ADJUSTING YOUR HF RECEIVER

N5KIP

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Disclaimers

- What works on one model of radio might not work well on another
- CW (narrow bandwidth) and SSB (wider bandwidth) will require different receiver adjustments
- Optimal receiver settings will change as the noise level changes

It’s the Antenna Dummy!

- **Your antenna is far more important than the number of receiver controls on your rig or what price category of transceiver you have**
- There are great receivers in QRP kit radios that have only RF gain, AF gain and perhaps a filter control
- Don’t be concerned if your vintage or entry level transceiver doesn’t have all the features discussed

“If you can’t hear ‘em, you can’t work ‘em”

- Think of conversation in a noisy room
- To carry on a conversation, you must hear the person trying to talk to you:
  - He or she must talk louder (increase signal strength) and/or
  - Lower the noise by moving to a corner, cup your hands to your ear etc.

(reduce receiver noise)

Squelch Control

- Very useful on FM VHF and UHF

- Steps in squelch adjustment for SSB and CW HF operating:
  - 1 Locate the squelch control
  - 2 Place squelch control in open position
  - 3 Apply super glue (okay, I’m kidding)

AF and RF Gain Adjustments

- Beginners are prone to turn up the RF gain all the way (more gain must be better, right?) and use the AF gain as a conventional volume control
- Try reducing RF gain by turning up AF gain and using the RF as the “volume control” resulting in a lower noise floor

Methods of RF Gain Adjustment

- Here are a few methods which reduce RF gain to result in a **better signal to noise ratio.**
- All seem to work
- Again, simply think in terms of turning up the AF gain and using the RF gain as a volume control

(Bob Heil (K9EID) has a You Tube video showing how on SSB he reduces RF gain in noisy conditions. He also turns off pre-amp, may add attenuation and uses slow ACG)

Quick & Easy RF Gain Adjustment

- **Adjust RF Gain to the "sweet spot"**
  - Turn RF and AF gain all the way down
  - Turn off ACG (I cheat and leave the ACG on)
  - Protect hearing, avoid headphones when ACG off
  - Turn up AF gain about midway then slowly turn up RF gain listening for signal clarity
  - Turn on ACG again if desired or if using headphones

Another Easy RF Gain Adjustment

- Set AGC to fast
- Tune to an unoccupied frequency, check the S-meter reading of the noise and if the meter is moving at all, reduce the RF Gain until the meter just stops moving.
- On many radios reducing the RF gain will cause the S-meter reading to rise because the S meter is actually reading from the RF gain circuit rather than actual signal strength. That's fine because what we are looking for is the point where the S-meter movement stops.
- For example, if you have S4 noise, reduce RF gain such that the S meter only deflects on greater than S4 signals

More Precise Adjustment

- 1 Set audio noise floor
- 2 Set receiver noise floor
- 3 Connect antenna
- 4 Determine if preamp is needed
- 5 Determine if attenuator is needed

- Turn off ACG, preamp and attenuator and disconnect antenna
- Set AF gain and RF gain to minimum
- Advance AF gain until just hear noise (audio noise floor)
- Turn on preamp
- Advance RF gain until you hear receiver noise just above the audio noise floor
- Connect antenna and tune unoccupied frequency. You should hear band noise
- Switch off pre-amp. If still hear band noise, pre-amp not needed and proceed to next step. If no longer hear band noise, turn on preamp and adjustment is complete
- If preamp not required, add ATT in steps. When no longer hear band noise, decrease ATT one step and adjustment is complete. (ATT may only have one step depending upon rig)

Preamp and Attenuator

- Preamp is typically needed only on higher frequencies with little noise. I virtually never use the preamp on HF
- Attenuators are most often used to reduce overload from very strong signals
- Attenuators may actually also improve S/N ratio on bands with lots of noise
- I often use ATT on 80, 40, 30 and even 20 meters due to high noise at my location
- Similar in concept to reducing RF gain

Example

Attenuator Off

S5 noise
unoccupied frequency

Nearby 40 meter SSB signal

S/N ratio (in S units) about 9 to 5
50.2/3.2 microvolts = <u>16.7</u>

Attenuator On

< S1 noise (ATT on)
unoccupied frequency

Nearby 40 meter SSB signal

S/N ratio (in S units) about 6 to 1
6.3/0.2 microvolts = <u>31.5</u>

Illustration

- CW signal on 20 meters
- Note drop in S meter with ATT on
- Despite drop in S meter, the signal is easier to copy with the attenuator on due to decreased noise level

Automatic Gain Control (AGC)

- A closed-loop feedback regulating circuit which provides a controlled output signal amplitude, in spite of variation of the amplitude of the input signal.
- ACG limits variation in volume between signals of differing strength
- Ham radio receivers typically allow for ACG adjustment as slow, fast or off.

ACG Adjustment

- Fast ACG may work against you with fluttering signals (polar path for example)
- Try slow ACG on SSB. Audio may “pump” with fast ACG
- Fast ACG may help with weak CW signals
- Consider turning off ACG for weak signals if RF gain is properly adjusted

IF Filters for SSB

- SSB filters are typically in the range of 1.8 to 3.0 kHz
- Narrower the filter, the less the noise but at expense of audio fidelity.
- I have set the SSB filters on my IC 7200 to 1.9, 2.4 and 3.0 kHz and use the 2.4 kHz filter about 90% of the time
- On the IC 7200, the filter shape can be set “soft” (gentle roll off) or “sharp” (steep roll off).
- Many favor the sharp filter shape but I have not developed a preference. Your mileage may vary

IF Filters for CW

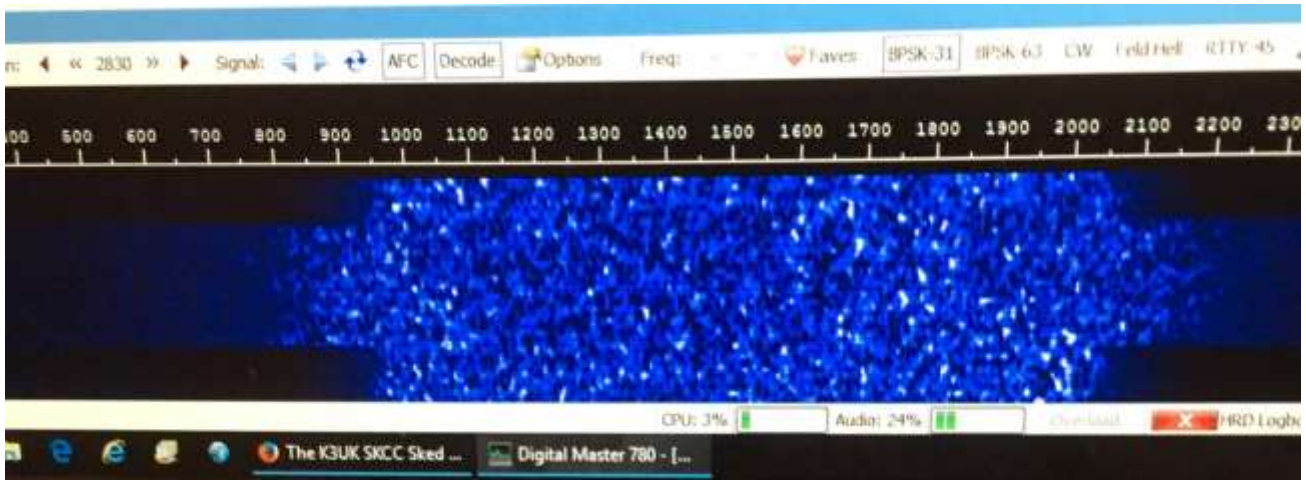
- CW filters are typically in the range of 100 to 600 Hz
- I set my IC 7200 DSP CW filters at 600, 400 and 250 Hz
- In my experience, a narrow filter is quite helpful in reducing noise and bringing out a weak CW signal
- May hear “ringing” with very narrow filters (less so with DSP compared to mechanical filters)
- I tune the band listening for “CQ” using a wide filter, zero beat, then narrow the filter for a QSO
- If calling CQ, a wide filter allows you to hear slightly off frequency responders

Filter “Slope”

- Your rig may allow adjustment of filter slope (“shape”)
- Sharp slope (rapid roll off) is said to be preferable
- To my ears, a filter with a sharp slope is virtually indistinguishable from a somewhat narrower filter with a soft slope
- You will develop your own preferences when it comes to filter widths and slopes

Getting a Sense of Filters

Use your digital software (in this case, Digital Master 780)
to get an idea of what different filters “look like”



Sharp Slope

Soft Slope

Sharp Slope

40 Meter SSB Noise with 1 kHz DSP Filter

Icom IC 7200 Sharp and Soft Slope Alternated

Bandpass Filters

- Used to adjust the low and high frequency cutoff
- Dual bandpass filters function as variable filter (widens or narrows the passband like a regular filter)
- I have occasionally found it useful to cut the lower audio frequencies which contain considerable noise (rumble) but little essential audio from the normal human voice
- On my IC 7200, I rotate either of the twin passband controls clockwise to cut these lower frequencies
- Sometimes cutting the higher frequencies seems to help

Let's "Play The Price is Right"

Passive Audio Bandpass Filter

What's the Correct Price?

A $ 3.64

B $ 23.99

C $ 79.99

D $ 129.99

Let's Play "The Price is Right"

Passive Audio Bandpass Filter

A $ 3.64 Correct Answer

B $ 23.99

C $ 79.99

D $ 129.99

Simple Acoustic Cavity CW Filter

- PVC elbow from the hardware store
- Mine resonates best at about 800 Hz
- Others have built plastic or wood chambers, used plastic tumblers etc. Size and shape of the cavity determines the resonant frequency
- See Wikipedia for formulas applicable to different shapes (closed tube, open tube, rectangular, sphere etc.)
- A larger cavity resonates at a lower frequency

Picking Up Good Vibrations

Elbow Alone Resonates
About 850 Hz

Elbow and Extension Resonates
About 600 Hz

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In this case,
a speaker is built
into the base of the PVC elbow

A Resonant Speaker for CW

This acoustic design makes listening a pleasure.

Bill Sepulveda, K5LN

I'm an avid CW operator and spend lots of my retired time on the air in that narrow-band mode. Since adding a new radio to my operating table, I noticed there was something missing when I listened to CW signals. There was lots of noise, the signal was not crisp and clear. I was having trouble hearing the stations clearly, and I would find myself turning the volume up pretty high.

I remembered that I had one of the Skytec CW-1 resonant speakers that were available several decades ago. I found the vintage speaker in my junk box, hooked it up, and wow — the CW signal jumped right out of the speaker! It was super clear, crisp, and loud. I had to reduce the volume on the radio, and I also noticed that the background was way down and I had no problem copying the signal at a reduced volume. What a relief.

Since adding a new radio to my operating table, I noticed there was something missing when I listened to CW signals.

After using this great speaker and experiencing how well it worked, I started searching the Internet to see if others were suffering from the same situation, and if anyone had ventured into making a new configuration of the CW resonant speaker. A search revealed a few articles and videos, but they lacked construction details. Also, I wanted something that was small and attractive, so I built the resonant speaker shown in the lead photo.

How It Works

After considerable trial and error with different configurations, I figured it out. The audio from the speaker will be peaked at a specific audio frequency, with a narrow bandwidth, when the speaker size and acoustic cavity are tailored to specific dimensions. For example, using a specific speaker and baffle size, a specific depth of speaker cavity, and a matching size and length of a resonator tube, the device will act just like a filter in the radio. However, it will also enhance the audio volume.

I finally determined a repeatable configuration that would peak a signal at approximately 700 Hz and increase the volume of the signal by quite a bit. I don't have the test equipment to measure the loudness, but you'll be pleasantly surprised once you hear it. Also, adding a sleeve in the open end of the device will help move the center frequency down to about 550 Hz, if desired.

Here are step-by-step instructions on how to make the parts, and how to assemble them.

Making a CW Resonant Speaker

Table 1 shows the list of materials along with suggested sources. You can search the Internet or use the suggested sources. You will need solder, a soldering iron, and basic hand tools, such as cutters, pliers, and wire strippers. You will also need a Dremel® tool and a saw to cut PVC pipe, and some coarse as well as 100-grit sandpaper.

Make the Speaker Cavity

Cut a 2-inch diameter schedule 40 PVC pipe to a length of 1 inch. Make the cut square and straight. Sand and clean the inside and outside edges of the PVC pipe. Drill a ¼-inch hole, ⅜ inches from one edge of the tube. On the opposite side of the tube, and on the same edge, make a mark that lines up with the center of the ¼-inch hole. Measure ¾ inches from that mark to the right and left. Drill a ¼-inch hole at each location, also at ⅜ inches from the edge of the tube. Deburr and clean both sides of the three holes. Set this speaker cavity aside for now.

Make Two Cover Disk Baffles

Using a clear plastic CD cover as source material, draw a 2⅛-inch circle. Then draw a 2⅜-inch circle and cut the circles out of the plastic disc cover — be careful not to crack the plastic. I used a Dremel tool to cut mine. Then finish the edges with a small grinding wheel.

Notch Filters

- Automatic notch filters eliminate a narrow constant frequency tone (or multiple tones) from a SSB signal.
- Audio quality may be degraded, especially if the automatic notch filter tries to eliminate multiple tones
- Manual notch filters eliminate a single narrow frequency tone which is selected by rotating the control knob. It is considered by many superior to the automatic notch filter
- The width of the manual notch filter may be adjustable
- I may be lazy, but the automatic notch filter worked great on the few occasions I've needed it. Never have needed the manual filter

NB and DSP NR

- Noise blankers (NB) work well to control short bursts of energy like auto ignition and light dimmers
- Digital Signal Processing (DSP) Noise Reduction (NR) is often helpful in dealing with noise
  - Step 1 A/D conversion
  - Step 2 Signal processing in the form of computer performed complex mathematical operations on the digital signal (7 -10 dB noise reduction is typical per ARRL testing)
  - Step 3 D/A conversion
- Depending upon your rig, there may be more than one NR protocol available and you may be able to adjust the amount of processing desired

RIT and XIT

- Split operation is common among rare DX stations but also found in the QRP Fox Hunts and similar activities where there may be pileups. Listen for “up” or “down”
- Work split using RIT, XIT or dual VFO’s
- Receiver Incremental Tuning (RIT or “clarifier”) allows you to set the frequency on which you wish to transmit then listen on a nearby frequency
- Transmitter Incremental Tuning (XIT) allows you to listen on the transmit frequency of a station working split and automatically transmit up or down in frequency where the DX station is likely listening.

Importance of Ambient Noise

- Human hearing has about 100 dB range
- Library like room has noise level of about 40 dB leaving only 60 dB to play with
- Encapsulating headphones reduce noise by about 15-25 dB
- Quality in ear monitors reduce noise about 25 dB
- In ear monitor and external ear muffs reduce noise about 40 dB
- Once you regularly use headphones, you're likely to list that speaker on ebay

A Word About Menus
Reset Is Your Friend

- My entry level IC 7200 has 32 menu items not including the menus associated with front panel controls
- Even if each menu had only two possible options (most have multiple), that's over 1000 permutations
- Stuff happens
- Keep a record of the menu selections and control settings that you have found to be useful
- **In the event of malfunction, reset!**

Video References

- https://www.youtube.com/watch?v=W0tnt8MXYwE (You Tube Amateur Extra lesson 6.4 on Filters and Impedance Matching)
- https://www.youtube.com/watch?v=1sX0VsINGu8f (Bob Heil,K9EID, on ACG and RF gain adjustment from Ham Nation episode 130)
- https://www.youtube.com/watch?v=hM_ID-tivsA Radio Terminology explained AGC Automatic Gain Control
- https://www.youtube.com/watch?v=9_uYHwAQcQ0 Setting "split" on a Kenwood TS-590S
- https://www.youtube.com/watch?v=26oCCEZRANk Icom IC-7200 Notch Filter Demo

References

- John (K5JS) kindly provided a great online reference.
  Look for “Noisy K3…” at http://www.w3fpr.com/

- “For The New General Class Operator: HF Radio SSB Phone Receiver Functions” see: http://www.barrowhamradio.org/images/articles/New%20HF%20Operator%20-%20HF%20Radio%20SSB%20Phone%20Receiver%20Functions.pdf