Aligning H. H. Scott 340B tuner—First Pass

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Sources:

1. "Service Bulletin for Model 340B Tuner/Amplifier," H. H. Scott (late model version).
2. "H. H. Scott Tuners: Evaluation, Troubleshooting, Service, and Alignment," Dave Roehr (2005-2006).

Unfortunately, I have not been able to find a service manual for the 340B that gives a detailed alignment procedure for the tuner. The best reference I've found so far is 1 above, which describes how to align the tuner but does not provide a lot of specifics for transformers, trimmers, coils, etc. To supplement this, I used Dave Roehr's treatise on Scott tuners that, in some cases, differs from the guidance in the Service Bulletin but also provides fairly detailed instructions on how to proceed.

The Roehr paper describes well the symptoms of a poorly aligned receiver. If your unit has these symptoms or if you have changed multiple tubes (as I did), you will probably at least need to align the front end and the IF strip. If these aren't providing a good signal to the limiter/ratio detector and the multiplex decoder, you may not be able to receive stereo even if these circuits are operating correctly. If you're having trouble receiving stereo, the first thing to do (after checking the tubes) is to align the front end and IF strip.

One note about alignment method for Scott tuners/receivers: the service literature strongly recommends NOT doing a so-called "visual alignment," where you use a scope to examine the actual pass band wave-form of the IF stages and adjust the stages for the proper shape (sweep/marker generator alignment). I tried this method with a Scott 314 mono tuner and the results were poor. The alignment was much better by peaking signal strength in the stages, so maybe the Scott engineers were on to something. Any input on contrasting methods would be gratefully received.

Aligning the RF section ("front end") and the IF strip is fairly straightforward and can actually be done by using the signal meter and a weak broadcast signal (such that the signal meter is less than ½-scale, maybe 40% deflection) unless there are serious problems with the tuner or you've done something major like changing out an IF transformer. The ratio detector can also be aligned reasonably well by ear.

HOWVER, like many others have said, you really shouldn't try to align the MPX decoder unless you have the instruments to do it or you may really mess it up. If it seems to be working well (you are getting stereo reception with separation, the FM STEREO light comes on when it should, and there's no distortion on a moderate-to-strong stereo signal compared to mono), you may want to leave it alone or seek professional help if it's not working well.

Instruments used:

-Sencore SG-165 FM stereo multiplex generator/stereo analyzer
-Rigol 100 mHz, two channel digital oscilloscope, with distortion analysis capability (via Fast Fourier Transform)
-Hex and slot alignment tools to turn the slugs in the transformers and coils.

RF (Front End) Alignment

I ended up using mostly the Roehr method for this, as it provided better results on dial accuracy adjustment. His instructions are actually reversed from the ones in the Service Bulletin, as follows (with a couple of modifications by me):

1. Set the receiver on its right side with the power transformer down and the front facing you at an angle and propped as needed to be sure it's steady. You'll need to get at the top and bottom of the chassis for the adjustments to the various transformers and coils.
2. **BE CAREFUL as you adjust things under the chassis. You will be adjusting things occasionally that are in proximity to potentially lethal high voltages!**
3. Warm up the receiver for 15-20 minutes before starting. You want it to be stable at operating temperature. Switch the receiver to mono mode.
4. Hook the scope to one of the Tape Monitor RCA outlets on the back of the unit in order to watch quality of the signal (either one).
5. Inject low-level RF from the Sencore 165 into the antenna terminals through its matching pad (I used the 75 ohm outputs) at 92 mHz modulated with 400 hZ sine wave at full (75 kHz deviation) modulation. Use just enough signal for a reasonably clean looking sine wave on the scope from the Tape Monitor output (microvolt range), but no more.
6. The signal meter should read midway or less at this point with the input signal as described (you can turn the speakers off on the 340B if you don't want to listen to a lot of 400 Hz audio).
7. Using the signal meter, adjust the FM ANT and the FM RF coils (slotted screws next to the tuning cap box and clearly labeled) on the top of the RF unit for maximum signal/highest front panel meter readout. In general, it was easier to use the Scott's own meter for these adjustments, versus the scope. The FM RF peak is fairly subtle. Run the coils through the peak and back a couple of times to be sure you're getting the true peak.

You can do the next steps with the signal generator or use broadcast stations with known frequency. The Sencore's signal tuning dial is not exact, so I used broadcast station signals with known frequencies.

8. Make sure the dial cord pointer is set such that it stops exactly on the furthest left and right index marks on the scale (0 and 100 on the log scale). Adjust the pointer or the dial cord (per Service Bulletin) if this isn't straightforward.
9. Tune to an upper-band station of known frequency around 106 mHz or so. If this station doesn't appear on the correct frequency as indicated on the dial, set the dial pointer where it should be and adjust the FM OSC on the top of the RF unit until the station appears where you have the pointer set. Tune it slowly to get the maximum signal strength peak.
10. Now go to a station at the lower end of the band (90 or 91 mHz) of known frequency and see if it the pointer is on the correct frequency for this station. If it is, check the middle of the band (around 100 mHz). If all is pretty close (say 0.1-0.2 mHz or so), you're done (remember, this is vintage analog!).
11. If the lower end station is not where it should be, you'll have to adjust the oscillator coils in the 'silver box' underneath the RF unit below the chassis, and this is a little tricky. There are three screws on the box holding the bottom on the box, as well as a clip for the bottom plate chassis ground contact. Loosen the top screw and take out the middle screw (be careful not to drop any of these little screws into the hot chassis!), move the brass clip aside and remove (only!) the small cover in the center of the silver box. When you do, you'll see two holes in the box, left and right, exposing a loose 2-3 turn coil in each.
12. If the lower end station is higher frequency than the pointer (set to its correct frequency), you'll need to spread out the coils (the left seems most sensitive at this frequency) to lower the frequency. DO THIS CAREFULLY and just a little at a time and use a NON-CONDUCTIVE tool (I use a wooden dowel) until the known station appears at the right place in the dial. It's hard to get exact, so just get it close.
13. If the lower end station is at a **lower** frequency than the correct place on the band (where you have the pointer), you'll need to squeeze the coils together slightly.
14. After you get it close, go back to the higher frequency station and check to see that it's still in the right place on the band. Touch up FM OSC if not. You may have to go back and forth a couple times to get it close.
15. It's a little strange, but it actually worked for me and my tuner was receiving about 0.8 mHz too high, so it really needed adjustment (mainly of the FM Oscillator, probably because both RF tubes had been replaced) and I was able to get it pretty close across the band using this procedure.
16. Close the silver box back up. Don't over-tighten the screws and make sure the chassis ground clip is in the right place.

IF STRIP ALIGNMENT

You'll need a tool for slotted slugs for the IF transformers and a hex alignment tool for the limiter/ratio detector transformer. These transformers need adjustment from the top and the bottom (2 slugs each to adjust the transformer primary and

secondary). Remember, when you're going into the bottom to get at the lower slug, be careful to avoid contact with high voltage!

A word about these slugs (also called cores): in a 50 year-old radio these slugs don't always move smoothly; they can take a set over time and kind of jump instead of turning slowly or, worst case, be stuck in place. BE GENTLE when you turn them with the tools. The compressed powdered ferrite material is fragile and will crumble and even crack if you over-crank them, then you are in a world of hurt.

Don't crank either slug in too far or you may hit the other one and maybe jam or break the slugs.

DON'T USE METAL TOOLS on these slugs, either. You may be tempted to use an allen wrench on the hex slugs or a metal screwdriver on the slotted ones. If you do, it 1) messes with the inductance of the coil you're trying to tune and 2) you will wear out the hex-keyed holes or slots, as the hard metal will grind away at the ferrite material.

If you get one that's truly stuck, get on the web and look up "stuck tuning coil slug" or such for advice. The only one I ever had that was really stuck, I either ended up breaking or someone did it before me. Fortunately, I had a spare to use from the ham radio junk box, but good luck finding either the transformer or the slug if you break one. I had to drill that slug out (carefully!) and install the new one.

You likely won't have to move them very far if the tuner is anywhere close to where it needs to be. When tuning a hex coil slug, it's possible to put the tool too far in from either the top or bottom and end up turning the opposite slug, so don't put the tool in any further than you need to engage the slug you want.

IF Alignment Procedure:

1. Keep the scope hooked up as before to a TAPE MON output (mono mode).
2. Go to a quiet part of the band and inject RF modulated at 400 hZ at 75 kHz deviation into the antenna terminals. Go for the weakest signal needed to give a reasonably clean sine wave in the scope. Keep the Scott's signal meter below ½ scale. (If you use too strong a signal, the limiters will kick in and prevent an accurate alignment). NOTE: This does work out to somewhere around 3 to 6 microvolts from the SG-165 into the tuner, as far as I can tell from the settings, as I don't have any device that will measure signal level this low. The tuner will find it, though, as it works with uV-level signals routinely and this level gives about 40% deflection of the signal strength meter, which seems about right.
3. There are three IF cans to adjust, starting between the mixer and first IF stage (T201), between the first and second IF stages (T301), and between the second IF stage and the limiter stage (T302).

4. The Service Bulletin says to tune the top and bottom slugs in each transformer at the same time for the peak signal/output level either on the scope or the front panel meter. First, I find the Scott's own meter easiest to use when peaking the transformers. Second, I'm not coordinated enough to do them at the same time, so I tune the top one (from the top of the chassis) first, then the bottom one.
5. T201 is the transformer on the RF unit next to the 6U8 tube with slotted top and bottom slugs. Tune the top and then the bottom for maximum deflection of the Scott's panel meter or output level measured by the scope (so called 'peaking the stage').
6. Next, peak T301 top, then bottom (slotted slugs). T301 is located between V203 (6AU6A) and the power transformer.
7. Then, peak T302 top, then bottom (slotted slugs). T302 is located between V204 (6AU6A) and V205 (6HS6).
8. After doing all three, go back and do them all again. If you've changed the tubes or done other work in the tuner, you may find the RF and IF alignment will greatly increase the signal level for all signals.
9. At this point, signals were good, but the FM Stereo light was not working on middle-strength stations. Although the Service Bulletin calls for adjusting during MPX alignment, I adjusted the "Stereo Threshold Adj" pot control at this point on the MPX decoder unit, near V502. This adjustment controls when the FM Stereo Light comes on and, more importantly, the threshold at which the MPX decoder kicks in to generate stereo. It is sensitive and can be adjusted to the point that very weak stereo stations will decode, but these are quite noisy in stereo mode and listening in mono cuts noise way down, so adjust accordingly. The observed sensitivity was a good thing because it indicates that the 19 kHz pilot is making it through well to the decoder.

RATIO DETECTOR ALIGNMENT

The ratio detector is what separates the audio signal from the frequency modulated IF signal. Its adjustment is key to un-distorted sound from strong stations and to getting a proper signal into the multiplex decoder for generating stereo audio from the broadcast signal. If it's not adjusted properly, you may find yourself without stereo and stations won't tune properly.

The ratio detector transformer, T303 is located between V205 (6HS6) and V503 (12AX7). T303 has hex-keyed slugs.

Procedure I used (basically from the Service Bulletin):

1. Inject modulated RF through the antenna, as per above at low signal level (3-6 microvolt). Keep the tuner in mono mode.
2. Monitor the output on the scope (through TAPE MON) and adjust the bottom (primary) slug in T303 for maximum signal/output. In this case, the scope

was more sensitive on this adjustment than the signal meter. NOTE: the Service Bulletin calls for an AC VTVM (vacuum tube volt meter) for the adjustment. This is fine if you have one of these, but I find the scope more sensitive.

3. Then, increase the RF input to that of a strong signal (Service Bulletin recommends 1000 microvolts). This level will drive the signal strength meter full scale.
4. Adjust the T303 top (secondary) slug for least distortion (THD). I did this with my scope in FFT mode, where I can see the harmonics and I got a clear minimum in distortion peaks by adjusting this slug. If you have an actual distortion meter, you can adjust for minimum distortion level. This method is very accurate.

An alternative to this method is to adjust using broadcast stations by ear. Tune in a weak station and adjust for maximum signal with the bottom slug. Then tune to a very strong station and adjust the top slug until you get distortion in the audio, then back off to a point just before the distortion begins. I've done this a couple of times to good effect with other Scott tuners. Some frown on this inexact method, but it can work reasonably well in my experience.

NOTE: Some procedures say you should de-activate the ratio detector smoothing electrolytic capacitor for this procedure (C317, 25 uF/25VDC) by lifting a leg of the cap. The Service Bulletin doesn't call for this and Roehr's paper says this is "one of those things everyone knew you had to do" back in the day, so they just assumed it. I did NOT do this, for better or worse.

MULTIPLEX DECODER ALIGNMENT

Alignment of the MPX decoder is somewhat more complicated than the other steps and requires a source of stereo multiplex RF with 19 kHz pilot signal and left and right channel output modulated with sine wave audio. The Sencore SG-165 has this capability with two levels of 19 kHz pilot (5% and 10%) and 400 Hz sine wave audio in either left or right channel. The signal is injected at the antenna terminals. You need the scope for this alignment as well (a sensitive AC VTVM could also be used for most of it). Some procedures recommend repeating some steps with a higher-frequency audio (8 kHz), but the Sencore only has 400 Hz.

There are only single (top) slugs in the coils and transformers in this stage.

Here's the procedure from the Service Bulletin, exactly as it appears, with each section followed by some comments:

"Adjust the scope to read peak-to-peak voltages and place the scope probe at the junction point of C535, C534, C536, and T501. With a stereo signal from the multiplex generator connected to the antenna terminals, peak T501 and L501 for maximum pilot level as seen on the scope. Minimum recommended pilot level at this point is 20-40 volts peak-to-peak."

Comments (Adjusting Pilot Level):

1. The test point is on the back of T501 on the MPX decoder subassembly. Look for the big 4700 pf mica cap and hook the scope to the side of the cap that attaches to the pin of T501 (scope ground clip to the chassis nearby).
2. The pilot feature on the generator must be active for a stereo signal to be present.
3. Unfortunately, I was only able at this time to complete part of this adjustment because the L501 slug is frozen. I was only getting about 15 V peak-to-peak for the pilot level (which showed up clearly on the scope), but the pilot signal for weak stations had been clearly coming through in routine operation, so I peaked T501 and left it at that for now until I can figure how to free the slug in L501 without damaging it.

"With reference to the same 19 KC test point used in the previous step, use a shorting cinch and short this test point to the opposite side of C537 to kill the 19 KC pilot level. Using another shorting cinch, short the junction point of R503 and R504 directly to ground. Adjust T502 for 0 [zero] *beat as seen on the scope. Remove the short from the junction point of R503 and R504 and the short between the 19 KC test point and the opposite side of C537."*

Comments (adjusting 38 kHz):

1. "Cinch" is quaint language for a shorting jumper lead with clips on each end.
2. Shorting out the 4700 pF C537 definitely kills the pilot signal from the multiplex generator.
3. Shorting the junction of the two resistors to ground results in a low-level, odd-looking signal on the scope. This point is located also where the negative side of the 5 uF/15V cap terminates on a tie strip on the left side of the MPX decoder sub-assembly.
4. Adjusting T502 is adjusting the 38 kHz for "zero beat." I'm actually not sure what this means when looking on a scope or what we're zero-beating against (zero-beating is a process for adjusting two simultaneous signals close in frequency for zero frequency difference). When zero-beating two signals by sound, you adjust until the two-tones become one. The signal was noisy on the scope and I could see no change when I varied T502. I took careful note of where it was set, and just put it back where it was. (see also note below)
5. I noticed when you turn the slug in T502 after removing the shorts, you can actually hear a soft, high pitch squeal coming from the chassis (speakers were turned off), probably one of the MPX tubes, when it was turned significantly away from the working set point.

6. More work to do to understand this step. Dave Roehr's procedure (pages 58-59) procedure is more descriptive, but you have to do another scope trick to generate a 'stable lissajous figure' to accomplish the same thing. This is another, visual way to show phase (frequency) difference and adjust for the "zero beat" when the figure stabilizes. I'll probably try Dave's whole MPX adjustment procedure at some point soon and this may have been exactly the method the Service Bulletin assumed I knew how to do.

"Turn the right channel separation pot and threshold adjust pot completely counter-clockwise. Turn the left channel separation pot clockwise. With a left channel stereo signal connected to the antenna terminals, take a reference reading of the left channel of the VTVM.

Take output from the right channel (TAPE OUT jacks). Adjust L501 for maximum separation and then adjust the right channel separation pot for a further increase in separation. Now, modulate the right channel of the stereo signal and adjust the left channel separation pot for maximum separation. Those separation adjustments may have to be done several times in order to achieve maximum separation on both channels."

"Reduce the input signal to 10 mV [microvolts presumably?] *at the antenna terminals, turn the "Threshold Adj" until the "Stereo" light comes on."*

Comments (Adjusting Stereo Separation):

1. I found the Service Bulletin and Roehl's procedure are pretty similar here. My work was confounded by the fact (once again) that I can't tune L501 (the 38 kHz coil), which is part of the separation adjustment.
2. So, I did the best I could using the separation pots clearly marked on top of the MPX unit. A scope with two input channels is very useful on this step.
3. Set the receiver to stereo mode.
4. With the pilot signal at 10%, I set the SG-165 to modulate the LEFT side audio with 400 hZ sine wave.
5. I plugged the scope input into the RIGHT TAPE MON output and adjusted the RIGHT side separation ("R Sep Adj" pot on the MPX unit) for the least output from the RIGHT channel.
6. I then switched the generator to modulate the RIGHT channel input only and adjusted the LEFT separation pot (labeled "L SEP ADJ" on the MPX unit) for the least output from the LEFT TAPE MONITOR output.
7. I went back and forth a couple of times to optimize the adjustment.
8. I calculated the separation from the RMS voltage difference seen between the driven and un-driven channels and got 23 dB separation with L side driven and 27 dB with the right side driven. This is not great, as we should be able to see something like 30 dB minimum, but I suspect that part of this is that my SG-165 needs to be calibrated for better separation (a problem sometimes when using vintage test gear to test vintage audio gear). Not

being able to adjust L501 also affects the ability to optimize between channels.

9. Nevertheless, this level of separation sounds good to the ear and the actual separation level probably better than my measurements indicate.
10. I had already adjusted the Stereo Threshold adjustment (above), so didn't do it again. If you want to do it 'by the numbers' and you know the RF output level of your multiplex generator, you can do it this way

RESULTS

Despite the fact that I could only do part of the MPX decoder alignment at this time, the tuner seems to be working quite well. Sensitivity is up and stations tune properly with good stereo operation. Stereo has a very low-level hiss compared to mono, even on strong stations. I suspect this is due to the built in pre-emphasis settings of the tuner and is moderated slightly by using the "Sub Channel Filter" setting. Fisher experts recommend changing the R-C constant to reduce this, but it's not highly objectionable so that's a consideration for another day. The manual recommends using the "scratch filter" as well, but I didn't find it necessary to do this.

Feedback on this "living" write up would be gratefully received!

Dave

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