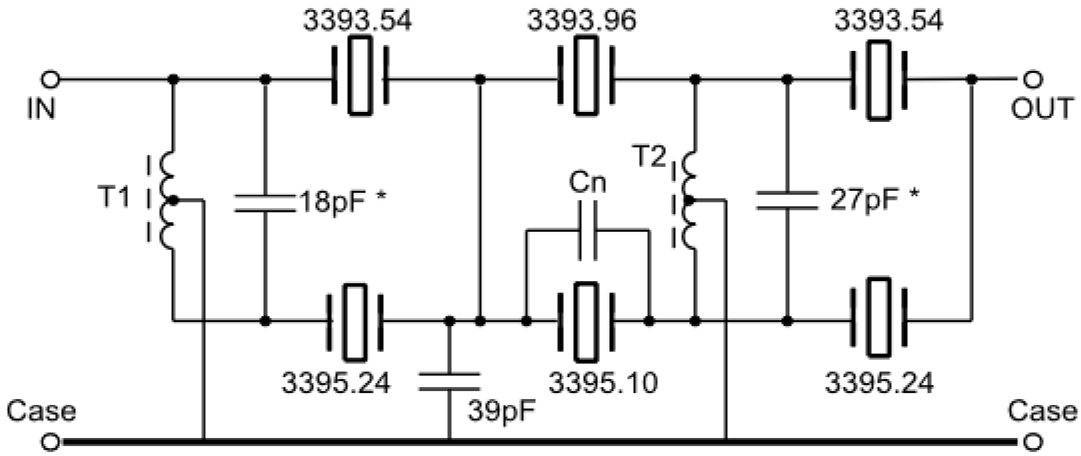
c) The later SSB filter p/n 404-283 was also measured and showed similar results to 404-200.

d) All filters showed some signs of attenuation notches each side of the main response somewhere between -60dB and -85dB.

e) All filters were also tested using L networks to match them to a 50Ω environment and this allowed the passband ripple to be reduced to about 1dB suggesting that there was some small, probably capacitive, reactance in the 2000Ω test jig.

f) Health warning - only one filter of each type was tested.

ad.2. SSB Filter 404-200 Circuit



Notes:

1. Frequencies (in KHz) appear to be the series resonant values for each crystal
2. * = adjust in test - values vary between filters to optimise the ripple and passband position
3. Cn = neutralising capacitor, typically about 0.47pF - 0.68pF
4. The left most four crystal cases are connected to the IN ground, the right most two to the OUT ground.

Figure 19. SSB Filter 404-200 Circuit

T1 total inductance = 65.5uH (resonates at 872.7KHz with 500pF).

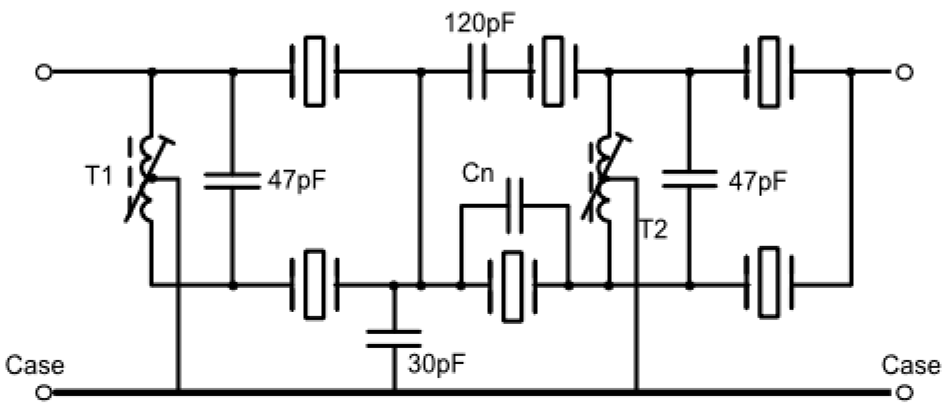
Toroids have an outer diameter of 0.38inches and a thickness of 0.13inches. Material not known.

There was no evidence of any varnish on either toroid transformer which was surprising.

The internal crystal parameters are shown on the "Crystals for IF Filters" page on this web site.

ad.3. SSB Filter 404-283 Circuit

This filter was purchased second hand and received with a fault in the form of a 30dB dip in the passband. Opening up the filter revealed a broken PCB track which has subsequently been repaired and the filter now exhibits the correct overall response.



Notes:

1. Crystals are only marked with reference numbers, not frequencies: 3101-1, 3101-2, 3101-3.

2. Cn = neutralising capacitor, typically about 0.47pF - 0.68pF,. Colour coded Brown-Grey-White-Silver.

3. The left most four crystal cases are connected to the case on one side and the remaining crystals to a ground on the other side of the case.

4. Transformers T1 and T2 are mounted in screening cans approximately 0.4inches (10mm) square.

Figure 20. SSB Filter 404-283 Circuit

Figure 21. Heathkit Filters

The lower right photo shows the repair to the broken track on the top right corner of the PC Board. The top and bottom connections are made to the case and the left and right hand connections are signal in and out.

As you can see, the filters can be disassembled but the critical trick is to melt the solder seal around the base without melting the component joints on the PCB. This means supporting the base of the filter and applying heat quickly to the outside of the base to soften the solder so that the cover may be pulled off. I use a plumbers gas blowlamp for this purpose. Once cool, repairs may be made and the unit resealed with a large soldering iron. Any scorched/burnt paint can be cleaned off and replaced. If you need to varnish any of the inductors then leave the filter open for several days to dry before resealing.

Right click on any photo and save it to your hard drive as required.

The AM and CW filters only used four crystals and their performance is not really adequate for today's more packed bands. Modification / redesign is possible to add the additional two crystals as long as the pole zero frequencies are correct for the application. A new PCB will be required. Another option is to obtain and disassemble another AM/CW filter in order to use two of the crystals and a tuned circuit to create the additional filter section.

ae) Printed Circuit Boards (PCBs)

The HW and SB series transceivers used a (mostly) common set of printed circuit boards. Because of the similarity among different levels, it is possible that different versions of the same board may have been used during production (i.e., earlier production runs may have used on version of a given board while later production runs may have use a different version, or even two different versions). While unlikely, it is also possible that a given board may have been replaced with a different version as a repair.

Board	Part #	Used In	Comments
Modulator	85-127P221	SB-100, SB-101	
	85-127-1	SB-101	
	85-127-2	HW-100, HW-101	
	85-127-3	SB-102	
IF	85-128P222	SB-100	
	85-128P376	SB-101	
	85-128-2	SB-101, SB-102	
	85-128-3	HW-100	
	85-128-4	HW-101	R104 and R105 are 47Ω, R106 is 22kΩ, R110 is unused, Meter zero pot is 10KΩ and mounted externally
	85-128-5	SB-102	R106 changed to 33kΩ, R110 changed to 510Ω
Bandpass	85-129P223	SB-100	
	85-129-2	SB-101	
	85-129-3	HW-100	
	85-129-4	SB-102	
	85-129-5		
	85-129-6	HW-101	Board is not screened for aux oscillator components
Audio	85-130P224	SB-100, SB-101	
	85-130-1	SB-101	
	85-130-2	HW-100	
	85-130-3	SB-102	
	85-130-4	HW-101	Board is not screened for sidetone volume control
RF Driver	85-131P225	SB-100	
	85-131-2	SB-101	
	85-131-3	HW-100	
	85-131-4	SB-102	
	85-131-5	SB-102	
	85-131-6	HW-101	
Crystal	85-132P226	SB-100	
	85-132-1	HW-101, SB-101, SB-102	
Heterodyne Oscillator		SB-100	
	85-133-1	HW-101, SB-101, SB-102	
Driver Grid		SB-100	
	85-133-2	HW-101, SB-101, SB-102	
Driver Plate	85-131P229	SB-100	
	85-133-3	HW-101, SB-101, SB-102	

Table 11. Printed Circuit Board Part Numbers and Usage

ae.1. Modulator Printed Circuit Board 85-127-x

I have been able to identify three (or possibly four) different revision levels (1, 2, 3) of this board.

ae.1.1. 85-127P221 (SB-100, SB-101)

ae.1.2. 85-127-1 (SB-101)

ae.1.3. 85-127-2 (HW-100, HW-101)

R28 (22k) is the audio input from a phone patch and is not present as the HW-10x series does not support a phone patch.

R9 (V3 cathode resistor connected to pins 3 and 8) is shown as 1k on the large schematic and 2k on the “how it works” description. It appears that either value may be present depending upon the build date.

ae.1.4. 85-127-3 (SB-102)

ae.2. IF Printed Circuit Board 85-128-x

There are five (or possibly four) different revision levels of this board. Some differences are (to be sorted out ...):

Revision Level P376 (SB-100)

R104 and R105 are 56Ω

R106 is 22kΩ

R110 is 330Ω

Meter zero pot is 200Ω

Revision Level 2 (SB-101, SB-102)

R104 and R105 are 56Ω

R106 is 22kΩ

R110 is 330Ω

Meter zero pot is 200Ω

Revision Level 4 (HW-101)

R104 and R105 are 47Ω

R106 is 22kΩ

R115 is 220Ω

R110 is unused

Meter zero pot is 10KΩ

Revision Level 5 (SB-102)

R104 and R105 are 56Ω

R106 is 33kΩ (this reduces the screen voltage on V3) – note: this change in value is recommended for all models.

R110 is 510Ω (compensates for the change in R106 to permit zeroing the “S” Meter)

Meter zero pot is 200Ω

ae.3. Bandpass Printed Circuit Board 85-129-x

ae.3.1. 85-129P223 (SB-100)

ae.3.2. 85-129-2 (SB-101)

ae.3.3. 85-129-3 (HW-100)

ae.3.4. 85-129-4 (SB-102)

ae.3.5. 85-129-5 (??)

ae.3.6. 85-129-6 (HW-101)

The components associated with the XTAL oscillator (V5 pins 1, 8, and 9 - R220, R225, crystal Y202, 8-50pf trimmer cap, C210, C221, C222, L202) are not present and there is no provision for an external LMO/VFO.

R205, the 2nd RX Mixer (V12) screen resistor is 100k (vs 330k on SB-102)

R223, the 2nd RX Mixer (V12) Cathode resistor is 1k (vs 330 ohms on SB-102)

R210, the Heterodyne oscillator (V19a) grid resistor is 10k vs 4.7 k on the SB series

ae.4. Audio Printed Circuit Board 85-130-x

ae.4.1. 85-130P224 (SB-100, SB-101)

ae.4.2. 85-130-1 (SB-101)

ae.4.3. 85-130-2 (HW-100)

ae.4.4. 85-130-3 (SB-102)

ae.4.5. 85-130-4 (HW-101)

The CW Sidetone volume is fixed and there is no volume control as on the SB series.

ae.5. RF Driver Printed Circuit Board 85-131-x

ae.6. Crystal Switch Board 85-132-x

ae.7. Het Osc, Driver Grid, and Driver Plate Switch Board 85-133-x

af) Heathkit Linear Master Oscillators (LMOs)

This section contains information on the Heathkit Linear Master Oscillators used in the SB series of transmitters, receivers, and transceivers.

In all cases, the LMO tuning range is from 5.0 MHz to 5.5 MHz with a slight overlap at each end. Due to the mixing scheme use, 5.5 MHz corresponds to the low end of the band and 5.0 MHz corresponds to the high end of the band.

af.1. LMO Part Numbers & Usage

Model	Part No:	Tube	Comments
HW-100		6AU6	FET oscillator with 6AU6 as VFO amp.
HW-101		6AU6	FET oscillator with 6AU6 as VFO amp.
SB-100	110-32	6BZ6	
SB-101	110-40	6CB6	
SB-102	110-48	Transistors	
SB-110	110-28	6BZ6	
SB-300	110-13	6AU6	
SB-301	110-40	6BZ6	
SB-310	?	6CB6	
SB-400	110-13	6AU6	
SB-401	110-32	6BZ6	
SB-640			

Table 12. Heathkit LMO Part Numbers & Usage

af.1.1. Heathkit TRW LMO

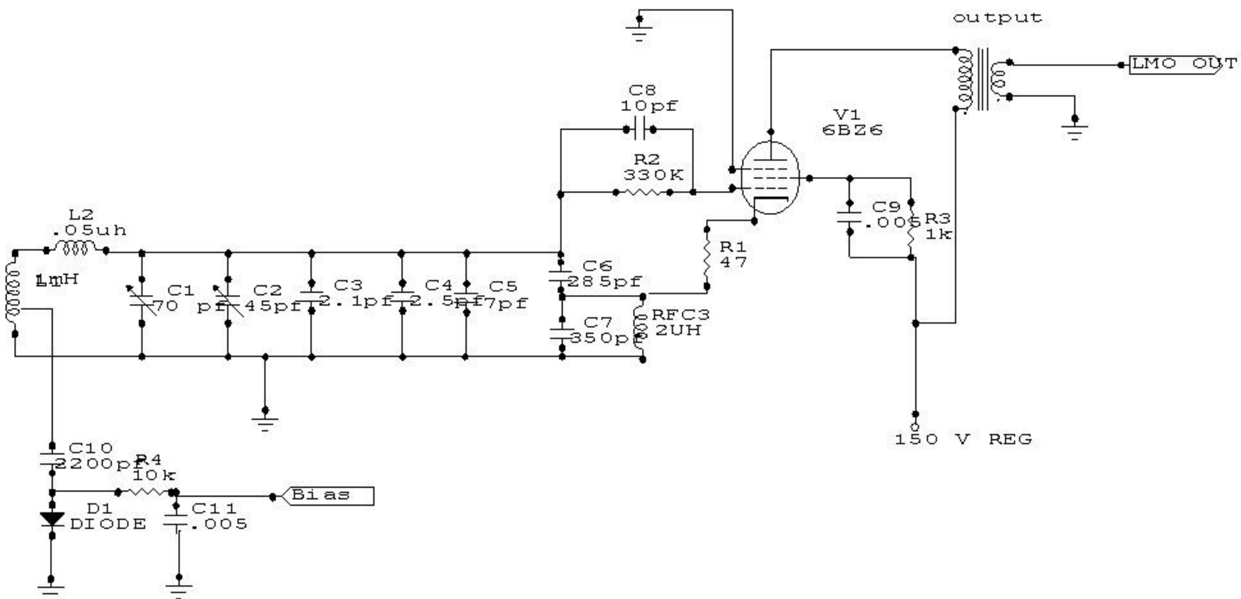


Figure 22. Heathkit TRW LMO

af.1.2. LMO Part Number 110-13

This LMO is used on the SB-300 receiver and SB-400 transmitter.

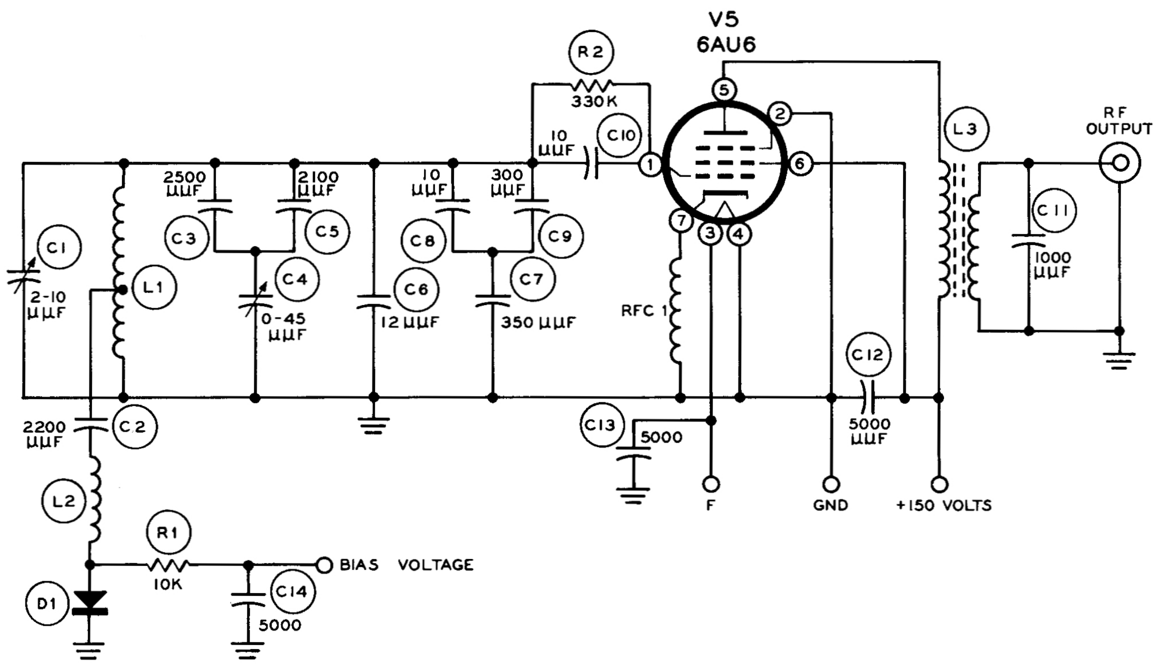


Figure 23. LMO Part Number 110-13

af.1.3. LMO Part Number 110-32

This LMO is used on the SB-100 transceiver and SB-401 transmitter.

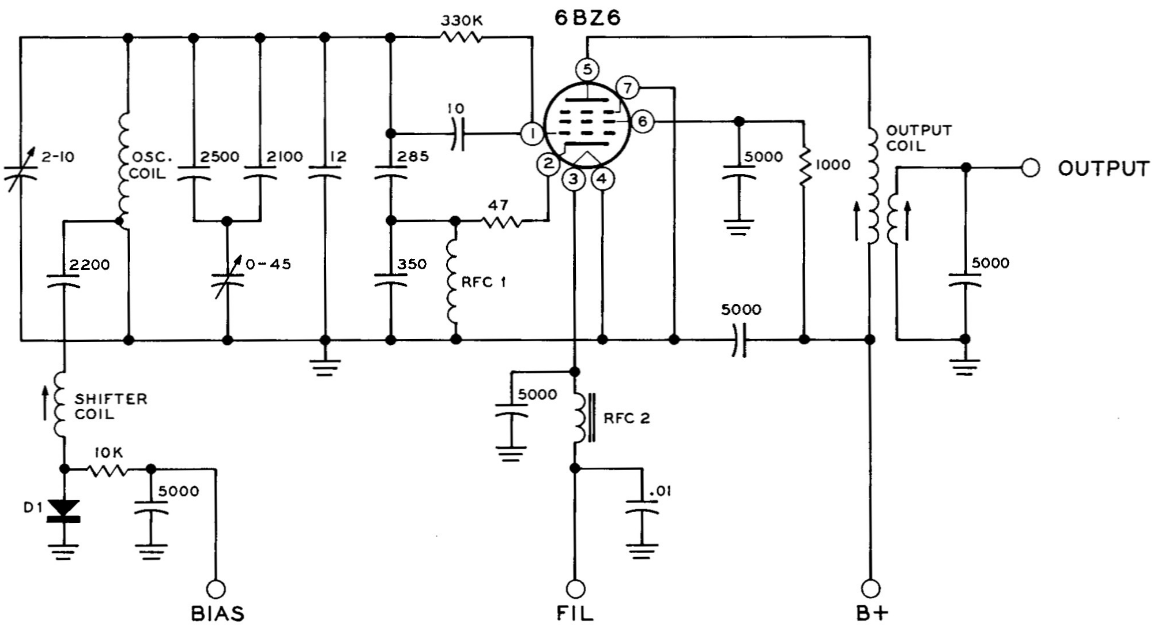


Figure 24. LMO Part Number 110-32

af.1.4. LMO Part Number 110-40

This LMO is used on the SB-101 transceiver and SB-301 receiver.

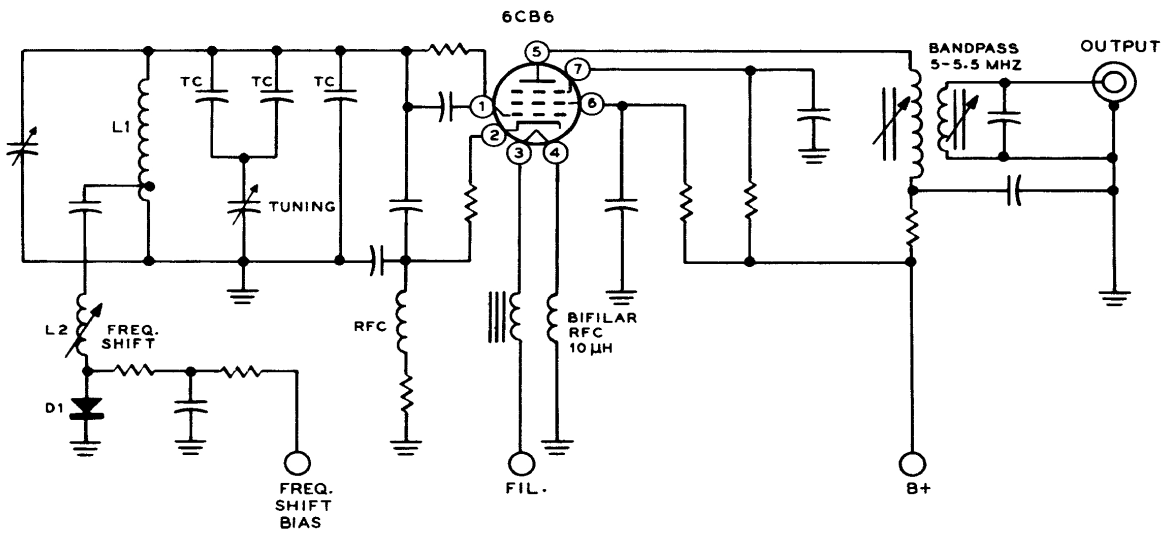


Figure 25. LMO Part Number 110-40

af.1.5. SB-102 LMO (ver6)

This LMO is used on the SB-102 Transceiver.

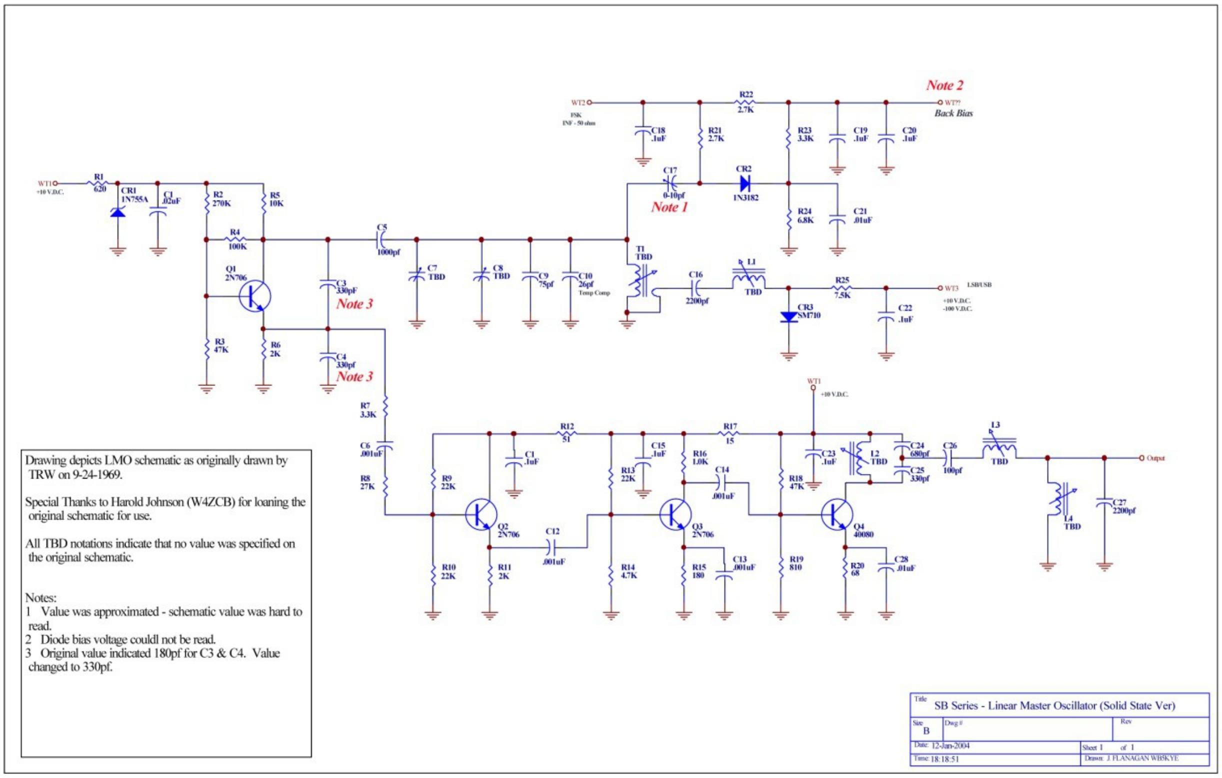


Figure 26. SB-102 LMO (ver6)

af.2. LMO Repair and Service Notes

af.2.1. LMO Remove and Replace

While not easy, the LMO can be removed from the unit without removing the front panel using the following procedure:

1. Disconnect the power cable from the back of the radio since you will be working close to the A.C. power switch.
2. Turn the main tuning dial fully counter-clockwise until it hits the stop (the slide rule dial should be near 0 and the circular dial near 90.
3. Remove the main tuning knob on the front panel
4. Loosen the nut on the main tuning shaft bushing so that the bushing can be lifted up and the shaft pulled forward to disengage the beveled pulley from the metal ring on the circular dial.
5. Loosen the set screw on the circular dial and move the dial slightly forward to disengage the spiral groove follower from the spiral groove on the rear of the circular dial.
6. Disengage the spiral groove follower from the slide rule dial pointer and move it to the right so it is next to the power switch.
7. Disconnect the wires soldered to the terminal strip on the rear of the LMO being sure to note which wire connects to each lug on the terminal strip.

   Tube type LMOs have three wires, B+, Fil, and Bias (goes to 33kΩ resistor)

   The solid-state LMO used in the SB-102 only has 2 wires, +10v and SSB Bias (goes to 33kΩ resistor)
8. Disconnect the LMO output by unplugging RCA connector on the rear of the LMO.
9. Under the chassis, remove the four nuts and lock washers holding the LMO assembly in place. Two of the nuts are located under cable bundles and may be difficult to get to, but it should be possible to get a 1/4” socket in to remove the nuts.

Remove assemblies mounted to the top of the LMO:

SB-102 only: Remove the 4 screws holding the “doghouse” to the top of the LMO and lift the doghouse, slide rule dial assembly and pilot lights off to the side

All others with tube type LMO: Remove the two screws holding the slide rule dial and pilot light assembly to the LMO and lift the assembly off to the side

At this point, it should be possible to lift the LMO and circular dial from the chassis.

To replace the LMO use the following procedure.

1. Use a small screwdriver to turn the LMO shaft fully counter clockwise
2. Place the circular dial on the LMO shaft – leave the set screw loose for now

3. Position the LMO and circular dial on the chassis using care that the circular dial does not fall off of the shaft.
4. Start the four nuts (and lock washers) that hold the LMO to the chassis. Make sure the screws are in the center of the slots, that the LMO is squared up to the front panel, and the LMO shaft is centered behind the hole in the front panel escutcheon before tightening the nuts.
5. Replace the assemblies located on the top of the LMO that were removed earlier making sure that the spiral groove follower pin is engaging the pointer on the slide rule dial
6. Insert a small screwdriver through the hole in the front panel escutcheon and turn the LMO shaft fully counter clockwise until it hits the stop.
7. With the circular dial at 90 and the slide rule pointer near 0, slide the circular dial back on the LMO shaft while engaging the spiral groove follower in the inner most groove of the circular dial. Temporarily tighten the set screw holding the circular dial.
8. Reconnect the wires to the terminal strip on the rear of the LMO
9. Plug the coax cable into the LMO output socket on the rear of the LMO
10. It may be necessary to move the circular dial forward or backward to obtain smooth operation of the spiral groove mechanism while turning the LMO shaft using a screw driver.
11. Re-engage the main tuning shaft pulley as described in Re-engaging the Main Tuning Pulley *on page 68*.
12. It will be necessary to perform the circular dial calibration as described in Dial Calibration *on page 67*.
13. Replace the large tuning knob and reconnect the power cable.

af.2.2. Heath Tube-Type LMO Repair

by Glen E. Zook, K9STH Copyright 2012 by author

The tube-type Linear Master Oscillators ("LMO") used in the Heathkit SB-Line equipment is a very stable and accurate means of controlling the frequency in the equipment. Unfortunately, as the units age, many LMOs develop a "warble" when tuning. This "warble" usually stops when the frequency control knob is not rotated. However, accurately "zero-beating" another station is made harder by this "warbling" and it is generally a major distraction from the otherwise excellent performance of the SB-Line equipment.

The primary cause of this "warble" is a break-down of the original lubricant used on the pivot points of the shaft of the main tuning variable capacitor. Removing this unwanted sound is not hard.

Next, one of the "L" shaped side panels has to be removed. It is best to remove the panel on the same side as the oscillator tube. There are no internal parts connected to this side whereas there are components attached to the other side. To remove the panel, there are a total of 10 hex-head sheet metal screws that have to removed. The bottom 2 sheet metal screws also hold the lugs which attach the LMO to the chassis. A 1/4 inch "nut driver" is the tool to use to remove the sheet metal screws.

It will be noted that 2 or 3 of these sheet metal screws are covered with a red lacquer. The purpose of this lacquer was to act as a seal which would be broken if the covers to the LMO were removed and thus the factory warranty on the LMO would be violated. Of course, the warranty has long run out, considering that the LMOs are 40, or more, years old!

After removing the panel, make sure and do not disturb the small variable capacitor inside the unit. Look closely at the rotor of the main variable capacitor. Depending on the actual individual who assembled the LMO, there will be varying amounts of dried lubricant ("grease") showing. This has to be removed. I generally use WD-40 and a toothbrush to eliminate this old lubricant.

Then, check the "stops" on the main tuning shaft. These rotate as the dial is tuned with each stopping at one full turn of the shaft after the last one stopped. Over the years, these "stops" start sticking to each other and the shaft may not be able to be turned through the slightly over 5 revolutions to tune the 500 kHz frequency range (with a few kHz over at each end). Spray WD-40 on these and make sure that the shaft easily turns the 5+ revolutions. Watch the main tuning capacitor to make sure that it mostly opens and mostly closes. The “stops” actually prevent the capacitor from going completely from open to closed.

Putting a knob on the tuning shaft makes turning it MUCH easier! If the shaft cannot be turned the full 5 revolutions, then use a small screwdriver to separate the ones that are sticking. Spray a little more WD-40 on the “stops”. You may have to force the shaft in the direction which the full 5 revolutions would normally be made. Work the shaft “back and forth” until the “stops” break free. Then, run the shaft back and forth several times the full 5 revolutions. If the shaft is still hard to turn, put a little WD-40 on the “worm gear” at the rear of the shaft which activates the gear which rotates the variable capacitor.

Then, put a lubricant of your choice on the pivot points on the air variable capacitor.

Although cleaning the old lubricant from the pivot points often eliminates the “warble”, it will often return in a relatively short period of time. To prevent the “warble” from returning, a short piece of braid has to be connected between the shaft of the rotor on the variable capacitor and the frame of the capacitor. Various persons have devised ways to connect this braid. The method described herein is pretty simple to do and is very effective.

Before continuing, it is necessary to note that there are at least 2, maybe more, systems of getting from the worm gear of the main tuning shaft and the variable capacitor. Both use a gear on the shaft of the variable capacitors but those gears are very different. The earlier version, Heath part number 110-32, uses a large diameter gear that is relatively thick and the later version, Heath part number 110-40, uses a relatively small diameter gear that is fairly thin. The method of attaching the braid to the shaft is similar, but different approaches have to be made.

There are 2 setscrews which hold the gear onto the variable capacitor shaft. One of those setscrews is exposed when the variable capacitor is almost fully open (minimum capacitance) and the other is exposed when the capacitor is about halfway open. It is the setscrew that is exposed when the capacitor is halfway that is of interest. Remove this setscrew. Sometimes this setscrew has a normal “slot” and sometimes it requires an Allen wrench (NOT a Bristol).

Acquire a piece of braid about 2-inches long. This can be tinned or not. Using braid from a short piece of RG58/U coaxial cable works great.

Now comes the difference between the LMO with the large gear and one with the smaller gear. With the large gear, cut off a length of 8-32 machine screw about 1/2th inch long, so that you just have the thread portion. That is, no “head” on the screw.

Replace the setscrew with this 8-32 rod. Using a pair of needle-nosed pliers, securely tighten the rod. Next, tin just the ends of the braid, not more than about 1/8th inch. Tin the end of the threaded rod with resin core solder (it will "tin" pretty easily). Then, solder one end of the braid to the threaded rod with the braid going in the direction of the frame of the variable capacitor.

Tin the center of the frame of the variable capacitor, about 1/4 inch is plenty. Solder the "other" end of the braid to the frame.

Rotate the main tuning shaft through the entire 5 turns and make sure that the braid doesn't touch any components. If it does, bend the point at which the braid attaches to the threaded rod so that the braid "clears" everything.

The reason for using just a threaded rod only 1/2 inch long is that if a head was on the screw, it will not clear the gear itself and any longer and the rod will interfere with the worm gear and therefore the full 5 revolutions will not be possible.

The LMO utilizing the smaller gear is somewhat easier in the fact that an 8-32 machine screw that is 1/2 inch long clears both the gear itself and the worm gear. Therefore, the head does not have to be removed.

Replace the setscrew with the new machine screw. Using a screwdriver, tighten the machine screw.

Tin the head of the machine screw. Attach the end of the section of braid and follow the above directions to complete the attachment of the braid.

Replace the side panel removed before, making sure to replace the "lugs" which mount the LMO to the chassis.

Finally, reverse the removal procedure to return the LMO to the unit.

af.2.3. Photos Showing Added Grounding Braid

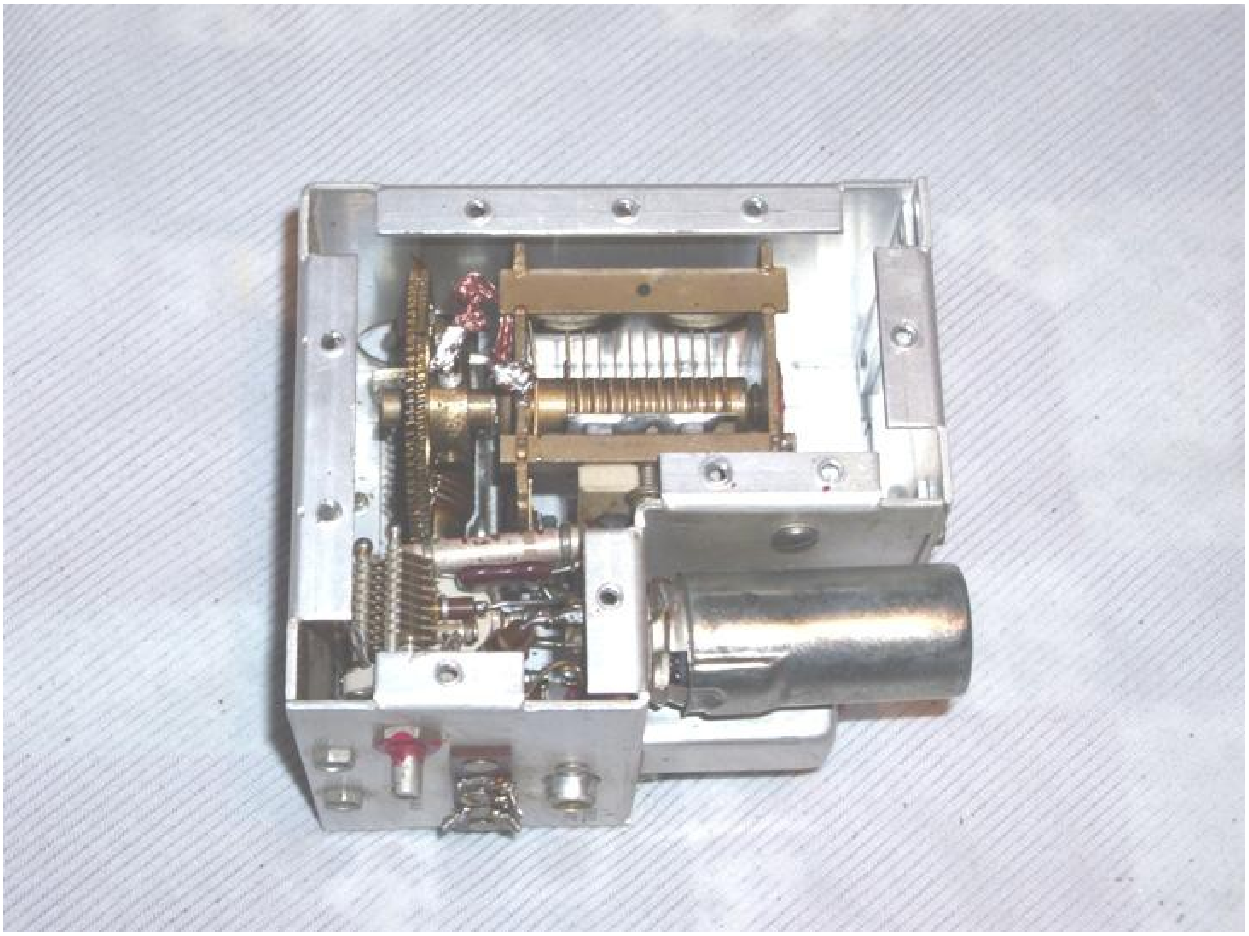


Figure 27. LMO With Added Ground Braid

The braid can be seen in the upper left-hand corner of the LMO. This is the version with the larger gear, the Heath part number 110-32.

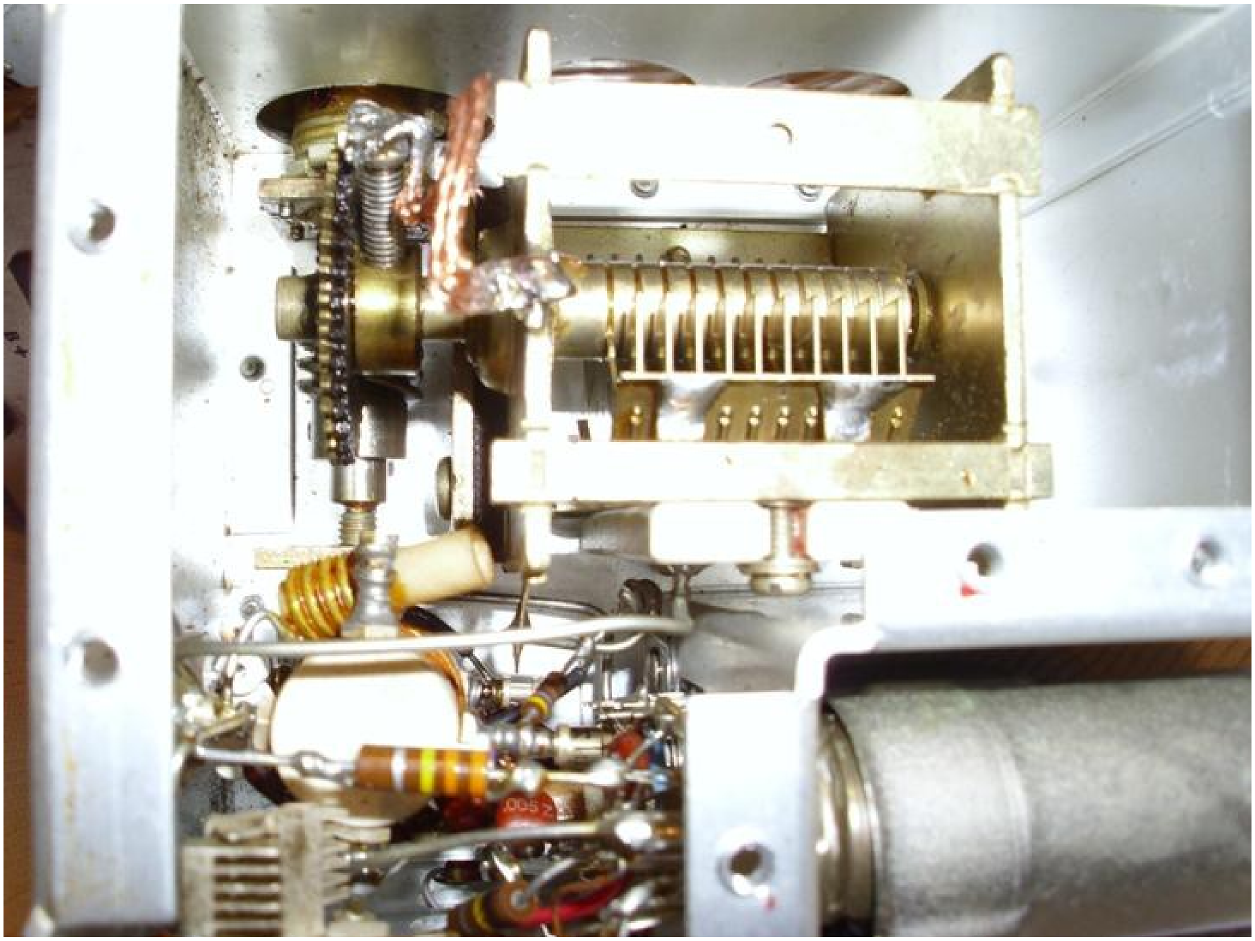


Figure 28. LMO With Added Ground Braid (Example 2)

Again, the braid can be seen in the upper left-hand corner. This is the version of the LMO with the smaller gear, the Heath part number 110-40.

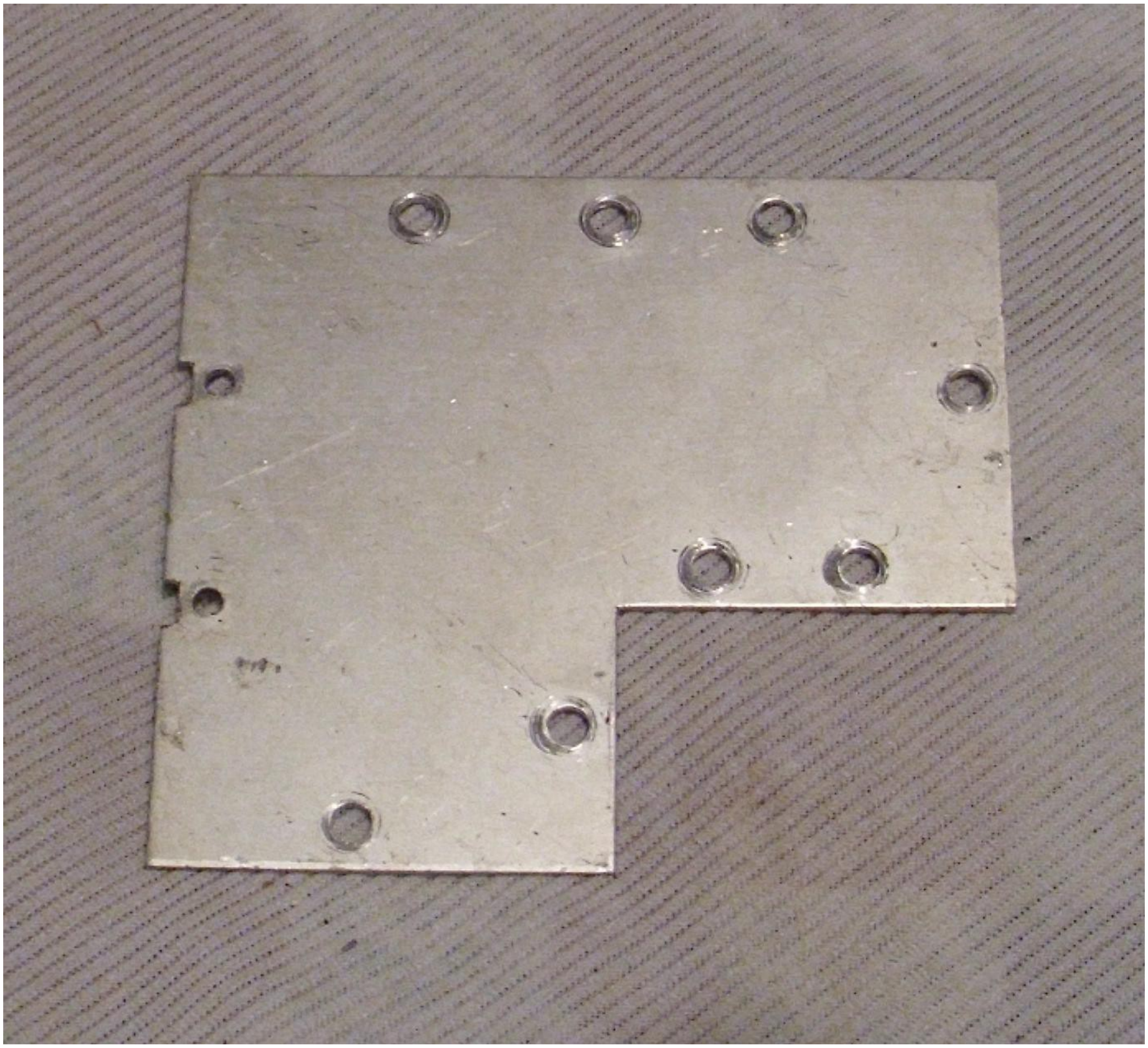


Figure 29. LMO Side Panel (removed)

This is the side panel which has to be removed to repair the LMO. Note the “notches” on the left-hand side where the “lugs” which hold the LMO on the chassis are attached.

af.2.4. Repairing and Recalibrating a Stuck LMO

By KI4IUA

The LMO on my SB-301 would only make about 2 ½ of the five turns before hitting a stop.

Here’s how it's supposed to work: The TRW LMO contains a variable cap that will turn continuously through 360 degrees without some external mechanism to stop it. It is driven by a gearing system that allows one revolution of the variable cap for around 5 revolutions of the drive shaft which extends out the front of the LMO housing. On the drive shaft there are six control washers whose purpose is to provide a physical stop at either end of those 5 revolutions. Each washer, in turn, will allow part of one revolution before a tab on that washer contacts a tab on the adjacent washer. The adjacent washer then joins in the turning until its tab contacts the next washer and so on until approximately 5 turns have occurred. The last washer's tab will contact a protruding pin on the frame of the LMO and will stop the turning of the entire assembly at the extreme end of the tuning. This same situation occurs when turning in the opposite direction.

The brass collar is adjusted to the proper stopping place in the capacitor travel since it has a pin locking it to the first washer. This whole mechanism is preset at the factory so normally you would not have to worry about it. On mine, the grease had hardened and at least a couple of the washers would not slip, reducing the number of turns possible.

I maybe could have sprayed some solvent into the washers and freed them, however, I wanted to clean out the old grease and start with some fresh so I discarded the solvent idea and proceeded with the disassembly. With the washers stuck as they were, I could not determine the exact end of the tuning so marking the shaft for reassembly wasn't an option. I would have to re-determine the stopping points electronically and I will detail that later.

With all the front panel controls removed and the panel itself removed, I took the dial off the drive shaft of the LMO. It was held with one setscrew. If you don’t have a long hex wrench to use I would suggest that you obtain one as you will need it when you later perform the adjustment of the dial. This can be quite tedious. I found a really handy one at my local ACE hardware. It’s called a Precision Screwdriver and you will want the 5/64” one, ACE part no. 2167310.

With the dial removed, the shaft and washers will be clearly visible at the front lower left of the LMO housing. The collar holding the washers takes a 1/16” hex wrench. With the collar removed, you can see the hole in the first washer and the corresponding pin in the back of the collar that fits the hole. Remove the washers and give them a good cleaning.

I used a dry rag and then coated the washers with a fresh coat of white lithium grease that I obtained from the auto parts store. There may be a better grease to use and time will tell if the lithium grease will work out ok. One other source says black moly-lube but I couldn’t find that so I used the white lithium. Replace the washers with the tabs pointing out toward the front. Make sure the outside washer has the hole for the collar pin.

Replace the collar and lightly tighten the setscrew with very little play between the washers. Attach a frequency meter to the RCA jack output of the LMO. Put the mode switch to USB which is where the Heath manual has you start alignment. This is the only switch other than the on/off switch that needs to be set to a particular position.

Insure that the loose controls from the front panel are not shorting out and then apply power.

You will be setting the LMO to track between approximately 5.5 MHz. and 5 MHz. The critical part is to get the counter clockwise stop to end up at around 5.5 MHz. and the fully clockwise stop to end up at approximately 5 MHz. This may seem backward to you until you recall (or check the circuit description in the manual) that the LMO tunes backward from the actual frequency received. The LMO will actually tune a little bit more than 0.5 MHz. wide and you will want to center the tuning range within this bandwidth.

Start out with the brass collar lightly tightened so that the shaft can slip beneath the setscrew. Watch your freq meter and get one end of the tuning range within 10 KHz. of the desired tuning stop. For example: 5.510 on the counter clockwise end or 4.990 MHz. on the clockwise end.

If you can get it this close you will probably have it close enough. Mine worked out this way and the later dial adjustment required little change. Once you have the LMO within this range, you can tighten the setscrew with your new ACE driver. The rest of the work is done by following the Heath manual.

When I first approached the LMO problem with my SB-301 I thought I had made a serious mistake in removing the collar and washers. I found that using the frequency meter as above, I was able to get the LMO back to the original good adjustment. The satisfaction and knowledge gained from this project gave me some of the enjoyment I missed in not being the original builder of this rig and a renewed appreciation for the guys at Heath who made it all possible.

af.2.5. Heathkit SB-102 Transceiver LMO Stability Fix

Source: unknown

I noticed many SB-102 solid state VFOs become unstable over the years. In most cases a light bump or tap on the radio will cause it to jump frequency, excessive random mechanical instability especially during warm-up. I have found late SB-series LMOs that jump from lightly closing a desk draw.

In most SB-102 radios I worked on this problem was attributed to a plate on the bottom of the LMO being warped possibly by the 2 screws securing the crystal filter bracket. In some of the late SB-102 kits shipped these screws were cheap, not machined as precise nor perfectly flat headed. On some chasses they can press on the bottom of the LMO

Remove the LMO from the radio, then the 4 small Phillips screws securing its cover plate. At this time while the LMO is open check for any dried up glue securing any disk capacitors to the side wall of the LMO. Re-glue if necessary (I use red TV Radio cement)

Inspect the cover plate, clean and re-tension grounding tangs. When re-installing re-bend any tabs and grounding tangs so it fits back on snugly, tighten its 4 mounting screws equally and pack the side “seams” with 6 strips of some copper braid. (folded copper de-soldering wick fits perfect just clean the flux off first with alcohol or lacquer thinner first) Then press in a thin bead of silicone over your pack (into the seam) this is for added mechanical stability.

Testing prior to installation

Power the LMO up on a bench supply and tune it to a receiver tuned to around 5.250 MHz (BFO ON). You should note rock solid stability (give it a couple hard taps) When re-installing the LMO I like to use 4 thin washers to slightly lift it of off the chassis (NOTE: no more than index card thickness or the calibration knob wont line up) This is so the LMO is secured by 4 equal points rather than just randomly pressing to the chassis.

ag)Matching Heathkit Paint

ag.1.1. Matching Heathkit Paint: Part 1

I get all of the paint that I use on 'boat anchor' cabinets computer matched at my local Sherwin-Williams store. I have found that acrylic satin finish paint comes out pretty darn close to the original finish. The paint runs under $11 a quart. So far every cabinet that they have matched has been 'right on', including the Collins St. James gray.

You will need either a paint gun, or, if your local store happens to be one that has the ability to 'load' spray cans then you can go that way. Of course having spray cans loaded is going to add to the price of the paint.

I normally drop off a cabinet, cabinet lid, etc., of what I want to be matched. At least at my local store, which tends to be very busy, I get my paint either late in the afternoon or the next morning. If your store isn't that busy, they might be able to do it for you while you wait.

Also, some automotive parts stores also have paint matching. However, what they use is often lacquer or enamel, both of which do not dry to as 'hard' a finish as acryllic.

By the way, the acrylic paint that I buy does clean up with water: You don't have to worry about paint thinner, lacquer thinner, etc.

Now, for the texture: I use Rusteoleum American Accents Stone Creations to give me a crackle. Also, Rustoleum has two other paints that might be used. They are 'Hammered' and 'Texture'. These do NOT give a real deep type of finish. However, they do work as an undercoat in many applications.

The formula for the light green like was used on the SB-104 cabinet is as follows:

For 1 quart Sherwin-Williams ProClassic Extra White satin base:

- BAC Colorant OZ 32 64 128
- B1- Black - 7 1 1
- L1- Blue - 6 1 -
- N1- Raw Umber - 62 - -
- Y3- Deep Gold - - 1 1

I do have the Sherwin-Williams formulas for several of the Heath colors as well as Collins, National, and Hallicrafters.

Unfortunately, on the Heath SB-Line there were no less than 5 different colors used on the cabinets and 3 different colors used on the front panels. It was possible to order a 'complete' set consisting of the SB-301 receiver, SB-401 transmitter, SB-630 station control, SB-600 speaker, and the SB-200 linear at the same time and the equipment would arrive with 5 different cabinet colors. Then the front panels could vary through any, or all, of the 3 different colors used on them.

At one time or another, I have had all 5 colors of cabinets and still have all 3 colors of front panels. The formula for the SB-104 cabinet is, in my opinion, the most pleasing of all of the SB-Line cabinet colors and I have repainted all of my cabinets that color. That is the color that I 'stock' for repainting of SB-Line cabinets.

As for the dark green, called 'Apache green', that was pretty much the same color for many years. Also, the gray like on the DX-40 cabinet was the same for decades.

Unfortunately, there are not any 'off the shelf' colors that match those on the Heath equipment. There are some that are not 'bad' looking but they are definitely different from the original.

ag.1.2. Matching Heathkit Paint: Part 2

Believe it or not, Wal Mart has probably the best selection of spray paints around these days. It is better than Lowe's or Home Depot (the two local home-improvement centers in this part of the Dallas, Texas, area) and much better than any of the paint stores (including Sherwin Williams and others). Well, a trip to one of the local Wal Mart(s) produced a can of Krylon Light Sage Gloss (#2018) that just happened to match the two cases that were identical. Thus, it was used to repaint all of the cabinets that were in need of paint. If you can find the Light Sage Satin, I would use it because the gloss is just a bit too glossy. I had to overspray with Crystal Clear Krylon to "tone down" the paint. This paint is on the lighter side of the Heath paints, but not the lightest. However, it definitely was within the range of paints that Heath originally used on the cabinets.

Now, my SB-600 speakers needed their grills repainted. Looking at the various front panels of the SB-Line equipment I saw at least three different shades of green! Well, Krylon Sage Satin (#3512) just happened to almost perfectly match at least two (maybe three) of the green used on the front panels of my Heath SB-Line equipment. I say maybe three because one unit was slightly faded from being in sunlight (before I got the rig). Of course, I used the Sage Satin to repaint the grills.

There also seems to be a slight deviation in the "Apache Green" paints used on the Seneca, Apache, Mohawk, SB-10, Warrior, etc. However, it is much closer in color than any of the other equipment that I have seen. Unfortunately, if you want an "exact" match, you will have to go with the paint from Total Electronics. However, if you want a paint that is fairly close and looks fine, then there are two possible choices. The first is the same Krylon Sage Satin and the other is a private brand from Wal Mart (Color Place Rust Control Evergreen #21032). The Sage Satin is a shade on the light side and the Evergreen is a shade on the dark side. I prefer the look of the Sage Satin, but you might just like the Evergreen.

For the older Heath gray, I like to use Krylon Smoke Gray Gloss (#1608). It is a "tad" lighter than some of the older units, but looks pretty good.

ag.1.3. Matching Heathkit Paint: Part 3

I used a Krylon spray-paint that I found at the local hardware store to repaint the Cheyenne's cabinet. It's **Krylon Indoor/Outdoor Gloss Hunter Green**. This isn't an exact match for the original Heathkit paint (which is slightly lighter and, in my opinion, contains a bit more blue), but I find it is close enough for my tastes.

ah) HW-101 and SB-10x Service Bulletins

This section contains a compendium of service bulletins for the HW-101, SB-100, SB-101 and SB-102 transceivers. The HW-101 is included due to the large number of similarities between the HW-101 and SB-10x series of transceivers.

ah.1. HW-101 Service Bulletins

ah.1.1. HW-101-1: VFO Drift

FEBRUARY 11, 1971
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-1*

The vfo coil has been changed to improve the drift problem experienced in many units. The old coil [PN 40-810] should be replaced by the new coil [PN 40-1976] whenever a unit displays excessive drift. This has been made a permanent change in all future production.

ah.1.2. HW-101-2: Repeated Heterodyne Oscillator Tube Failure Inadequate USB-LSB Frequency Shift

SEPTEMBER 14, 1972
HW-101 BULLETIN NO: SSB TRANSCEIVER *HW-101-2*

Change: R-212 from 220 Ohm to 330 Ohm 1/2 watt resistor [PN 1-4].

Lack of VFO shift range can be corrected by changing the value of the FET source resistor. Change: R-947 from 470 Ohm to 1000 Ohm [PN 1-9].

ah.1.3. HW-101-3: Carrier Null Control Failure

FEBRUARY 16, 1973

HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-3*

Recently an improved mounting method was devised for the [PN 10-147] controls in kit models SB-102, SB-401 and HW-101. Current production utilizes a fiber washer for greater clearance and the case of the control is grounded by a separate wire. We are anxious to know if this will reduce the failure rate. Please make note of any change, good or bad, and keep us posted.

ah.1.4. HW-101-4: Low Output on 40 Meters

OCTOBER 29, 1973
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-4*

SEE BULLETIN NO: SB-102-5 DATED OCTOBER 29, 1973

ah.1.5.   HW-101-4: Low Output on 40 Meters

OCTOBER 29, 1973
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-4*

1. **REMOVE** the 1-1/2" bare wire from hole 1 on the **DRIVER PLATE** circuit board & the ground foil of the **RF DRIVER** board.

2. Connect a 3/4" bare wire between the ground foils of these same two boards.

3. **REMOVE** the 1-3/4" bare wire from hole 1 in the **DRIVE GRID** circuit board & the ground foil of the **RF DRIVER** board.

4. Connect a 3/4" bare wire between the ground foils of these same two boards.

5. **REMOVE** the 2-3/4" bare wire which ties the ground foils of the circuit boards to the shields.

6. **REMOVE** the coil cover. Then **REMOVE** four of the light spring clips & their hardware as shown:

[[[**NOTE**: The pictorial shows removal of the set of clips & hardware located directly down from the 2 holes in the cover; the other set to be removed is directly across and down from the 3 holes in the cover.]]]

7. Readjust the driver grid & drive plate coils as instructed in the HW-101manual.

ah.1.6.   HW-101-5: Alternate Method of Neutralizing the Final Amplifiers

MAY 23, 1974
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-5*

SEE BULLETIN NO: HW-100-3 DATED MAY 23, 1974.

ah.1.7.   HW-101-5: Alternate Method of Neutralizing the Final Amplifiers

MAY 23, 1974
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-5*

NOTE: Be sure unit is off and power supply high voltage capacitors are discharged.

1. Disconnect final plates and screen grid. **
2. Turn unit on.
3. Rotate the band switch to 28.5.
4. Place the VTVM RF probe in the antenna connector.*

5. Set the function switch to tune.
6. Rotate the level control fully clockwise.
7. Adjust the preselector control for a maximum indication on the VTVM.
8. Adjust the final control for a maximum indication on the VTVM, with the load control set at the 50 ohm position.
9. Using an insulated screwdriver, adjust neutralizing capacitor for a minimum indication on the VTVM.
10. Readjust the neutralizing capacitor for a minimum indication on the VTVM.
11. Turn the function switch to the off position.
12. Discharge high voltage power supply capacitors.
13. Reconnect final plates and screen grid.

* VTVM and RF probe will be needed.

**To remove screen voltage in SB-100, HW-100 and HW-101 disconnect R920 [100 ohm resistor] from buss wire between pins of V8 and V9. In the SB-102 removal of accessory plug is all that's required. To remove high voltage in SB-100, SB-101 and SB-102 disconnect red wire at lug 4 [in SB-100 lug 3] of terminal strip BK that goes to grommet BL. In HW-100 and HW-101 disconnect red wire going to lug 1 of RF choke in final cage.

NOTE: Take adequate steps to eliminate any possible contact with B+ or B+ shorts to chassis after disconnecting wire and resistor.

ah.1.8. HW-101-6: SB & HW Series Audio Preamplifier & VOX Circuit Troubleshooting Guide

MAY 23, 1974
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-6*

SEE BULLETIN NO: SB-100-3 DATED MAY 23, 1974 (see Page 150

ah.1.9. HW-101-7: SB & HW Series Instability & Corrective Information

MAY 23, 1974
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-7*

SEE BULLETIN NO: SB-100-4 DATED MAY 23, 1974 (see Page 151)

ah.1.10. HW-101-8: Oscillations or Low Drive

DECEMBER 18, 1974
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-8*

SEE BULLETIN NO: SB-100-5 DATED DECEMBER 18, 1974 (see Page 152)

ah.1.11. HW-101-9: Self Oscillations Occurring After Installation of Steel Comb Brackets

MAY 2, 1975
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-9*

SEE BULLETIN NO: SB-100-6 DATED MAY 2, 1975 (see Page 153)

ah.1.12. HW-101-10: S-Meter Drift

MARCH 26, 1976
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-10*

To bring the meter drift to an acceptable level, install the following:

CHANGE: R107 from 100K Ohm 1/2 Watt to 100K 1 Watt [PN 1-28-1]

This makes the voltage divider string more stable with temperature changes caused by internal heating.

This change will be made in future production runs.

ah.1.13. HW-101-11: Low Receiver Sensitivity

HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-11*

SEE BULLETIN NO. HW-100-7 DATED NOVEMBER 15, 1976

ah.1.14. HW-101-12: Improperly Manufactured 6HS6 Tubes

JANUARY 14, 1977
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-12*

Some 6HS6 tubes supplied with the HW-101 were improperly manufactured with the suppressor grid and cathode pin outs interchanged. These tubes will glow brightly when power is applied.

All of these tubes, with this trouble, have been removed from stock. Any new 6HS6 tubes ordered from parts replacement will be okay.

Some HW-101 kits will temporarily have 6AU6 tubes substituted for the 6HS6 until production quantities of the good tubes are available.

ah.1.15. HW-101-13: Germanium Diode Change

APRIL 13, 1977
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-13*

The seven germanium diodes [PN 56-26-1] used in this kit are selected [PN 56-26] diodes. They are selected for low reverse-current characteristics.

Due to the low percentage of the tested diodes meeting the low reverse-current spec, the germanium diodes in this kit are being changed as follows:

- CR1, CR2, CR3 and CR4 in the Balanced Modulator circuit are being changed to [PN 56-87] hot-carrier diodes.
- CR901, CR941 and CR201 are being changed to non-selected [PN 56-26] diodes.

Install these changes only when needed.

ah.1.16. HW-101-14: Improve ALC Adjustment

APRIL 28, 1977
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-14*

Remove: R202 (10 k ohm) and replace with a jumper wire.

ah.1.17. HW-101-15: Driver and Mixer Switch Shields Will Not Take Solder

JUNE 2, 1977
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-15*

The two switch shields which have a zinc coating, will not take solder. To correct this, the coating on these shields has been changed to a “lustre lite” coating. The part number of the shield remains the same, [PN 206-519]. The new shields can be identified by the “gold” color.

Any switch shield that will not take solder should be changed to the newer-type shield.

ah.1.18. HW-101-16: Side Tone Too Loud

AUGUST 23, 1977
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-16*

Complaints are being received that the side tone is too loud when using headphones with this unit. To reduce the side tone level,

CHANGE: R326 from 1 Megohm to 3.3 Megohm [PN 1-38].

ah.1.19. HW-101-17: Transceiver Oscillates In Transmit With the Mic Keyed

SEPTEMBER 28, 1977
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-17*

If it is not possible to null the carrier and get more than ~25 watts with the microphone keyed and the mic level turned down, V12 [PN 411-124] may be causing the transmit mixer to oscillate. The mic level control will operate nearly normal in tune, but will exhibit normal control over the first 75% of the rotation and will decrease the output over the last 25%.

If V12 is an Elmenco tube, replace V12 [PN 411-124] with a GE tube. (**NOTE**: If a GE tube is not available, it may be necessary to try several Elmenco tubes for a satisfactory result.)

ah.1.20. HW-101-18: RF Choke in Final Plate Circuit Overheats or Difficult to Neutralize on 10 Meter & 15 Meter Bands

JANUARY 20, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-18*

6146B tubes in the final amplifier may be causing this problem. To correct, replace with 6146A tubes.

A label will be installed on the back panel of the HW-101 recommending the use of 6146A tubes only. The 6146B tubes should not be used as a replacement.

ah.1.21. HW-101-16: VFO Shift

FEBRUARY 2, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-19*

The trimmers on the VFO tuning capacitor tend to align at their minimum capacitance. Therefore, the head of the screw may not be under sufficient pressure against the spring plates of the trimmers, and intermittent frequency shift can result. Changing C-947 from 56 to 47pf NPO [PN 21-147] will allow the trimmers to tune to a point with tighter compression.

ah.1.22. HW-101-20: Low Power Output, S-Meter Drift, Etc

FEBRUARY 3, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-20*

The #44 pilot lamps presently used in the unit unbalance the series-parallel filament line because of their 250ma current requirements.

In each unit service, change the pilot lamps to type #47 [PN 412-11].

This change will be incorporated in future runs.

ah.1.23. HW-101-21: Distorted Audio, No Carrier Null or Erratic Power Output in Voice Mode

MARCH 31, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW0101-21*

This problem may be caused by V1 oscillating at approximately 65KHZ, especially if a "GE" brand tube is used at this location.

To correct, INSTALL: .005 uf capacitor [PN 21-57] in parallel with the .2 uf capacitor at C3. Install only as needed.

ah.1.24. HW-101-22: Relative Power Meter Pegs on 15 And 10 Meter

APRIL 14, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-22*

Diode CR-901 [PN 56-26] should be mounted on terminal strip BR with 1/2" leads. This introduces a slight amount of inductance into the circuit, which cures the problem.

The next manual level will include this instruction.

ah.1.25. HW-101-23: Relays Remain Energized After Transmit Condition

JUNE 5, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-23*

After keying the transceiver with PTT for thirty to forty seconds, a positive voltage in excess of 10 volts appears at the control grid, pin 9 of V12, thus keeping the relays energized.

To correct the problem, replace V12 [PN411-124]. IEC Brand tubes have been found defective in several cases, but other brands may also cause this problem.

ah.1.26. HW-101-24: Poor AGC Action

JUNE 5, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-24*

Leakage in the 6HS6 tubes [PN 411-247] at V10 and/or V11 has been found to cause:

- poor AGC action
- Fast S-meter decay
- poor sensitivity when RF gain control is fully clockwise.

This usually occurs after warmup of at least an hour. A positive voltage, usually over 1 volt, will appear at the grid, pin 1, of either one or both tubes.

Replacement of the tube with the positive voltage corrects the problem.

ah.1.27. HW-101-25: 100 KHz Calibrator Spurs

JUNE 5, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-25*

Strong signals may occur at other than 100khz points.

Look at the calibrator output [ahead of output diode] with an oscilloscope. Use high input gain and a slow sweep speed. If the upper portion of the sine-wave signal appears choppy or uneven, the Y201 crystal may be at fault.

After installation of a new crystal [PN 404-43], recheck with oscilloscope.

ah.1.28. HW-101-26: Receiver Recovery Slow

AUGUST 3, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-26*

THIS BULLETIN OBSOLETE. REFER TO BULLETIN NO: HW-101-36 DTD OCTOBER 10,1978.

ah.1.29. HW-101-27: Erratic VFO Tuning

JULY 24, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-27*

Erratic tuning can be caused by an intermittent electrical contact in the vernier drive of the tuning capacitor. This causes a change in the ground path from the capacitor frame. This affects the capacitance and subsequently, the tuning.

To prevent this, solder a heavy gauge wire or braid from the stop stud to a solder lug under the closest mounting screw. This provides a suitable short ground path from the capacitor frame to ground.

ah.1.30. HW-101-28: Carrier Nulls with C14 Trimmer Plates Completely Meshed

JULY 24,1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-28*

SEE BULLETIN NO: HW-100-14 DATED JULY 24, 1978.

ah.1.31. HW-101-29: Poor Preselector Tracking

JULY 24, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-29*

SEE BULLETIN NO: HW-100-13 DATED JULY 24, 1978.

ah.1.32. HW-101-30: Poor Preselector Tracking

HW-101 *BULLETIN NO:* *HW-101-30*

This problem is more noticeable on the 10-meter band. It may be caused by the drive belt slipping or by one of the variable capacitors not turning due to excessive friction in its bearings.

Check the belt for being loose or worn and replace as needed. Lubricate the bearing of the variable capacitors.

If lubricating the capacitor bearings does not allow the rotor to turn freely, replace the capacitor [PN 26-122].

ah.1.33. HW-101-30: Loading Capacitor Turns as Plate Capacitor is Rotated

AUGUST 1, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-30*

SEE BULLETIN NO: HW-100-16 DATED AUGUST 3, 1978.

ah.1.34. HW-101-30: Loading Capacitor Turns as Plate Capacitor is Rotated

HW-101 *BULLETIN NO:* *HW-101-30*

This problem can be caused by:

- Insufficient friction in the loading capacitor or;
- Excessive friction between the plate and load tuning shafts.

If the problem persists after freeing and lubricating the shafts, install a rubber grommet [PN 73-3] on the loading capacitor shaft between the pulley and the RF cage. Apply slight pressure to the grommet as the pulley set-screw is tightened. This will add enough friction to keep the loading capacitor still while tuning the plate control. Use only as needed.

ah.1.35. HW-101-31: Relays Chatter in VOX Mode

AUGUST 3, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-31*

SEE BULLETIN NO: HW-100-15 DATED AUGUST 3, 1978.

ah.1.36. HW-101-32: "Chirping" and Slow Receiver Recovery

AUGUST 3, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-32*

If "chirping" of the audio in the receive mode and slow recovery of the receiver after long periods of transmitting are encountered, remove the cover of RL2 and check for carbon buildup at the base, just below the contact. Clean dirt or carbon tracks, or replace if necessary.

A dirt or carbon buildup will cause the +300 volts to be applied to adjacent contacts such as the bias or AGC lines, adversely affecting receiver cutoff by upsetting the operation of 1] V12, receiver mixer; 2] V10, RF amplifier; and 3]V11, first receiver mixer.

ah.1.37. HW-101-33: ALC Meter Reads Below Zero

AUGUST 21, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-33*

SEE BULLETIN NO: HW-100-18 DATED AUGUST 21, 1978.

ah.1.38. HW-101-34: S Meter Drift

AUGUST 22, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-34*

SEE BULLETIN NO: HW-100-17 DATED AUGUST 22, 1978.

ah.1.39. HW-101-35: Poor IF Sensitivity

SEPTEMBER 26, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-35*

SEE BULLETIN NO: HW-100-19 DATED SEPTEMBER 26, 1978.

ah.1.40. HW-101-36: Receiver Recovery Slow

OCTOBER 10, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-36*

SEE BULLETIN NO: HW-100-20 DATED OCTOBER 10, 1978.

ah.1.41. HW-101-37: R-940 Shorting To Shield

OCTOBER 11, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-37*

To prevent the leads of R-940 shorting to ground, install a length of sleeving [PN 346-1] on each lead of R-940.

This will be incorporated in future production.

ah.1.42. HW-101-38: Poor Carrier Suppression

OCTOBER 13, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-38*

The HW-101 carrier suppression specification is -45db or below. If the carrier cannot be nulled on both USB and LSB to this level, try changing R9 on the modulator board from a 1K Ohm to a 390 Ohm [PN 1-48].

This change will reduce the injection level to the balanced modulator and hence reduce the carrier suppression level.

ah.1.43. HW-101-39: Identification of The 6146a Tubes

NOVEMBER 20, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-39*

The 6146A tubes [PN 411-75] used at V8 and V9 of this unit are marked '6146A' in white ink on the side of the tube. These tubes may also have '6146B' etched in the galss. These tubes have been reworked by G.E. and are acceptable for use in the HW-101.

Most tube cartons will contain the following insert to explain the situation to the customer:

IMPORTANT INFORMATION;

THE TUBE SUPPLIED WITH THIS NOTICE IS TYPE 6146A, AS PRINTED ON ONE SIDE OF THE TUBE, EVEN THOUGH THERE MAY BE A 6146B ETCHED ELSEWHERE ON THE TUBE ENVELOPE. ALWAYS REPLACE V8 AND V9 WITH 6146A TYPE TUBES

Replace the backing from this label and place the label at any convenient location inside the cabinet top.

ah.1.44. HW-101-40: Noise or Static From Speaker When Chassis Tapped Lightly

NOVEMBER 28, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-40*

If noise or static is heard from the speaker when the chassis is lightly tapped, check for intermittent tubes, cold solder connections, or intermittently shorting filaments in the pilot lamps by tapping each lamp lightly. This produces noise in the filament supply but usually will not produce any difference in the lamp brilliance.

ah.1.45. HW-101-41: Relay Chatter in Any Setting of The VOX Sensitivity Control

DECEMBER 11, 1978
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-41*

If the relays chatter in the VOX mode, try performing the procedures in BULLETIN'S HW-101-13, -31 and -38. If these changes do not correct the problem, perform the following:

1. With a scope, check for excessive noise at the junction [point 8] of R213 and R214. Any noise on the white-red-red wires coming from the mode and function switches will override the reverse bias to D201, thus activating V12B.

2. Replace the two white-red-red wires with shielded cable [PN343-15].

3. Ground the shields to a ground foil near the junction of R213 and R214.

ah.1.46. HW-101-42: Unit "Warbles" When Chassis Is Tapped

DECEMBER 27, 1978

HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-42*

This "warble" has been traced to the VFO assembly. This occurs especially when the leads of the C946 and C953 capacitor combination is too long, enabling the capacitors to vibrate.

To solve this problem, glue the top of C946 [4700pf] to the chassis wall of the VFO assembly. The PN 350-12 glue may be used.

ah.1.47. HW-101-43: Poor Sensitivity or Grid or Plate Driver Coils Will Not Tune

January 24, 1979

HW-101 *Bulletin No: SSB Transceiver* *HW-101-43*

Check the lugs that are nearest the chassis and verify that they are not folded under the capacitors; thus shorting them out.

ah.1.48. HW-101-44: No Ground Pin on Tube Sockets at V10 And V11

January 25, 1979

HW-101 *Bulletin No: SSB Transceiver* *HW-101-44*

The 7-pin tube sockets [PN 434-112] now used at V10 and V11 on the RF driver circuit board do not have a ground pin in the center. Only the 7-pin socket [PN 434-129] at V6 on this board uses a ground clip.

ah.1.49. HW-101-45: VFO Will Not Adjust Properly

February 16, 1979

HW-101 *Bulletin No: SSB Transceiver* *HW-101-45*

If the unit will not track at 0 and 500, or if it will track at 0 and 500, but the error at 100, 200, 300, 400 is greater than specifications, then make sure the slug in the VFO coil is adjusted to the lower of the two peaks. To check, insert the shorter end of PN 490-1 tuning tool into the coil. The body of the tool should just touch the top of the coil form. If it sticks out a half inch, the coil is at the wrong peak. Turn slug into coil and readjust tracking.

ah.1.50. HW-101-46: Low Power Output; Poor VOX Sensitivity

April 25, 1979

HW-101 *Bulletin No: SSB Transceiver* *HW-101-46*

See Bulletin No: HW-100-21 Dated April 25, 1979

ah.1.51. HW-101-47: Driver Preselector Won't Peak for Full Output at 7.0 MHZ

May 15, 1979
HW-101 *Bulletin No: SSB Transceiver* *HW-101-47*

See Bulletin No: HW-100-23 Dated May 15, 1979

ah.1.52. HW-101-48: PEC [PN 84-22] No Longer Used

May 15, 1979
HW-101 *Bulletin No: SSB Transceiver* *HW-101-48*

The next production run of HW-101's will use discrete components instead of the PEC at V15A since the manufacturer will no longer supply this part. However, the parts replacement department has a three year supply of these on hand, so continue to order the PECs if an older unit requires one.

ah.1.53. HW-101-49: Changeover to 6146B Finals

May 15, 1979
HW-101 *Bulletin No: SSB Transceiver* *HW-101-49*

The 6146A final amplifier tubes are no longer available from the manufacturer. Future productions runs will use the 6146Bs. These are GE brand tubes and have been tested in the HW-101. No difficulty was encountered in neutralizing the finals; nor did the RF choke in the final plate circuit overheat. The tube replacement label [PN 390-146] should be removed from all units brought in for service.

ah.1.54. HW-101-50: R940 Overheats

July 30, 1979
HW-101 *Bulletin No: SSB Transceiver* *HW-101-50*

In new units, R904 100 ohm [PN 6-101] is a film-type resistor. During installation, the body of the resistor may rub against the driver shield, resulting in the resistor shorting to the shield. When installing a new resistor or reworking the unit, position this resistor away from the shield.

ah.1.55. HW-101-51: Operation of Mode Switch Trips VOX

July 30, 1979
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-51*

Dress wht-org-org lead from foil side of modulator board away from V1 foils.

If dressing of this lead fails to correct the problem, install filter in line with wht-org-org lead. Use the unused foil at point "A".

Shows .024uf connected from wht-org-org to ground --- 2.2K ohm resistor in line going to R1

ah.1.56. HW-101-52: VFO Stops Working at High End of All Bands

August 15, 1979
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-52*

This problem occurs in all modes except LSB. In LSB, the VFO operates okay.

To Correct:

- Change: R947 from 1000 ohm to 470 ohm [PN 6-471]
- Add: [PN 56-56] diode from gate of Q941 to ground; anode of diode to gate.

ah.1.57. HW-101-53: Low Transmitter Output; Low Receiver Sensitivity

September 20, 1979
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-53*

When cleaning the unit during prework [tube sockets, potentiometers, etc.], don't overlook the SSB/CW filter slide switch located with the RF gain control. This switch handles both transmit and receive signals and dirt and grease build-up can affect the performance of both functions.

ah.1.58. HW-101-54: Receiver Audio Troubleshooting Information

September 27, 1979
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-54*

Equipment needed:

Audio Signal Generator

Oscilloscope

01uf capacitor 500 volts or greater [PN 21-16]

Procedure:

1. connect a 4 ohm load to the speaker jack.
2. set the AF gain control full clockwise.
3. set the generator to 1 KHZ at .01 volt RMS
4. connect the generator to V13, pin 7 through the .01uf capacitor.

The signal voltages for the points listed should compare with the values given below:

Pin 1 of V14 = 50mv p-p

Pin 9 of V14 = 1.5v p-p

Pin 8 of V14 = 1.5v p-p

Pin 6 of V14 = 35v p-p

Speaker Jack = .6v p-p

Add these voltages to your shop schematic.

ah.1.59. HW-101-55: AVC Decay Too Fast; S Meter Drops Too Quickly

November 19, 1979
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-55*

Check for open R117 [PN 6-332]

When replacing this resistor, be sure to dress it away from the AVC wire ends protruding from the IF board to insure that the wire ends will not pierce the resistor's film coating.

ah.1.60. HW-101-56: Low Grid Drive on Certain Portions of One or More Bands

JANUARY 21, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-56*

The cause may be an improperly aligned or intermittent 8.395 - 8.895 Mhz bandpass filter, T202 [PN 52-65].

An alignment problem can be corrected by sweep aligning T202.

Equipment Required:

- Post/Marker Sweep Generator (IG-5257 or equivalent) with Demodulator
- Probe (IG -5257) and Attenuator.
- Oscilloscope (IO-4550 or equivalent).
- RF Generator (MS-27 or equivalent).

Procedure:

- Unsolder T202’s two mounting lugs on the bottom of the Bandpass circuit board.
- Turn the unit over and remove the screw from the top of T202. Remove the shield from T202.
- Connect your equipment as shown below:

- [[Shows the RF Generator (set at 5.5mhz) connected to the Marker/Sweep Generator (set at 4.5 Mhz marker on and Lo Sweep), which is in turn connected to the O-scope. The Attenuator is connected to the Sweep Generator.]]
- Connect the demodulator probe's red lead to C402 (lead closest to front of transceiver); black lead to ground.
- Unplug the coax cable from the VFO (LMO) and connect to the attenuator (set to 0 dB).

Set the controls and switches as follows:

RF Generator

- Frequency Dial...............................5.5 Mhz

Marker Sweep Generator

- Marker......................................ON
- Trace...FCW
- Sweep Range.................................LO

Unit Under Test

- Mic Level.......................................FCW
- Preselector......................................FCCW
- Key the transmitter and adjust T202 for a wave form similar to the one shown.

[[Base ref line graduated, starting at 4.5mhz - 4.75 - 5.0 - 5.25 - 5.5; Vertical plane is defined .1V - .2V - .3V. The waveform rises to .2V (TOP TRIMMER)/4.75 Mhz, remains steady till approximately 5.25 MHz/.3V which indicates (BOTTOM TRIMMER). Trace then drops back down to .2V where at approximately 5.5 Mhz, (MIDDLE TRIMMER). [this is just prior to the trace dropping back to the base line]]]

ah.1.61. HW-101-57: Relay Chatter in VOX Mode

JANUARY 21, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-57*

This can be caused by the 0 to -50 Volt pulse at pin 9 of V1B when switching from transmit to receive. This is fed back to the VOX circuit through the MIC control.

Perform the suggestions in TEBs HW-101-31 and HW-101-41. If this doesn't correct the problem, then install two 0.1 uF capacitors [PN 27-28] across R308. This will reduce pulse rise time and improve VOX operation. Note: In some older transceivers, it may be necessary to add a higher value capacitor; perhaps as high as 0.47 uF.

Perform this modification on an "as-needed" basis.

ah.1.62. HW-101-58: Receiver Oscillations

JANUARY 21, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-58*

The following symptoms may be present:

- The S meter deflects upscale when the CW filter is switched in.
- Oscillations occur with the RF Gain control at maximum and the Bandswitch is changed.
- Oscillations may die out after three to four minutes.

To correct, retune T103 [PN 52-79] to it's top peak. (This may also give you more audio output.)

ah.1.63. HW-101-59: Finals Will Not Neutralize; C913 at Maximum Capacity

MARCH 7, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-59*

Check for missing bare wire between Driver Plate board and RF-Driver board at location shown in drawing below.

[[Looking down at the RF-Driver Circuit Board - the Driver Plate Circuit Board is 'bonded' to it, by the short bare wire at a location on the PCB's approximately half-way between the right side of the chassis and the switch shaft that passes through the Driver Plate CB]]

If the bare wire is missing, install a 11/16 inch large braid [PN 345-1] between these two boards. If a bare wire is already installed, replace with the braid to improve reliability.

In either case, be sure the braid doesn't short to adjacent foils.

ah.1.64. HW-101-60: RF Mod in CQ Magazine

APRIL 10, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-60*

The March, 1980 issue of CQ Magazine ran an article on interfacing the HW-101 to a Drake 2B receiver. Among other things, the article implied that Heath Company is supplying an RF gasket and metal inserts to replace the rear panel nylon inserts to correct an RF leakage problem from the back of the HW-101 during transmit.

This has been generating numerous phone calls to Technical Consultation from customers wanting the modification parts; whether they have RF leakage problems or not.

Currently, Heath does not offer such a modification for the HW-101 since Tech Consultation or Engineering has no evidence of any severe RF leakage problems.

If you discover that an HW-101 has rear panel RF leakage while you are servicing it, you can correct it by connecting a three inch length of brain [PN 345-1] between two solder lugs [PN 259-1] and mounting it on the rear cabinet top and rear panel on the transceiver. Be sure to sand the area around the solder lug on the cabinet top. Refer to the pictorial below.

[[Pictorial shows the 3" braid as stated above - connected in the center of the rear flange of the top cover to the middle of the rear back plane of the chassis]]

Perform this modification on an "as-needed" basis and only if standard servicing procedures do not correct; re:, lockwashers between the RF driver board and chassis, tube shields at V6 and V7, all hardware tightened.

ah.1.65. HW-101-61: Parasitic Oscillations

JUNE 20, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-61*

Parasitic oscillations occurring in the HW-101 may be caused by excessive component lead length. The leads of the components installed on V8 and V9 tube sockets should be kept to a minimum and dressed as shown in the pictorials below.

[[Pictorials indicate a direct-path method of interconnectivity, keeping component lengths at their minimum]].

ah.1.66. HW-101-62: Phase Shift Circuit Board Parts List

JUNE 20, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-62*

The following components are being used to replace the PEC [PN 84-22] at V15A in the current production run of the HW-101. This list is intended as a quick reference when servicing the newer transceivers. Continue ordering [PN 84-22] if the PEC must be replaced on older units (re: Bulletin No. HW-101-48).

Circuit Comp. No.	Description	Heath Part No.

C331	.01 uF ceramic disk capacitor	21-16
C332 thru C336	470 pF mica capacitor	20-128
R341 thru R346	470 kilo Ohm, 1/2 watt resistor	1-33
Phase shift circuit board		85-2138-1
“F” connector (3 qty.)		432-734

ah.1.67. HW-101-63: VOX Delay Too Short

AUGUST 12, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-63*

Change: C213 from a .2 uF capacitor to a .47 uF capacitor [PN 27-61].

ah.1.68. HW-101-64: Load Control Squeaks with the HW-101-30 Mod Installed

AUGUST 13, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-64*

Install a 1/4” flat fiber washer [PN 253-62] between the grommet and the RF cage. Make this change only to units with the modification described in Bulletin No. HW-101-30.

ah.1.69. HW-101-65: CW Sidetone Inoperative

AUGUST 21, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-65*

This problem will occur only in units that use the phase shift circuit board in place of the PEC (see Bulletin HW-101-62, dated June 20, 1980).

ah.1.70. HW-101-66: Rotary Switch Detent Change

NOVEMBER 4, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-66*

The [PN 266-85] rotary switch detents are being replaced with [PN 266-1116] detents. The new detents [PN 266-1116] are directly interchangeable with the old ones.

Continue to use the old detents as replacements until Parts Department’s stock is depleted.

ah.1.71. HW-101-67: Cannot Zero S Meter with the Meter Zero Control

DECEMBER 11, 1980
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-67*

Change:

- R104 from 47 ohm resistor to 75 ohm resistor [PN 6-750]
- R105 from 47 ohm resistor to 22 ohm resistor [PN 6-220]

Make this change on an as-needed basis.

ah.1.72. HW-101-68: Wiring for Use With The HD-15 Phone Patch

MARCH 12, 1981
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-68*

Refer to the pictorial and perform these steps:

[[Pictorial shows the part of the PCB area where the C12 and V1 (6EA8) are installed]]

Install a 22 kilohm [PN 6-223] resistor across points A and B.

Install one end of a 2 feet coax cable [PN 343-15], center conductor to foil pad A, shielded conductor to ground.

Route the coax cable back to the SPARE JACK and make connections.

ah.1.73. HW-101-69: No Power Output in USB Or LSB; Tune Okay

MAY 8, 1981
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-69*

This may be caused by an open 3.3 megohm resistor [PN 6-335] at R915. Failure of this resistor causes the ALC circuit to function incorrectly.

ah.1.74. HW-101-70: Sidetone is Too Loud

JUNE 30, 1981
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-70*

To correct, install a volume control circuit.

Parts needed:

- one 500 kilohm control [PN 10-149]
- one 0.005 uF capacitor [PN 21-27]
- one fiber washer [PN 253-34]

Installation:

- Remove and discard R326.
- Install a 0.005 uF capacitor [PN 21-27] between the underside foil of pin 1 of V15 and the end lug of the volume control (inside lug that is nearest R302 & 303).
- Install a 500 kilohm CW volume control [PN 10-149] with a fiber washer [PN 253-34] as shown.
- [[This is installed at the lower right hand corner of the PCB, where the middle lug is positioned where it can connect to the foil where C311 connects]].

ah.1.75. HW-101-71: The #266-1116 Switch Detent Breaks During Installation

SEPTEMBER 25, 1981
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-71*

This occasionally happens when installing the switch detent to the front panel.

To correct, install two 3-48 x 3/8" screws [PN 250-172] with two lockwashers [PN 254-7], and two [PN 252-1] nuts.

[[The 3-48 x 3/8" screws and nuts are inserted through the switch detent on the inside of the panel, along with one of the lockwashers. The other lockwasher and control nut are then connected on the outside of the front panel]].

ah.1.76. HW-101-72: VOX Cycling

OCTOBER 21, 1981
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-72*

This may be caused by a spike introduced at the input of the VOX amplifier.

To correct, install a [PN 57-27] diode in series with the white-red-red wire at the junction of resistors R213 and R214.

[[The diode is placed in series between the aforementioned junction of R213/214 and lug 2 & 3 of the PTT switch. The cathode connected to the wire going to the junction, and the anode connected to the path going to the PTT switch]].

ah.1.77. HW-101-73: Tone in Audio When Switch To CW; Relay Chatters When Key is Closed

NOVEMBER 13, 1981
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-73*

Check for an open 40 uF capacitor [PN 25-36] at C5 in the PS-23A power supply.

ah.1.78. HW-101-74: Keys Continuously When Used With the SA-5010 Memory Keyer

JANUARY 21, 1982
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-74*

This may be caused by a defective 6EA8 tube [PN 411-124] at V15. To check for a defective tube, increase the volume to maximum on the HW-101, switch to CW mode, and listen for a 1-kilohertz tone. If a tone is heard, replace V15.

ah.1.79. HW-101-75: R940 Overheats

MARCH 11, 1982
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-75*

If the 100-ohm resistor [PN 6-101] at R940 overheats, change:

- C701 and C801 from 680 pF 300 volt to 680 pF 500 volt [PN 20-735].

Install the higher voltage rated capacitor on all units received for service.

ah.1.80. HW-101-76: Carrier Null Control Installation Change

FEBRUARY 25, 1982
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-76*

The case of the 200-ohm carrier null control [PN 10-147] has been changed to an aluminum case. Therefore, you cannot solder a wire to the case as was done on the older type control. If you attempt to solder a wire to the case, the heat will damage the plastic parts inside the control. So, when replacing a carrier null control with the new type, use the following procedure:

Melt a small amount of solder onto the two mounting tabs of the 200 ohm control [PN 10-147].

Now place a fiber washer on the shaft of the control and install it from the foil side of the board. Solder the five tabs to the foil.

ah.1.81. HW-101-77: VFO Stops Oscillating at High End of Dial

APRIL 23, 1982
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-77*

Two peaks will be noticed when adjusting the VFO coil, one near the top of the coil and the other near the bottom of the coil. Adjust the VFO coil to the top peak to correct this problem. However, to do this it may be necessary to adjust the slugs in T941 to reduce the output level. Reduce the output level from 3-volt RF to about 2-volt RF.

ah.1.82. HW-101-78: Tune Control Slips

APRIL 29, 1983
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-78*

To prevent the loading shaft from slipping when the tune control is adjusted, install two nylon washers and a spring washer behind the loading shaft pulley onto the loading shaft. Use the following installation procedure and illustration to install the washers.

Parts needed:

QTY	DESCRIPTION	PART NO.
2	flat nylon washer	253-49
1	spring washer	253-36

Procedure:

- Remove V6, V7, V10 and V11.
- Remove the loading shaft pulley.
- Install the spring washer [PN 253-36] between the two nylon washers [PN 253-49] on the loading shaft.
- Reinstall the pulley by firmly pushing it onto the shaft and compressing the spring washer between the nylon washers.
- Reinstall V6, V7, V10 and V11.

ah.1.83. HW-101-79: Driver Stage Oscillates on 15 Meters

SEPTEMBER 14, 1983
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-79*

Bend the driver neutralizer wire exiting from hole "W" on the RF driver circuit board flat against the circuit board as shown in the pictorial below. This will eliminate the oscillation. Perform this on an "as needed" basis.

[[Pictorial shows neutralizer wire bent flat against PCB - down along side of C412.]]

ah.1.84. HW-101-80: Low Transmitter Output Due to Low VFO Output

SEPTEMBER 14, 1983
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-80*

To check, measure the voltage at the emitter of Q942. The voltage should be about 8.6 VDC. If the voltage is significantly less (i.e. 7.5 VDC), replace Q942 with a hand-selected [PN 417-118] transistor with the generic marking 2N3393 on it. This replacement should increase the output by 0.1 VRF. Next, change R945 from a 4700 ohm resistor to a 47 kilohm resistor [PN 6-473]. This will raise the VFO output by another 0.1 VRF. These power increases may make the difference between a unit that will meet transmitter power specs and one that will not.

ah.1.85. HW-101-81: Preselector Capacitors Won't Take Solder

JANUARY 27, 1984
HW-101 *Bulletin No: SSB Transceiver* *HW-101-81*

The variable capacitors [PN 26-122] have been found to have corrosion on the pins used to solder the frame to the driver board. The last production run and all parts in replacement stock had this condition. To correct, remove the capacitor from the circuit board. With fine sandpaper or a small ignition file, remove the corrosion. Tin the pins before reinstalling. Be careful not to damage the plates of the capacitors.

Replacement parts stock has been reworked.

ah.1.86. HW-101-82: S Meter Drifts; IF Oscillates

SEPTEMBER 21, 1984
HW-101 *Bulletin No: SSB Transceiver* *HW-101-82*

Check the brand of 6AU6 tubes at V3 and V4. If a brand other than GE is used at these locations, replace them with GE brand tubes. Parts replacement will stock only GE brand of 6AU6 tubes [PN 411-11].

ah.1.87. HW-101-83: Oscillation on 15 Meters

FEBRUARY 8, 1985
HW-101 *Bulletin No: SSB Transceiver* *HW-101-83*

On the RF driver board in the newer units, the tube sockets at V10 and V11 were changed to types without the center ground post. Consequently, the switch shields aren't grounded at those points. To correct, refer to the drawing below and use large metal braid [PN 345-1] to ground the switch shield to the RF driver board ground foils at V10 and V11 and at the ends of the shield where the bare wires are located. Resolder the ground post connections at V6 and V7.

ah.1.88. HW-101-84: R1, R6 and R7 Out of Tolerance or Open

DECEMBER 22, 1988
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-84*

The wattage rating of the resistors used R1, R2, and R7 are too low. This can cause them to go out of tolerance and eventually open. To prevent this failure, change:

- R1 from a 100 kilohm, .5 watt resistor to a 100 kilohm, 1 watt resistor [PN 6-104-1].

- R6 AND R7 from a 33 kilohm, .5 watt resistor to a 33 kilohm 1 watt resistor [PN 6-333-1].

Also check the 100 kilohm resistor at R215 and the 22 kilohm resistor at R316 for signs of overheating. If necessary, replace them with 1 watt resistors: 100 kilohms [PN 6-104-1] and 22 kilohms [PN 6-223-1].

ah.1.89. HW-101-85: VOX Activates When Mike Not Connected

APRIL 28, 1989
HW-101 *BULLETIN NO: SSB TRANSCEIVER* *HW-101-85*

If the optional cable to "patch jack" is installed, using the spare phono jack, and the VOX activates without a mike connected, suspect a poor ground at the spare phono jack. This phono jack is used as a ground connection for the power supply, including the 60 Hz filament supply. A poor ground at this point causes hum in the speech amp, tripping the VOX. To correct this problem, tighten the screws securing the spare phono jack.

ah.2. SB-100 Service Bulletins

ah.2.1. SB-100-1: Diode Leakage in The SB-100, SB-101, HW-100

May 23, 1974
SB-100 *Bulletin No:SSB Transceiver* *SB-100-1*

The silicon diodes used in the SB100 & SB101 are standard power diodes rated at 500PIV & 750MA. For each condition described, the diodes should be replaced with an equal value to maintain proper operation.

Diodes D902 & D903, when leaky, will have an effect on ALC indication. The ALC indication will be normal for the first half hour to an hour. Then the meter indication will start dropping off until there is very *little indication.*

D101, when leaky or defective, will cause slow or no receiver recovery after transmitting for any period of time.

D905, under leaky conditions, will cause very slow or no receiver recovery and false meter indications. The meter will kick up scale & slowly drift down to zero.

D201 will result in a decrease in VOX sensitivity to the point where the VOX circuit will not be activated. It can also result in increasing VOX delay, causing the relay to stay in the transmit condition.

ah.2.2. SB-100-2: Alternate Method of Neutralizing the Final Amplifiers

May 23, 1974
SB-100 *Bulletin No:SSB Transceiver* *SB-100-2*

NOTE: Be sure unit is off and power supply high voltage capacitors are discharged.

Disconnect final plates & screen grid.***

1. Turn unit on.
2. Rotate the BAND switch to 28.5.
3. Place the VTVM RF probe in the ANTENNA connector.**
4. Set the FUNCTION switch to TUNE.
5. Rotate the LEVEL control fully clockwise.
6. Adjust the PRESELECTOR control for a maximum reading on the VTVM.
7. Adjust the FINAL control for a maximum indication on the VTVM, with the LOAD control set at the 50 ohm position.

8. Using an insulated screwdriver, adjust neutralizing capacitor for a MINIMUM indication on the VTVM.
9. Readjust the neutralizing capacitor for a minimum indication on theVTVM.
10. Turn the FUNCTION switch to the off position.
11. Discharge high voltage power supply capacitors.
12. Reconnect final plates & screen grid.

**VTVM & RF probe will be needed.

***To remove screen voltage in SB-100, SB-101, HW-100 & HW-101 disconnect R920 (100 ohm resistor) from buss wire between pins of V8 & V9. In the SB-102 removal of accessory plug is all that's required. To remove high voltage in SB-100, SB-101 & SB-102 disconnect red wire at lug 4 (in SB-100 lug 3) of terminal strip BK that goes to grommet BL. In HW100 & HW101 disconnect red wire going to lug 1 of RF choke in final cage.

NOTE: Take adequate steps to eliminate any possible contact with B+ or B+ shorts to chassis after disconnecting wire & resistor.

ah.2.3. SB-100-3: SB & HW Series Audio Preamplifier & VOX Circuit Trouble Shooting Guide

May 23, 1974

SB-100 *Bulletin No:SSB Transceiver* *SB-100-3*

It is assumed that the basic steps such as making DC voltage measurement, checking tubes & reviewing the soldering have been completed.

The following information was compiled from the above transceivers in the 80M LSB position. The mike level control was at the 9:00 o'clock position.

AC signal voltages are listed below. These voltages were measured from the microphone connector through the VOX circuit. All measurements were made with a VTVM. A microphone or audio generator for .1V @ 1KHZ can be used as the signal source.

Mike Connector Lug 1	.1VAC
Pin 2 of V1	.02VAC
Pin 6 of V1	10-15VAC
Pin 6 Level Control	10-15VAC
Pin 5 Level Control	.5VAC
Pin 9 of V1	.2VAC

Pin 8 of V1	.1 - .3VAC
Center Arm of VOX Sensitivity Control	5-15VAC
Pin 7 of V17	5-10VAC
Pin 6 of V17	40-50VAC
Junction of C211-D201	40-50VAC
Pin 9 of V12	9-15VAC

By tracing the AC signal from stage to stage the point of trouble can be isolated & steps taken to correct it.

POSSIBLE TROUBLE AREAS:

- Check each of the shielded cables for a possible open or poorly grounded shield.- Check for continuity through each of the shielded cables.
- Check for a proper ground at the mike control level.
- If the frequency response of the audio stage is not within specifications check the values & installation of C1, C2, C3 & C9.
- A change in VOX delay after operating for a period of time can be caused by leakage in diode D201. The other possibility is a change in value of capacitor C213. Either component could experience a change in operation characteristics due to heat.

ah.2.4. SB-100-4: SB & HW Series Instability and Corrective Information

May 23, 1974
SB-100 *Bulletin No: SSB Transceiver* *SB-100-4*

We suggest you check for each of the following possible causes:

1. Intermittent, rosin or cold solder joints.
2. Loose hardware at the tube sockets, terminal strips, circuit boards, shields and rear panel sockets.
3. Poor lead dress at tube sockets V8 & V9. The component leads must be short as possible.
4. Check C925 (Final tune capacitor) to be sure it is isolated from the tuning shaft. This is to prevent RF from traveling on the shaft to the front panel.
5. Check all edges of the final enclosures for proper grounding to the main chassis.

6. Check the hardware for the side rails to be sure a good ground is being provided.

7. Be sure that all the ground clips on the coil cover are making good contact with the switch shields.

8. Check the soldering of the switch shields to the center pins of tube sockets V6, V7, V10 & V11.

9. Check the ground leads from the switch board & shields, to be sure they are going to ground foil & not to the preselector capacitor foil pods on the RF driver board.

10. Check for broken or shorted pigtails on each of the shielded cables in the unit.

11. Check RFC801 & L901 for any signs of deterioration or physical damage, (burn spots). If apparent replace the part.

12. Improper adjustment of the Het. Osc. coils could cause improper mixing action, resulting in the final operating at a different frequency appearing as instability.

13. Change driver & final tubes then re-neutralize per manual instructions.

14. Check driver tube shield to be sure that it has a good ground contact with the socket spring clip.

15. Check for a good ground between the front panel & chassis.

16. Check the SWR of the antenna system at the frequency of operation. Should be below 2:1.

17. Check the antenna coax for leakage, poor connectors & broken shield connections.

18. Is the transmitter properly grounded?

19. Be sure all shields & tube shields are installed.

20. Realign using a properly terminated 50 ohm non-reactive dummy load.
    NOTE: This does not include a light bulb.

21. Check for normal Het. Osc. test-point voltage.

22. Check for proper LMO injection voltage 1.0-1.5 VRF.

23. Check for a high AC ripple content in the LV-B+, HV-B+ and bias voltages from the power supply.

24. Check to be sure that the shafts do not touch each other in the insulated coupling, and that the set screws do not touch the PA shield.

25. Check to be sure that the PA tune shaft turns the variable capacitor & is not slipping in the insulated coupling.

ah.2.5. SB-100-5: Oscillations or Low Drive

December 18,1974
SB-100 *Bulletin No: SSB Transceiver* *SB-100-5*

Loose boards cause sporadic self oscillations & unstable RF conditions, particularly at the high [15 & 10 meter] bands. The comb brackets which have been used are aluminum & could not be soldered. Steel brackets are now available [PN 204-2096] & should be used whenever encountered in the field. Both the switch shields & the driver boards should be soldered to these brackets.

This change helps to increase grid drive as well as increase stability.

ah.2.6. SB-100-6: Self Oscillations Occurring After Installation of Steel Comb Brackets

May 2, 1975
SB-100 *Bulletin No: SSB Transceiver* *SB-100-6*

It has been found that in a number of units, self oscillations are still occurring after installation of both steel comb brackets [Part No: 204-2096].

To correct the condition, the screws around the RF driver board must be tightened securely. Also, the lock washers between the circuit board & chassis must be installed, otherwise a good ground is not assured. Retightening screws which are already snug will also cause these oscillations to disappear in units where it is a problem.

ah.2.7. SB-100-7: S-Meter Drift

March 26, 1976
SB-100 *Bulletin No: SSB Transceiver* *SB-100-7*

To bring the meter drift to an acceptable level, install the following:

- CHANGE: R107 from 100K Ohm 1/2 Watt to 100K 1 Watt [PN 1-28-1]

This makes the voltage divider string more stable with temperature changes caused by internal heating.

This change will be made in future production runs.

ah.2.8. SB-100-8: Transmitter Oscillates in Transmit with the Mic Keyed

September 27, 1977
SB-100 *Bulletin No: SSB Transceiver* *SB-100-8*

+ + + + Information not yet available + + + +

ah.2.9.   SB-100-9: Tuning Erratic

February 22, 1978
SB-100 *Bulletin No: SSB Transceiver* *SB-100-09*

Some of the earlier LMOS can be opened up for service, such as cleaning the wiper contacts on the tuning cap when tuning becomes erratic. Some of these units have fiber washers between the frame of the tuning capacitor and the worm gear assembly. Intermittent contact between the teeth of the gears can change the ground path for the tuning cap and also cause erratic tuning. Simply replacing a fiber washer with a metal washer will give good connection between the tuning cap frame and the worm gear assembly to eliminate this problem.

ah.2.10. SB-100-10: Relays Remain Energized After Transmit Condition

June 5, 1978
SB-100 *Bulletin No: SSB Transceiver* *SB-100-10*

After keying the transceiver with PTT for thirty to forty seconds, a positive voltage in excess of 10 volts appears at the control grid, pin 9 of V12, thus keeping the relays energized.

To correct the problem, replace V12 [PN 411-124]. IEC brand tubes have been found defective in several cases, b ….(rest is missing)

ah.3. SB-101 Service Bulletins

ah.3.1. SB-101-1D: Driver Oscillates on 40 Meters

June 12, 1967
SB-101 *Bulletin No:SSB Transceiver* *SB-101-1D*

Remove C-924 [.02 disc capacitor] from across 150K ohm resistor & delete from circuit.

ah.3.2. SB-101-2D: Switch Action Improvement

November 1, 1967
SB-101 *Bulletin No:SSB Transceiver* *SB-101-2D*

DELETE: (2) 253-67 (2) WASHER, .186OD, .054 THICK (1 EA FOR 100-445)

ADD: (2) C253-67 (1) " " " "

" (FOR 100-445)ADD: (2) B255-79 (1)SPACER, 1/8 SHOULDER, THREADED

ADD: (2) A263-7 (1)FOOT, FELT, 1/8" THICK

DELETE:(4) 266-91 (1)ACTUATOR, SLIDE SWITCH

ADD: (4) 266-97 (1) " " " "

ah.3.3. SB-101-3D: Improper Tuning

NOVEMBER 1, 1967
SB-101 *Bulletin No:SSB Transceiver* *SB-101-3D*

Delete: [2] 26-109 [2] Variable Capacitor, 2 Sect. P.C. Mtg

Add: [2] 27-122 [2] Variable Capacitor, 2 Sect. P.C. Mtg

Delete: [4] 85-131-1 [1] PC Board, RF Driver Mixer [85-131 Screened 605-1225]

Add: [4] 85-131-2 [1] PC Board, RF Driver Mixer [85-131 Screened 605-1616]

Reason for change: To correct tuning trouble.

ah.3.4. SB-101-4D: Improper Tuning on 40Meters

APRIL 18, 1968
SB-101 *Bulletin No:SSB Transceiver* *SB-101-4D*

Description of Change:

DELETE: (2) B21-31   (50) CAPACITOR, DISC .02 MFD Z5U

ADD   : (2) B21-31   (49)   "   "   "

"   "DELETE: (4) 85-131-1   (1) PC BOARD, RF DRIVER MIXER

ADD   : (4) 85-131-1   (1) "   "   "   "

REMOVE: C-424 installed across R-401

NOTE: SBM-100-1 called for the installation of this capacitor on SB-100 units. This capacitor should now be removed.

ah.3.5. SB-101-5D: Grounding Problems on Transceivers

June 3, 1968
SB-101   *Bulletin No:SSB Transceiver*   *SB-101-5D*

A quality of factory wired transceivers have been shipped with loose rivets both at the rear phono sockets & at the final tube sockets.

This is causing a serious grounding problem. Corrective recommendations are shown on the attached sheet:

NOTE: IF MY INTERPRETATION IS NOT CLEAR - PSE LET ME KNOW

Illustration shows the installation of a ground buss for the rear panel phono sockets. It also states that if the final tube socket rivets are loose, they should be drilled out & replaced with 6-32 hardware.

ah.3.6. SB-101-1: Meter Zeroing

November 25,1970
SB-101   *Bulletin No:SSB Transceiver*   *SB-101-1*

Original 10-147 control tolerance not sufficient to allow zeroing in all units. This part is being respecified to a closer tolerance. In the meantime, any field problems regarding zeroing of the meter can be corrected as follows:

Change: R-107 from 100K Ohm to 82K Ohm (1-159).

ah.3.7. SB-101-2: Repeated Heterodyne Oscillator Failure

September 14, 1972
SB-101   *Bulletin No:SSB Transceiver*   *SB-101-2*

Change: R-212 from 220 Ohm to 330 Ohm 1/2 Watt resister (1-4).

ah.3.8. SB-101-3: SB & HW Series Audio Amplifier & VOX Circuit Trouble Shooting Guide

May 23, 1974
SB-101 *Bulletin No: SSB Transceiver* *SB-101-3*

It is assumed that the basic steps such as making DC voltage measurement, checking tubes & reviewing the soldering have been completed.

The following information was compiled from the above transceivers in the 80M LSB position. The mike level control was at the 9:00 o'clock position.

AC signal voltages are listed below. These voltages were measured from the microphone connector through the VOX circuit. All measurements were made with a VTVM. A microphone or audio generator for .1V @ 1KHZ can be used as the signal source.

Mike Connector Lug 1	.1VAC
Pin 2 of V1	.02VAC
Pin 6 of V1	10-15VAC
Pin 6 Level Control	10-15VAC
Pin 5 Level Control	.5VAC
Pin 9 of V1	.2VAC
Pin 8 of V1	.1 - .3VAC
Center Arm of VOX Sensitivity Control	5-15VAC
Pin 7 of V17	5-10VAC
Pin 6 of V17	40-50VAC
Junction of C211-D201	40-50VAC
Pin 9 of V12	9-15VAC

By tracing the AC signal from stage to stage the point of trouble can be isolated & steps taken to correct it.

POSSIBLE TROUBLE AREAS

- Check each of the shielded cables for a possible open or poorly grounded shield.- Check for continuity through each of the shielded cables.
- Check for a proper ground at the mike control level.

- If the frequency response of the audio stage is not within specifications check the values & installation of C1, C2, C3 & C9.
- A change in VOX delay after operating for a period of time can be caused by leakage in diode D201. The other possibility is a change in value of capacitor C213. Either component could experience a change in operation characteristics due to heat.

ah.3.9. SB-101-4: Diode Leakage in the SB-100, SB-101, HW-101

May 23, 1974
SB-101 *Bulletin No:SSB Transceiver* *SB-101-4*

The silicon diodes used in the SB100 & SB101 are standard power diodes rated at 500PIV & 750MA. For each condition described, the diodes should be replaced with an equal value to maintain proper operation.

1. Diodes D902 & D903, when leaky, will have an effect on ALC indication. The ALC indication will be normal for the first half hour to an hour. Then the meter indication will start dropping off until there is very little indication.
2. D101, when leaky or defective, will cause slow or no receiver recovery after transmitting for any period of time.
3. D905, under leaky conditions, will cause very slow or no receiver recovery and false meter indications. The meter will kick up scale & slowly drift down to zero.
4. D201 will result in a decrease in VOX sensitivity to the point where the VOX circuit will not be activated. It can also result in increasing VOX delay, causing the relay to stay in the transmit condition.

ah.3.10. SB-101-5: SB & HW Series Instability & Corrective Information

May 23, 1974
SB-101 *Bulletin No: SSB Transceiver* *SB-101-5*

Instability -- Troubleshooting

We suggest you check for each of the following possible causes:

1. Intermittent, rosin or cold solder joints.

2. Loose hardware at the tube sockets, terminal strips, circuit boards, shields and rear panel sockets.

3. Poor lead dress at tube sockets V8 & V9. The component leads must be short as possible.

4. Check C925 (Final tune capacitor) to be sure it is isolated from the tuning shaft. This is to prevent RF from traveling on the shaft tothe front panel.

5. Check all edges of the final enclosures for proper grounding to the main chassis.

6. Check the hardware for the side rails to be sure a good ground is being provided.

7. Be sure that all the ground clips on the coil cover are making good contact with the switch shields.

8. Check the soldering of the switch shields to the center pins of tube sockets V6, V7, V10 & V11.

9. Check the ground leads from the switch board & shields, to be sure they are going to ground foil & not to the preselector capacitor foil pods on the RF driver board.

10. Check for broken or shorted pigtails on each of the shielded cables in the unit.

11. Check RFC801 & L901 for any signs of deterioration or physical damage, (burn spots). If apparent replace the part.

12. Improper adjustment of the Het. Osc. coils could cause improper mixing action, resulting in the final operating at a different frequency appearing as instability.

13. Change driver & final tubes then re-neutralize per manual instructions.

14. Check driver tube shield to be sure that it has a good ground contact with the socket spring clip.

15. Check for a good ground between the front panel & chassis.

16. Check the SWR of the antenna system at the frequency of operation. Should be below 2:1.

17. Check the antenna coax for leakage, poor connectors & broken shield connections.18. Is the transmitter properly grounded?

19. Be sure all shields & tube shields are installed.

20. Realign using a properly terminated 50 ohm non-reactive dummy load.

NOTE: This does not include a light bulb.

21. Check for normal Het. Osc. test-point voltage.

22. Check for proper LMO injection voltage 1.0-1.5 VRF.

23. Check for a high AC ripple content in the LV-B+, HV-B+ and bias voltages from the power supply.

24. Check to be sure that the shafts do not touch each other in the insulated coupling, and that the set screws do not touch the PA shield.

25. Check to be sure that the PA tune shaft turns the variable capacitor & is not slipping in the insulated coupling.

ah.3.11. SB-101-6: Alternate Method of Neutralizing the Final Amplifiers

May 23, 1974

SB-101 *Bulletin No. SSB Transceiver* *SB-101-6*

1. Disconnect final plates & screen grid.***

2. Turn unit on.

3. Rotate the BAND switch to 28.5.

4. Place the VTVM RF probe in the ANTENNA connector.**

5. Set the FUNCTION switch to TUNE.

6. Rotate the LEVEL control fully clockwise.

7. Adjust the PRESELECTOR control for a maximum reading on the VTVM.

8. Adjust the FINAL control for a maximum indication on the VTVM, with the LOAD control set at the 50 ohm position.

9. Using an insulated screwdriver, adjust neutralizing capacitor for a MINIMUM indication on the VTVM.

10. Readjust the neutralizing capacitor for a minimum indication on theVTVM.

11. Turn the FUNCTION switch to the off position.

12. Discharge high voltage power supply capacitors.

13. Reconnect final plates & screen grid.**VTVM & RF probe will be needed.

***To remove screen voltage in SB-100, SB-101, HW-100 & HW-101 disconnect R920 (100 ohm resistor) from buss wire between pins of V8 & V9. In the SB-102 removal of accessory plug is all that's required. To remove high voltage in SB-100, SB-101 & SB-102 disconnect red wire at lug 4 (in SB-100 lug 3) of terminal strip BK that goes to grommet BL. In HW100 & HW101 disconnect red wire going to lug 1 of RF choke in final cage.

NOTE: Take adequate steps to eliminate any possible contact with B+ or B+ shorts to chassis after disconnecting wire & resistor.

ah.3.12. SB-101-7: Oscillations or Low Drive

December 18, 1974
SB-101 *Bulletin No. SSB Transceiver* *SB-101-7*

Loose boards cause sporadic self oscillations & unstable RF conditions, particularly at the high [15 & 10 meter] bands. The comb brackets which have been used are aluminum & could not be soldered. Steel brackets are now available [Part No: 204-2096] & should be used whenever encountered in the field. Both the switch shields & the driver boards should be soldered to these brackets.

This change helps to increase grid drive as well as increase stability.

ah.3.13. SB-101-8: Self Oscillations Occurring After Installation of Steel Comb Brackets

May 2, 1975
SB-101 *Bulletin No. SSB Transceiver* *SB-101-8*

It has been found that in a number of units, self oscillations are still occurring after installation of both sets of comb brackets [Part No: 204-2096]. To correct the condition, the screws around the RF driver board must be tightened securely. Also, the lockwashers between the circuit board & chassis must be installed, otherwise a good ground is not assured. Retightening screws which are already snug will also cause these oscillations to disappear in units where it is a problem.

ah.3.14. SB-101-9: S-Meter Drift

March 29, 1976
SB-101 *Bulletin No:SSB Transceiver* *SB-101-9*

To bring the meter drift to an acceptable level, install the following:

- CHANGE: R107 from 100K Ohm 1/2 Watt to 100K 1 Watt [PN 1-28-1]

This makes the voltage divider string more stable with temperature changes caused by internal heating.

This change will be made in future production runs.

ah.3.15. SB-101-10: Low Receiver Sensitivity

November 15, 1976
SB-101 *Bulletin No: SSB Transceiver* *SB-101-10*

Note: Sensitivity of the unit is worse on the higher frequencies [15] & [10] meters.

Cure: Diode D907 may be in backwards or banded backwards.

ah.3.16. SB-101-11: Transceiver Oscillates in Transmit with Mic Keyed

September 27, 1977
SB-101 *Bulletin No: SSB Transceiver* *SB-101-11*

+ + + + Information not yet available + + + +

ah.3.17. SB-101-12: Tuning Erratic

February 22, 1978
SB-101 *Bulletin No: SSB Transceiver* *SB-101-12*

Some of the earlier LMOs can be opened up for service, such as cleaning the wiper contacts on the tuning cap when tuning becomes erratic. Some of these units have fiber washers between the frame of the tuning capacitor and the worm gear assembly. Intermittent contact between the teeth of the gears can change the ground path for the tuning cap and also cause erratic tuning. Simply replacing a fiber washer with a metal washer will give good connection between the tuning cap frame and the worm gear assembly to eliminate this problem.

ah.3.18. SB-101-13: Relays Remain Energized After Transmit Condition

June 5, 1978
SB-101 *Bulletin No:SSB Transceiver* *SB-101-13*

After keying the transceiver with PTT for thirty to forty seconds, a positive voltage in … (rest is missing)

ah.4. SB-102 Service Bulletins

ah.4.1. SB-102-1: Meter Zeroing

November 25, 1970
SB-102 *Bulletin No.SSB Transceiver* *SB-102-1*

Original 10-147 control tolerance not sufficient to allow zeroing in all units. This part is being re-specified to a closer tolerance. In the meantime, any field problems regarding zeroing of the meter can be corrected as follows:

Change: R-107 from 100K Ohm to 82K Ohm [PN 1-159].

ah.4.2. SB-102-2: Repeated Heterodyne Oscillator Tube Failure

September 14, 1972
SB-102 *Bulletin No.SSB Transceiver* *SB-102-2*

Change: R-212 from 220 Ohm to 330 Ohm 1/2 Watt resister [PN 1-4].

ah.4.3. SB-102-3: Low Grid Drive - Alignment Problems

March 23, 1973
SB-102 *Bulletin No.SSB Transceiver* *SB-102-3*

This has been related to the differences [internal electrode capacitance] between Tung-Sol & RCA 6146's. Purchasing has ceased buying Tung-Sol tubes; all new stock since late 1972 will be RCA's which give better performance. In addition, an additional alignment sequence is being put into the manuals which insures adequate grid drive -- previous tune-up was done in receive only where the peaks were broader than required for transmitter tuning. The new procedure uses the receiver sequence to get in the "ball park"; the added sequence peaks for maximum grid drive.

The following modifications to the manual will help avoid the many questions:

PAGE 103: 8th step, right column, last two sentences:

Then turn the meter switch to GRID [grid current]. The meter should have some up-scale indication. The meter may read as much as full scale -- this is normal.

PAGE 104: left column #2:

Turn the meter switch to GRID & adjust the MIC/CW LEVEL control for a grid current reading, just enough so a peak may be seen when making the adjustment in the next step.

PAGE 104: Right Column #4 - will be deleted.

PAGE 119: Right Column #14 - will be deleted.

ah.4.4. SB-102-4: LMO Instability

March 30, 1973
SB-102 *Bulletin No:SSB Transceiver* *SB-102-4*

We have a possible cure for some of the LMO instability problems in the SB-102. The following should help eliminate any stress on the LMO chassis when installed on the main chassis.

Remove and discard the lock washers & nuts used to mount the LMO to the chassis.

Use instead a #6 flat washer [PN 253-25] & hex lock nut [PN 252-27] at each lug, tightening each lug A TURN AT A TIME in a criss-cross pattern.

We recommend this be done on all SB-102 units in for service even if customer has no complaints about LMO.

ah.4.5. SB-102-5: Low 40 Meter Output

October 29,1973
SB-102 *Bulletin No:SSB Transceiver* *SB-102-5*

1. REMOVE the 1-1/2" bare wire from hole 1 on the DRIVER PLATE circuit board & the ground foil of the RF DRIVER board.

2. Connect a 3/4" bare wire between the ground foils of these same two boards.

3. REMOVE the 1-3/4" bare wire from hole 1 in the DRIVE GRID circuit board & the ground foil of the RF DRIVER board.

4. Connect a 3/4" bare wire between the ground foils of these same two boards.

5. Remove the 2-3/4" bare wire which ties the ground foils of the circuit boards to the shields.

6. Remove the coil cover. Then REMOVE four of the light spring clips & their hardware as shown:

> **NOTE:** the pictorial shows removal of the set of clips & hardware located directly down from the 2 holes in the cover; the other set to be removed is directly across and down from the 3 holes in the cover.

7. Readjust the driver grid & drive plate coils as instructed on page 102 in the SB-102 manual.

ah.4.6. SB-102-6: SB & HW Series Audio Preamplifier & VOX Circuit Trouble Shooting Guide.

May 23, 1974SB-102 *Bulletin No:SSB Transceiver* *SB-102-6*

It is assumed that the basic steps such as making DC voltage measurement, checking tubes & reviewing the soldering have been completed.

The following information was compiled from the above transceivers in the 80M LSB position. The mike level control was at the 9:00 o'clock position.

AC signal voltages are listed below. These voltages were measured from the microphone connector through the VOX circuit. All measurements were made with a VTVM. A microphone or audio generator for .1V @ 1KHZ can be used as the signal source.

Mike Connector Lug 1	.1VAC
Pin 2 of V1	.02VAC
Pin 6 of V1	10-15VAC
Pin 6 Level Control	10-15VAC
Pin 5 Level Control	.5VAC
Pin 9 of V1	.2VAC
Pin 8 of V1	.1 - .3VAC
Center Arm of VOX Sensitivity Control	5-15VAC
Pin 7 of V17	5-10VAC
Pin 6 of V17	40-50VAC
Junction of C211-D201	40-50VAC
Pin 9 of V12	9-15VAC

By tracing the AC signal from stage to stage the point of trouble can be isolated & steps taken to correct it.

POSSIBLE TROUBLE AREAS:

- Check each of the shielded cables for a possible open or poorly grounded shield.- Check for continuity through each of the shielded cables.
- Check for a proper ground at the mike control level.
- - If the frequency response of the audio stage is not within specifications check the values & installation of C1, C2, C3 & C9.

- - A change in VOX delay after operating for a period of time can be caused by leakage in diode D201. The other possibility is a change in value of capacitor C213. Either component could experience a change in operation characteristics due to heat.

ah.4.7. SB-102-7: SB & HW Series Instability & Corrective Information.

May 23, 1974
SB-102 *Bulletin No:SSB Transceiver* *SB-102-7*

We suggest you check for each of the following possible causes:

1. Intermittent, rosin or cold solder joints.

Loose hardware at the tube sockets, terminal strips, circuit boards, shields and rear panel sockets.

Poor lead dress at tube sockets V8 & V9. The component leads must be short as possible.

Check C925 (Final tune capacitor) to be sure it is isolated from the tuning shaft. This is to prevent RF from traveling on the shaft to the front panel.

Check all edges of the final enclosures for proper grounding to the main chassis.

Check the hardware for the side rails to be sure a good ground is being provided.

Be sure that all the ground clips on the coil cover are making good contact with the switch shields.

Check the soldering of the switch shields to the center pins of tube sockets V6, V7, V10 & V11.

Check the ground leads from the switch board & shields, to be sure they are going to ground foil & not to the preselector capacitor foil pods on the RF driver board.

Check for broken or shorted pigtails on each of the shielded cables in the unit.

Check RFC801 & L901 for any signs of deterioration or physical damage, (burn spots). If apparent replace the part.

Improper adjustment of the Het. Osc. coils could cause improper mixing action, resulting in the final operating at a different frequency appearing as instability.

Change driver & final tubes then re-neutralize per manual instructions.

Check driver tube shield to be sure that it has a good ground contact with the socket spring clip.

Check for a good ground between the front panel & chassis.

Check the SWR of the antenna system at the frequency of opertion. Should be below 2:1.

Check the antenna coax for leakage, poor connectors & broken shield connections.

Is the transmitter properly grounded?

Be sure all shields & tube shields are installed.

Realign using a properly terminated 50 ohm non-reactive dummy load.

NOTE: This does not include a light bulb.

Check for normal Het. Osc. test-point voltage.

Check for proper LMO injection voltage 1.0-1.5 VRF.

Check for a high AC ripple content in the LV-B+, HV-B+ and bias voltages from the power supply.

Check to be sure that the shafts do not touch each other in the insulated coupling, and that the set screws do not touch the PA shield.

Check to be sure that the PA tune shaft turns the variable capacitor & is not slipping in the insulated coupling.

ah.4.8. SB-102-8: Alternate Method of Neutralizing the Final Amplifiers

May 23, 1974
SB-102 *Bulletin No: SSB Transceiver* *SB-102-8*

NOTE: Be sure unit is off and power supply high voltage capacitors are discharged.

1. Disconnect final plates & screen grid.***

Turn unit on.

Rotate the BAND switch to 28.5.

Place the VTVM RF probe in the ANTENNA connector.**

Set the FUNCTION switch to TUNE.

Rotate the LEVEL control fully clockwise.

Adjust the PRESELECTOR control for a maximum reading on the VTVM.

Adjust the FINAL control for a maximum indication on the VTVM, with the LOAD control set at the 50 ohm position.

Using an insulated screwdriver, adjust neutralizing capacitor for a MINIMUM indication on the VTVM.

Readjust the neutralizing capacitor for a minimum indication on the VTVM.

Turn the FUNCTION switch to the off position.

Discharge high voltage power supply capacitors.

Reconnect final plates & screen grid.**VTVM & RF probe will be needed.

***To remove screen voltage in SB-100, SB-101, HW-100 & HW-101 disconnect R920 (100 ohm resistor) from buss wire between pins of V8 & V9. In the SB-102 removal of accessory plug is all that's required. To remove high voltage in SB-100, SB-101 & SB-102 disconnect red wire at lug 4 (in SB-100 lug 3) of terminal strip BK that goes to grommet BL. In HW100 & HW101 disconnect red wire going to lug 1 of RF choke in final cage.

NOTE: Take adequate steps to eliminate any possible contact with B+ or B+ shorts to chassis after disconnecting wire & resistor.

ah.4.9. SB-102-9: Oscillations or Low Drive

December 18, 1974
SB-102 *Bulletin No:SSB Transceiver* *SB-102-9*

Loose boards cause sporadic self oscillations & unstable RF conditions, particularly at the high [15 & 10 meter] bands. The comb brackets which have been used are aluminum & could not be soldered. Steel brackets are now available [PN 204-2096] & should be used whenever encountered in the field. Both the switch shields & the driver boards should be soldered to these brackets.

This change helps to increase grid drive as well as increase stability.

ah.4.10. SB-102-10: Self Oscillations Occurring After Installation of Steel Comb Brackets

May 2, 1975
SB-102 *Bulletin No: SSB Transceiver* *SB-102-10*

It has been found that in a number of units, self oscillations are still occurring after installation of both steel comb brackets [PN 204-2096].

To correct the condition, the screws around the RF driver board must be tightened securely. Also, the lock washers between the circuit board & chassis must be installed, otherwise a good ground is not assured.

Retightening screws which are already snug will also cause these oscillations to disappear in units where it is a problem.

ah.4.11. SB-102-14: Relays Remain Energized After Transmit Condition

June 5, 1978
SB-102 *Bulletin No: SSB Transceiver* *SB-102-14*

After keying the transceiver with PTT for thirty to forty seconds, a positive voltage in excess of 10 volts appears at the control grid, pin 9 of V12, thus keeping the relays energized.

- To correct the problem, replace V12 [PN 411-124].

IEC brand tubes have been found defective in several cases, but other brands may also cause this problem.

ah.4.12. SB-102-15: Poor AGC Action

June 5, 1978
SB-102 *Bulletin No:SSB Transceiver* *SB-102-15*

Leakage in the 6HS6 tubes [PN 411-247] at V10 and/or V11 has been found to cause:

Poor AGC action

Fast S-meter decay

Poor sensitivity when RF gain control is fully clockwise.

This usually occurs after warm up of at least an hour. A positive voltage, usually over 1 volt, will appear at the grid, pin 1, of either one or both tubes.

Replacement of the tube with the positive voltage corrects the problem.

ah.4.13. SB-102-16: 100KHZ Calibrator Spurs

June 5, 1978
SB-102 *Bulletin No: SSB Transceiver* *SB-102-16*

Strong signals may occur at other than 100khz points.

Look at the calibrator output [ahead of output diode] with an oscilloscope. Use high input gain and a slow sweep speed. If the upper portion of the sine-wave signal appears choppy or uneven, the Y201 crystal may be at fault.

After installation of a new crystal [PN 404-43], recheck with oscilloscope.

ah.4.14. SB-102-17: Poor Preselector Tracking

July 24, 1978
SB-102 *Bulletin No: SSB Transceiver* *SB-102-17*

This problem is more noticeable on the 10-meter band. It may be caused by the drive belt slipping or by one of the variable capacitors not turning due to excessive friction in its bearings.

Check the belt for being loose or worn and replace as needed. Lubricate the bearing of the variable capacitors. If lubricating the capacitor bearings does not allow the rotor to turn freely, replace the capacitor [PN 26-122].

ah.4.15. SB-102-18: Carrier Nulls with C14 Trimmer Plates Completely Meshed

July 24, 1978
SB-102 *Bulletin No: SSB Transceiver* *SB-102-18*

If C14 nulls the carrier with its plates fully meshed toward V2 [to the right], relocate C18, 12pf capacitor, to the other section of the null trimmer [C14].

ah.4.16. SB-102-19: Relays Chatter in VOX Mode

August 7, 1978

SB-102 *Bulletin No:SSB Transceiver* *SB-102-19*

This may occur when the VOX gain is in the near-full CW position with the MIC level advanced past the 12 o'clock position. Also, the unit will not return to receive when the operator stops talking.

Check the tube at V1. A "GE" tube will oscillate, thus causing the above problem. Other …(rest is missing)

ai) Using an HW-101 as a 100-watt PA

Hot Water for the K2 *By K1RFD*

Note: *I have included this article as others may find it useful. While the modification is written for the HW-101, it should apply equally well to the SB-100 and SB-101. The SB-102 already has the link on the driver output coil brought out to the rear panel jack labeled "Driver Output" and implements the switching needed to switch the link on L801 between the antenna connector (receive mode) and the Driver Output jack (transmit mode). It appears that the SB-102 final could be used as an amplifier for a QRP rig by feeding the QRP rig output into the Driver Output jack on the SB-102 and providing a way to key the SB-102 into transmit mode as described in this article.*

When I was a young ham in 1977, I saved money to buy and build a Heathkit HW-101. The rig has served me well over the years, going in and out of storage as my interests and addresses changed, but it seemed destined to return to storage forever after I finished building the K2.

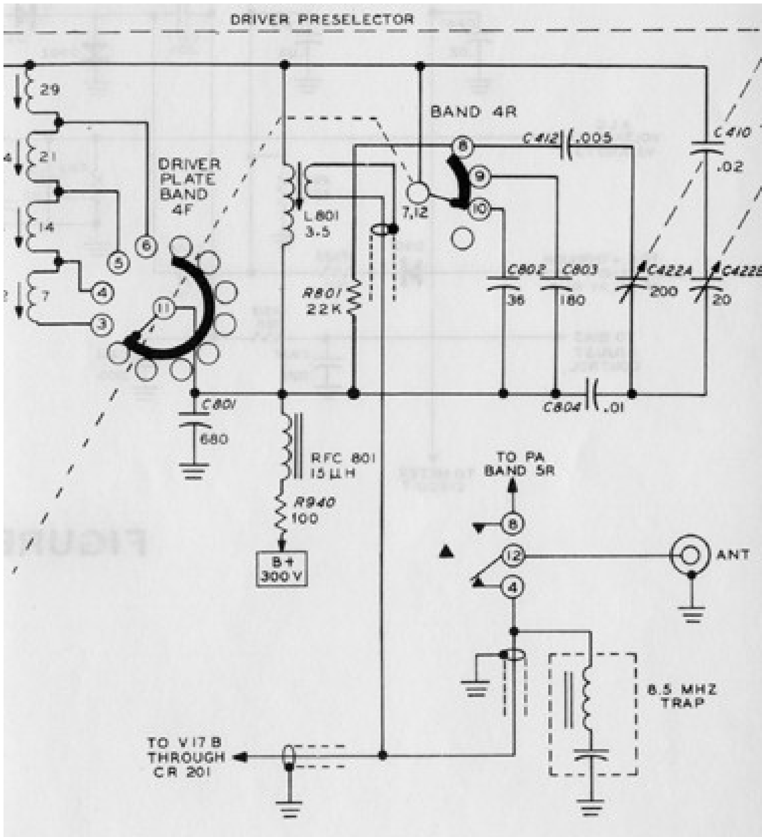
However, it occurred to me that the HW-101 has a perfectly good final amplifier stage, featuring a pair of 6146s, which might work well as a pair of "shoes" for the K2. The rig easily produces >100 watts output on 80 through 10 meters, excluding the WARC bands.

I got out the HW-101 schematic and considered various ways to drive either the finals or the driver from an external source. I decided the project would not be worth doing if it required extensive modification of the HW-101, since mine was (fortunately) in good working order.

The modification turned out to be easier than I expected. It can be done without rendering the HW-101 inoperative for its original purpose and it is easily reversible.

The key is that the HW-101's receiver front end is actually coupled to the plate circuit of the transmitter's 6CL6 driver. This allows the driver's L-C circuit to double as a receiver preselector. The signal from the antenna relay is coupled into this via an extra "link" winding around one of the driver plate circuit inductors (L801, in the diagram below).

Therefore, strange though it may sound, the HW-101's final stage can be used as an amplifier by feeding an exciter signal into its receiver input. Testing reveals that this presents a reasonable load impedance to the K2, and about 1 watt of drive is required to bring the HW-101 to full output. The modification consists of wiring one of the rear-panel jacks as an exciter input, and (optionally) wiring another as a receive antenna output.



ai.1. The Basic Mod

Remove the bottom cover. Run a short length of miniature coax from the "Spare" rear-apron phono jack to pin 4 of relay RL1. (This is the relay near the antenna connector). This is the same pin to which L905, the 8.5 MHz trap, is connected.

Re-label the Spare jack "Exciter In".

Build the K2 Amplifier Keying Circuit, which will drive the HW-101's T-R relay from the 8R output of the K2. I elected to build this in an external enclosure and connect it through the Aux I/O connector, but it can also be installed inside the K2. (Be sure to enable the 8R Hold feature of the newer firmware release.) Connect the output of this circuit to the PTT and ground lines of the HW-101's microphone connector. You can either use a substitute microphone plug, or wire the HW-101's PTT line to a rear-panel phono jack.

Verify that the PTT circuit is working correctly, then connect the antenna output of the K2 to the new Exciter In jack, and the antenna to the HW-101's antenna jack. Verify that the K2's receiver is working normally through the new antenna connection.

I have the KAT2, and I found it useful to connect the K2's Ant2 output to the HW-101, and Ant1 to an antenna switch which switches the antenna between the K2 and the HW-101. This makes it easy to switch between "barefoot" and the amplifier.

Be sure to disconnect the K2 completely when using the HW-101 as a transceiver.

ai.2. The Enhanced Mod

When the HW-101 switches to transmit, the receiver front end is disabled by applying a cutoff bias to the receive stages. It is (probably) important to avoid transmitting directly into the receiver front end when the receive circuits are active, that is, when the HW-101 is in the receive mode. An additional mod helps prevent this from happening accidentally. This mod requires that the receive-antenna option (160RX) be installed in the K2.

The mod involves re-wiring relay RL1, and using its two spare sets of contacts, for more sophisticated T-R switching, and wiring a "receiver" jack to the back panel. If you prefer to go this route, perform the steps below *instead* of the steps above.

Disconnect the shielded cable from lug 4 of relay RL1, and connect it to lug 11 instead. Disconnect the yellow wire that goes to the center pin of the back-panel ALC jack, and cover it with tape. Run a short piece of miniature coax from the ALC jack to lug 4 of RL1. Re-label this jack "Receiver Out".

Run another short piece of miniature coax from the Spare back-panel jack to lug 7 of RL1. Re-label this jack "Exciter In".

Connect a short piece of wire between lug 4 and lug 3 of RL1.

With this modification, the HW-101's T-R relay connects the HW-101's receiver front end to the antenna on receive, and to the exciter input only on transmit. It also routes the HW-101's antenna input to the receiver jack on receive.

Make the PTT connection between the K2 and the HW-101 as described in the previous mod. Connect the K2's antenna output to the HW-101's Exciter input, and the HW-101's Receive Out to the K2's receiver antenna connection. When using the K2 with the HW-101, enable the K2's receiver-in jack. Verify that the K2's receiver is working normally through the new antenna connection.

ai.3. Adjustment

Turn the MIC/CW Level control of the HW-101 fully counterclockwise, and the Mode switch to CW. Set the bandswitch to the appropriate band and the final tuning control to the appropriate position.

The final stage of the HW-101 can be tuned up by turning the K2's Power control to minimum and putting the K2 into TUNE. The HW-101 relay should activate and the plate current meter should show idle current. Advance the K2's Power control slowly until more plate current is noticed, then peak the HW-101's Driver Preselector control and dip the Final Tune as usual. Once resonance is reached, advance the K2's Power control until no further increase in plate current is noticed, then back it off a tad.

I found that full output power could be achieved on all 5 bands with between 1 and 2 watts of output from the K2.

The HW-101 exciter input presents an SWR of between 1.2:1 and 3:1 depending on the band.

If you plan to run SSB with this setup, be sure to check your signal on a scope to ensure that the amplifier is not being over-driven, as there is no ALC feedback to the K2.

Note that it does not appear that the setting of the MODE switch (CW vs. SSB) has any effect on the biasing of the final amplifier.

aj) Tube Substitutes

Whenever possible, tubes should be replaced with the specified type. This table lists some possible substitutes if the original type is not available.

Note: Tube types consisting solely of numbers may be ruggedized or industrial versions of the same tube.

Tube	Substitutes
0A2	6626, 6073
6AU6	6AH6, 6CG6, 6HS6, 6HR6, 6136 6678, 6660, 7543, 8425, 8426
6BE6	5750
6BN8	NONE
6CB6	6CF6, 6EW6, 6DE6, 6DK6, 8136
6CL6	6677, 6197
6EA8	6GH8, 6GJ8, 6HL8, 6KD8, 6LM8, 6MQ8, 6MU8, 6U8 -6678
6EB8	6CX8, 6GN8, 6HF8, 6JT8, 6LY8
6146	6146A, 6146B, 6146W
6GW8	NONE
12AT7	12AZ7, 7728, 6679, 6201, 5965, 5751
12AU7	12BH7, 5814, 5963, 6189, 6211, 6680, 6913, 6955, 7318, 7730
12AX7	5751, 6681, 7229
12AZ7	7728, 7025, 6681
12BY7	12BV7, 12DQ7, 8448, 7733

Table 13. Tube Substitution Chart

ak) Tube Test Data

Serial Number: ______________________________ Date: ________________________________

Designation	Function	Type	TV-7 Tube Tester Setup						Replacement Tests	
			Filament	Bias	Shunt	Range	Press	Min Value		
V1a (pentode)	Speech Amp	6EA8	6.3	0	---	D	3	28		
V1b (triode)	Cathode Follower		6.3	10	---	D	3	46		
V2	Isolation Amplifier	6AU6	6.3	16	---	B	3	58		
V3	1st IF Amplifier	6AU6	6.3	16	---	B	3	58		
V4	2nd IF Amplifier	6AU6	6.3	16	---	B	3	58		
V5a (pentode)	1st Transmit Mixer	6EA8	6.3	0	---	D	3	28		
V5b (triode)	Crystal Oscillator		6.3	10	---	D	3	46		
V6	2nd Transmit Mixer	6CB6	6.3	11	---	D	3	28		

Designation	Function	Type	TV-7 Tube Tester Setup						Replacement Tests	
			Filament	Bias	Shunt	Range	Press	Min Value		
V7	Driver	6CL6	6.3	10	---	D	3	30		
V8	Final Amplifier	6146	6.3	30	---	D	3	35		
V9	Final Amplifier	6146	6.3	30	---	D	3	35		
V10	RF Amplifier	6HS6	6.3	11	---	D	3	28?		
V11	1st Receiver Mixer	6HS6	6.3	11	---	D	3	28?		
V12a (pentode)	2nd Receiver Mixer	6EA8	6.3	0	---	D	3	28		
V12b (triode)	Relay Amplifier		6.3	10	---	D	3	46		
V13a (diode)	AGC	6BN8	6.3	0	70	A	2	40		
V13b (diode)	AGC		6.3	0	70	A	2	40		
V13c (triode)	Product Detector		6.3	15	---	D	3	13		
V14a (triode)	Audio Amp	6GW8 (ECL86)	6.3	14	---	B	3	60		
V14b (pentode)	Audio Output		6.3	32	---	C	3	72		

Designation	Function	Type	TV-7 Tube Tester Setup						Replacement Tests	
			Filament	Bias	Shunt	Range	Press	Min Value		
V15a (pentode)	Tone Oscillator	6EA8	6.3	0	---	D	3	28		
V15b (triode)	Tone Amplifier		6.3	10	---	D	3	46		
V16a (triode)	Carrier Oscillator	12AU7	12.6	24	---	B	3	56		
V16b (triode)	BFO		12.6	24	---	B	3	56		
V17a (triode)	VOX Amplifier	12AT7 (ECC81)	12.6	10	---	C	3	50		
V17b (triode)	Calibrator		12.6	10	---	C	3	50		
V18	Regulator	0A2								
V19a (triode)	Heterodyne Oscillator	12AT7 (ECC81)	12.6	10	---	C	3	50		
V19b (triode)	Cathode Follower		12.6	10	---	C	3	50		