A FarMedia "Lab and Listen™" Report

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Project: "Audiophile Modified" Scott 370 tuner evaluation
Client: (Name Removed by Request)

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Change History

Version	Date	Purpose
0.1	March 25, 2006	Document creation
0.2	March, 26, 2006	Crash recovery
0.3, 0.4	March, 27, 2006	Intermediate version
0.5	March 27, 2006	First writing pass done
0.6	March 28, 2006	First edit pass done
0.7	March 29, 2006	Fixed jpg problem that prevented PDF
0.8	March 30, 2006	First distribution for editor
0.9	April 3, 2006	Client Version
0.91	April 5, 2006	Minor edits, added to equipment lists, remarks on intermittent.
0.92	April 6, 2006	Added in tuner spec chart
0.95	April 7, 2006	Rearranged sections. Put Lab and Listen gear listing in appendixes

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1 Introduction: About this project

I was contacted for assistance in finishing up a tuner project. The project is a unit that was being modified to be an “audiophile tuner”. The tuner chosen as the baseline for this conversion is a Scott 370(A), serial number 238621.

As detailed in the history section, the 370 was the last tube design from Scott, and it was also a cost down version, which is not normally the place to find a gem. The modifications to this tuner are billed as enabling it to outperform a top of the line Scott 4310. I thought that the assertion was both provocative and interesting, and, as I happen to own a Scott 370-B, (which is electrically identical to the A version, but slightly different cosmetics), I thought there might be some information to be gleaned based on this modification set.

It turned out the modifier did not have access to the proper equipment to align it, so after some discussion I agreed to align the multiplex unit after all the modifications were complete. I would also do some analysis of the modifications and document my results and impressions of the two units, the audiophile modified tuner and my stock one.

I will hereafter refer to the modified unit as “audiophile modified tuner” and my unit as the “stock tuner”.

2 A brief outline of the Scott tuner product line

Scotts first FM tuner was the 310(A), shipped in 1954. Major improvements were introduced in the B version (including the famous “Silver plated front end” for stability and noise rejection) in 1957.

1957 through 1961 saw the introduction of a large number of series and versions from Scott.

Scott tube tuners were broadly separated into two categories: Broadcast monitors and Consumer tuners.

The Broadcast Monitor series tuners were the 310 models and the Consumer series tuners were the 311 series. (The 311’s were basically cost downs of the 310’s; they used the same front end (the Z FM-3) but removed an IF stage and limiter.)

There was also a separate consumer series with combined AM/FM tuners on one chassis. This was composed of the 330’s, two lower cost slide rule versions, the 300 and 320, and a preamp & tuner combo, the 331 series. Finally, a kit tuner, the mono LT-10 was released around 1961; it was again based on the 311 design.

By about 1962, all the Scott FM Tuners (save the low end mono 314) were FM MPX stereo systems.

The 310 broadcast series continued and morphed into the 310-E and the very high end and rare 4310.

The consumer 311 series was replaced by the stereo 350 series and the kit versions, LT- 110’s. The lone mono tuner was the low cost 314, again evolved from the 311 design.

A third generation front end design based on Compactron tubes was introduced around 1962. Compactrons are basically multiple tubes in a single envelope; this was done to keep the parts count (and therefore the cost) down. Compactrons were a last gasp for the tube industry before solid state took over, and were only used in a few Scott designs, the low end 370 tuner (& kit LT-111), and a tube receiver, the 345. (Curiously, the 345 uses Compactrons only in the multiplex and amp drivers, the front end is based on the venerable 350-D.)

The last all tube tuner models made by Scott were the 350-D and the kit version, the LT-110-B in 1967.

2.1 Scott tuner quick specs (from 61-65 catalogs)

The following table of representative models is gleaned from the published specs from HH Scott

Scott Tuner quick specs														
(From 1962-1965 catalogs)														
(frequency response rated 30-15K +/-1 dB in 11/63 catalog)														
Model	Positioning	yr/cost	IHFM Sensitivity (uV	Selectivity (dB)	THD (%) (2) mono/stereo	Hum (-dB 1Volt)	Capture ratio	S/N (dB)	Detector BW (Mhz)	IF Stages	Limiting stages	Stereo indicator	Separation (dB) (3)	
310-C	Broadcast FM monitor	60	2		0.5	66	2.2		2	3	3	n/a		
310-D(1)	Broadcast FM Mono	61/$184.95	2.0	50	0.5	66	2.2	60				n/a		
310-E	Broadcast Fm stereo	63	1.9	50	0.5	66	2.2	65	2	4	3	Automatic	35+	(from 11/63 catalog)
311-D	Consumer FM Mono		2.5		0.8	66	6		2	2	2	n/a		
314	consumer mono	61/$114.95	2.5	35	0.8	66	6	60	2	3	2	n/a		
320	Consumer AM/FM	60	3		0.8	66	8		2	2	2			
330-D	Consumer AM/FM	61/$209.95	2.5	35	0.8	65	6	60	2	2	2	n/a		
333(A)	Consumer AM/FM stereo		2.5	35	0.8	66	6	60	2	3	2	Sonic Monitor		
333-B	Consumer AM/FM stereo	64/289.95	2.2	35	0.8	65	6	60	2	3	2	Sonic Monitor		
340(A)	Consumer FM stereo receiver		2.5	35	0.8	65	6	60	2	3	2	Sonic Monitor	30	
340-B	Consumer FM stereo receiver	64/$399.95	2.2	34	0.8	65	6.0	65	2	3	2	Automatic		
350-B	Consumer FM stereo		2.2	35	0.8	66	6	60	2	3	2	Sonic Monitor	30	
350-D	Consumer FM Stereo	64/$224.95	2.2	35	0.8	65	6	60	2	3	2	Automatic		
355	Consumer AM/FM stereo preamp	61/$319.95	2.5	35	0.8		6	60	2	3	2	Stereo Guide eye	30	
370 (A/B/LT-11)	Budget consumer FM stereo	64/$159.95	3.5	32	> 1	60	6	55	1	2	2	Sonic Monitor		
399	Consumer FM rcvr	60	2.5		0.8	66	6		2	2	2	n/a		
4310	High End	64	1.9	55	0.5	70	2	60	2	4	3	Automatic	35+	
LT-10	Consumer FM Mono Kit	61/$89.95	2.2	35	0.8	66	6	60	2	3	2	n/a		
LT-110	Consumer FM Stereo Kit	62/$159.95	2.2	35	0.8	66	6	60	2	3	2	"activated"	30	
LT-112-B(1)	Transistorized Consumer FM Stereo		1.9	45	0.8	70	4	65	2.5	3	2	Automatic	35 @ 400Hz	
(1) Specs from servcie note:														
(2) Stereo THD not specified. Testing averages 2-3%														
(3) Where separation not specified, typically 30 db at 400 Hz														

3 First looks

The audiophile modified tuner arrived on 3/18/2006. It had been packed in two layers of bubble wrap, but was not double boxed. That was quite unfortunate, as it appears the tuner had been subjected to some rough handling during shipment

It had the following damage on arrival:

- The tuning knob has a chip out of the center of the knob.
- The vernier clutch slips. (This was later verified with the owner to be a preexisting condition.)
- The edges show some damage, and the upper right corner has a slight bend. (These both appear to be pre-existing damage as well.)
- I later discovered the multiplex unit was intermittent and non functional.

3.1 Audiophile modified tuner, front panel

There are no modifications or visible changes to the front panel.

3.1.1 Controls

The power/mode knob was missing its cap (as usual), and someone had creatively painted a gold top on it. I replaced it with a new and better looking Marshall one from my stock.

The clamping mechanism for the vernier is visible through the damaged spot on the center of the knob. This last generation of the tube front end uses a much smaller diameter shaft than the long running “Silver Plated front end” did, which is a long way to say finding a replacement tuning knob is even more impossible than usual.

3.1.2 Other notes on initial condition

- There was a complete set of tubes in the box. The tuner was apparently retubed by the modifier, and the mostly Scott logo'd original tubes were in the replacement tube cartons.
- There were no feet on the unit, so I promptly installed a set. This is an important detail for Scott units for several reasons:
  1. The convection cooling won't work properly without the airspace under it
  2. The faceplate edges are somewhat fragile and tend to get bent or chipped without feet to protect them.

3.1.3 Audiophile modified tuner, back panel and chassis top view

Visible changes to the back include:

1. A large capacitor epoxied to the top deck, with value obscured.
   I prefer to see these large capacitors attached via mounting clamps, as it is then both secure and removable. The capacitor is epoxied to the front metal "doghouse" making it impossible to remove and service the tuning eye tube. The leads are dressed through a cooling slot, but there isn't a grommet or anything to prevent the metal from chafing through the wire insulation. A potential problem is the inrush current of this capacitor is much higher than the power supply was designed for, which may lead to premature rectifier or transformer failure. Finally, the capacitor appears to be a photoflash unit. These capacitors are designed for intermittent use and not recommended for continuous duty filter applications.

2. Removal of the standard AC cord and alarmingly, the fuse. (More on this later.) The fuse hole was enlarged to accommodate a chassis mount IEC style power jack, and the AC cord hole was repurposed to fit a large ground post.
3. Replacement of the standard RCA phono jacks with a pair of audiophile grade gold ones.
4. Curiously, the 300 ohm antenna connections are not supplemented with either a chassis mount F connector or a 300 to 75 ohm matching balun. Considering the audiophile focus, this seems odd.
- It appears all the tubes have been replaced, aside from perhaps the tuning eye. (See the comment on the large capacitor previously.) The tubes in the boxes are mostly Scott labeled.

3.2 Stock tuner, front view

Front of stock tuner.

3.3 Stock tuner, back view

My tuner is a 370-B, with the later faceplate and knob cosmetics; the production electronics between the tuners are identical. I believe all the tubes in the stock tuner are originals

Back and chassis top view of stock tuner

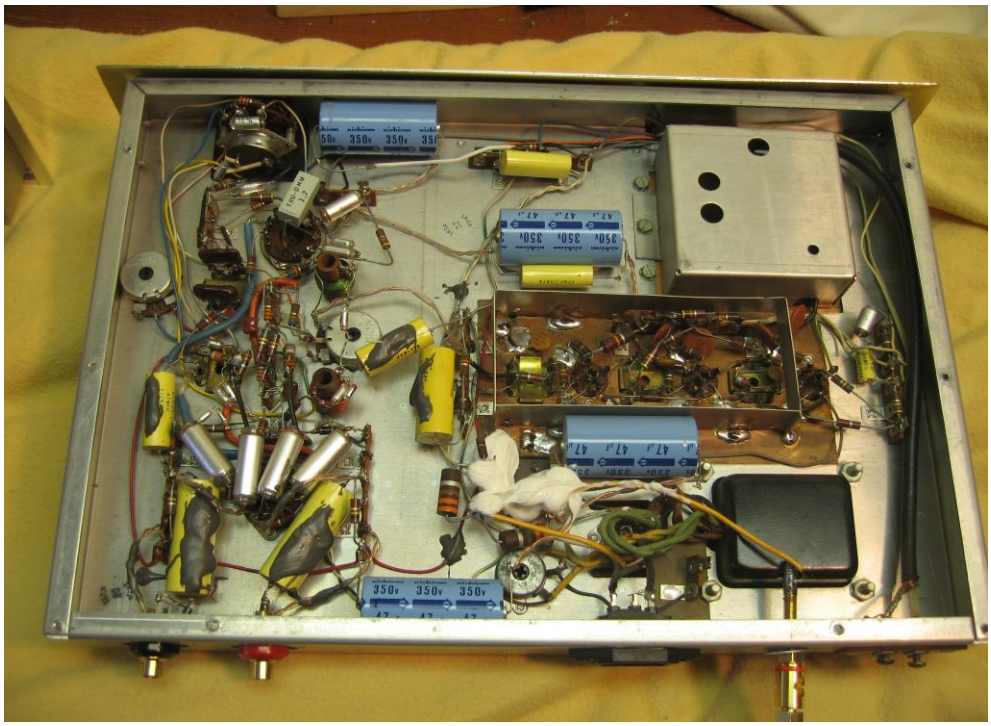
3.4 Section Summary

1. The jack retrofits are somewhat crudely done, although they appear to be serviceable. The audio and ground post connections use washers to help fill the holes enough to mount the part. I would have preferred to see small plates filling the cut-outs, and proper sized holes drilled in the filler plates, but I'm a bit of a neatnik.
2. The capacitor epoxied to the top deck on the audiophile modified tuner makes servicing the unit difficult, as the doghouse can no longer be removed to access the tuning eye and the tuning mechanism.

4 What Lies Beneath…

Next, I opened it up the two units to compare what had been done inside the chassis. This is where the rubber hits the road, the pedal goes to the metal, and all that rot.

4.1 Audiophile modified tuner, under chassis view



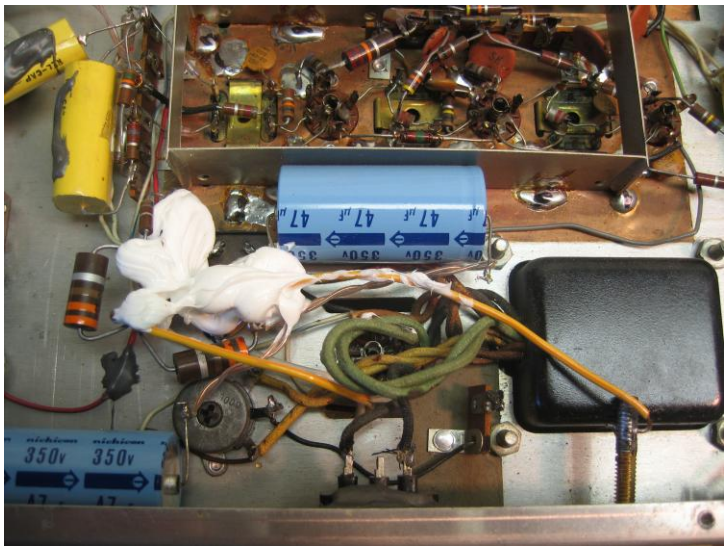
4.1.1 Obvious under chassis changes

- Lots of extra filter capacitance was added, in the form of “nichicon” axial lead electrolytics. They are the large blue capacitors epoxied to the chassis, which is indeed a solid way to mount them but will be a tad difficult to replace in the future. I was surprised by the apparently random use of the chassis grounding points for the extra filter caps, rather than using the common tie point at the power supply. I also found the lead dress to be rather messy, but it works.
- Replacement of the coupling capacitors with “Wonder” audiophile types.
- Replacement of the silver mica caps in the detector and multiplex with some silver bodied capacitors. I believe these are also audiophile types, hopefully they have the same high frequency characteristics as the micas do.
- Some signal wiring was replaced with some fancy stuff; it’s a twisted pair of some sort of copper wiring.
- The output filter inductors were removed. (This will probably increase the amount of 38 kHz signal and diode switching noise in the analog output.)
- The front panel power AC power switch was unhooked from the AC circuit and the twisted pair leads from the front to the back were removed.

- Installation of a large ground post by the power transformer. The grounding posts wire disappears into the goop; I assume it's attached to a chassis ground there. This is in spite of the fact that the ground post as also grounded to the chassis by the mounting washers and nut. If the post is intended as a star ground, it is not hooked up properly, however it serves as a general chassis ground just fine.
- The AC zip cord, chassis grommet, and fuse (!) was removed and an IEC style chassis jack was installed. The IEC jack is the standard variety, with no filtering or power switch. Curiously, the IEC ground lug is unattached, which leaves AC power cable ground unattached as well. In a modification as comprehensive as this one, I would have expected to see a switch that would attach the chassis ground to either the AC cord ground or the binding post for best hum reduction.
- There were no modifications to the heater string power supply. I had expected a conversion to DC, as that mod typically reduces hum significantly.

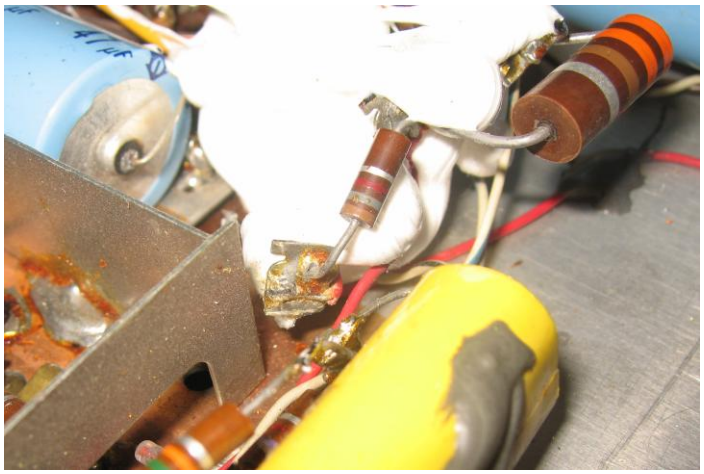
4.1.2 Power supply changes

Here's a close up of the modified power supply and B+ section.



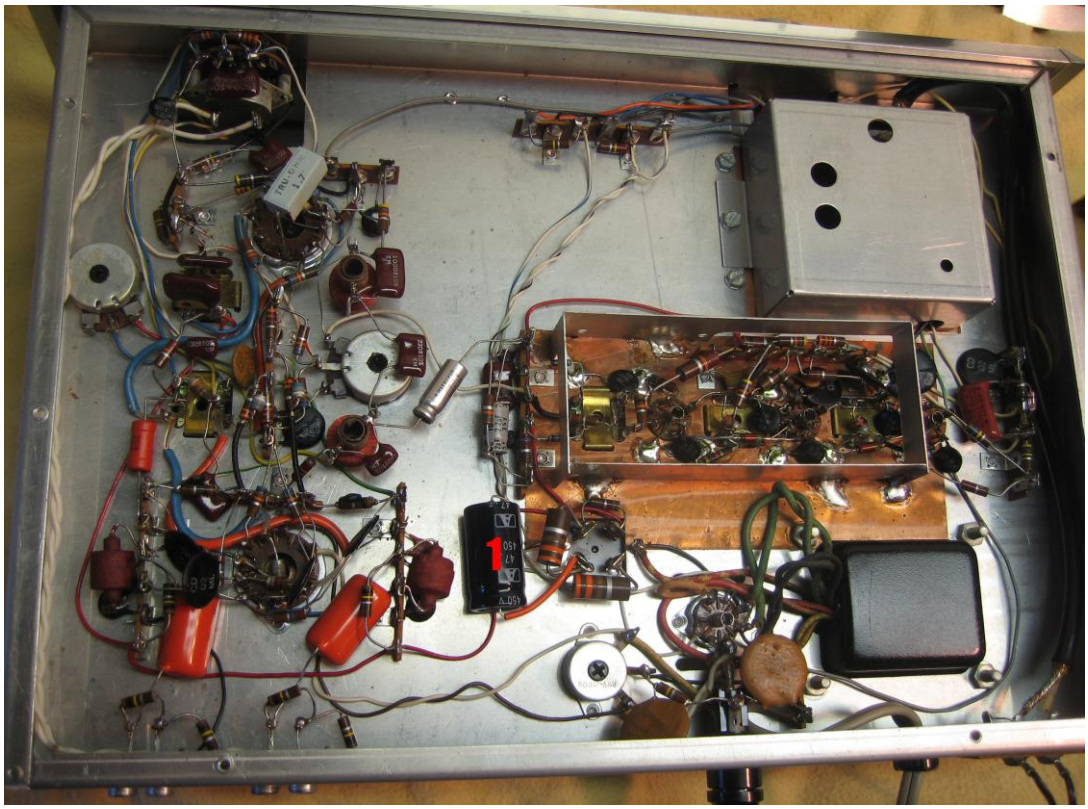
I was alarmed to see these two changes in the audiophile modified tuner:

- Removal of the AC fuse by the modifier. This will cause a catastrophic power supply and transformer failure when something goes wrong in the tuner. It also presents a fire hazard to the building. The fuse is supposed to be mounted where the IEC jack was installed.
- A rather cavalier modification of the B+ section that leaves some parts hanging in mid air. A generous application of insulating goop (RTV?) was required to prevent shorts. For example, the 330 ohm, 2 watt resistor (top right in following photo) has both leads hanging in mid air, supported only by the goop and the leads of the other components. The 1.8 K resistor is the same way; the end that was attached to the can filter capacitor still has part of the lug attached; apparently it was just clipped off. This all dangles rather close to the corner of the chassis ground shield for the IF section (see following photo).



It is considered good wiring practice to anchor both ends of parts to terminal strips or other similar mechanically secure points, especially high voltage leads.

4.2 Stock tuner, under chassis view

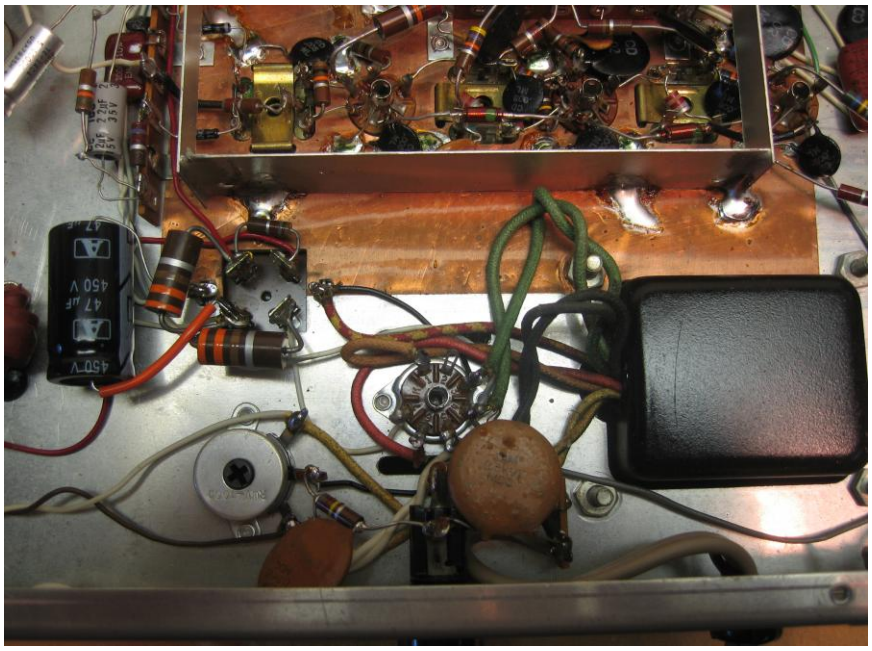


The stock tuner has preventative maintenance and one minor tweak.

- All the old and leaky signal path electrolytics are replaced.
- The usual leaky American Radionics capacitors replaced. The two output couplers are Orange Drops; the others are junk box parts.
- A minor tweak of another 47 uF of filter capacitance (1, above) added to the second stage of the B+ filter.

4.2.1 Power supply area changes:

Here's my stock tuner power supply section.



It is stock, aside from the extra filter capacitor mentioned earlier visible at center left.

4.3 Section Summary

Although the intentions for the modified tuner seem good, these changes are not up to my criteria for craftsmanship or safety standards.

1. The audiophile modified tuner power supply changes (e.g. more filtering) make some sense, but I do not like the rather crude methodology employed.
2. The AC mains hazard caused by removing the fuse is a bad idea, and an accident waiting to happen.
3. Depending on RTV "goop" to keep B+ leads safe and secure is likewise a bad idea.

5 Initial audiophile modified tuner evaluation

After the peeking and poking, it was time to fire it up.

5.1 Initial impressions:

- The tuning was asymmetrical going on and off station. The tuning eye works OK, but doesn't close as much as usual. These are both indicative of a misaligned IF and detector.
- The tuning eye has a bit of blur, perhaps due to old age? As I couldn't get into the doghouse, I couldn't run this one down.
- The sensitivity was a bit off as well. A 2 foot hunk of wire on the audiophile modified tuner failed to bring in the same stations as the stock tuner. This is indicative of a poorly aligned RF front end.
- The frequency markings were a bit off, but this is probably due to the dial being a bit loose on the tuning shaft.

With a strong signal, the tuner sounded acceptable in mono, but stereo was full of distortion and artifact sounds.

6 I.F. and Detector section

The “align by ear method” is rarely a satisfactory method to align the Scott I.F. and Detector. Although it worked OK when these tuners were new, age related drift, and the occasional well meaning twiddler will usually defeat attempts to use this method now.

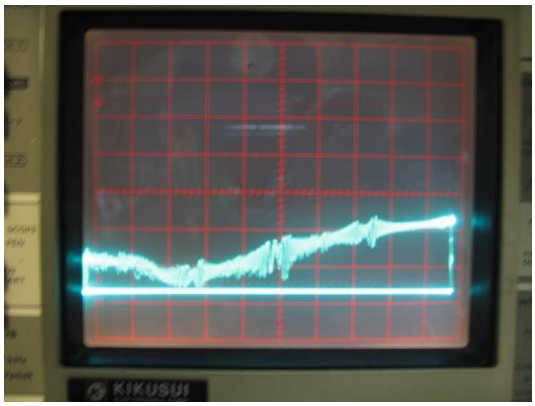
A misaligned I.F. stage will exhibit poor sensitivity and selectivity and an asymmetrical distortion pattern as you fine tune on and off the station. The I.F. stage requires a symmetrical response for lowest distortion and best selectivity, which in turn requires a FM signal generator with a sweep feature. (I use a modified Sencore SG-165) and a scope.

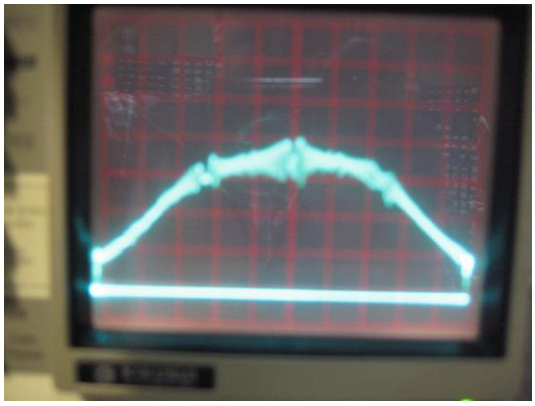
A misaligned detector will exhibit high THD and can prevent the stereo multiplex unit from operating at all. The detector requires the same equipment as the IF section, and additionally requires a THD meter to align properly.

6.1 Audiophile modified tuner changes

The audiophile modified tuner had very few changes here, just the aforementioned filter caps on the I.F stage’s B+ and replaced capacitors to the secondary of the detector stage.

6.2 IF alignment and detector





Audiophile modified tuner – (poor IF pattern) Stock tuner – (correct IF pattern)

The audiophile modified tuner had a rather misaligned IF stage, indicative of “by ear” tweaking. A few iterations through the IF section cleaned up the response to look like the stock tuner IF response on the right.

6.3 Section Summary

1. The audiophile modified tuner stereo distortion was over 10% when I started. It dropped to about 6% after inserting a low pass filter and the mono THD dropped to about 1.5% after careful adjusting. This is still higher than I usually see in a Scott, but it matched the stock tuner in this regard. Perhaps the generally higher THD is due to the narrower bandwidth detector design used in the 370’s.
2. As mentioned, previously, I had to use an A weighting filter to remove the extra ultrasonic noise from the output in order to adjust the detector, so the absolute numbers are somewhat problematic.

7 Multiplex section

7.1 Overview of modifications

The bulk of the modifications that were performed on the audiophile modified tuner were to the multiplex and final audio output stages.

- Virtually all capacitors were changed out, both signal path and oscillator micas.
- The output noise filter was removed. More on this issue in the measurements section.
- Some signal wiring was rerouted.
- Capacitor C320 on L 502 is supposed to be a 120 pF; it was replaced with a 100 pF. This is probably OK, as this L/C is the 67 kHz trap and a tunable circuit.
- C524 on the multiplex decoder is supposed to be a .25 uF; it was replaced with a .47 uF. I'm not sure what changing this will do; it's part of the 38 kHz chopper circuit. **Update**: This value destabilized the 38 Khz oscillator. The oscillator frequency wandered over several kilohertz, and it was impossible to set to 38 kHz. I replaced the too large value with the correct value capacitor (a .22 mica one) and was able to lock in the oscillator tuned circuit again.
- A 308K resistor was tacked onto the wiper of balance pot and went to the diode matrix. Its intent is unknown, and as it prevented me from aligning the multiplex; I removed it.
- Lastly, a wire going to the mono/stereo selector switch was clipped in two near the AC switch. As this connection is required for the multiplex to operate, (it forces mono) I assume this was an accident done during the AC switch modification. I repaired it with a bit of orange heat shrink tubing.

I had to remove/repair the last three modifications to get the multiplex unit to work again.

7.2 Multiplex repair

The audiophile modified tuner's multiplex unit was non functional when it was received. The two channels are mono but 180 degrees out of phase, suggesting the switching matrix isn't actually switching correctly.

Upon further research, the most serious problem is the two coils (L 501 and L502) have stuck and cracked slugs. Happily, I was able to acquire some replacements from a junked donor multiplex sub chassis unit, probably from a LT-110. The new 19 KHz coil needed a tad more capacitance to reach the proper range.

After replacing the coils, fixing the wire, and removing the resistor, it was possible to tune up the multiplex unit again. Unsurprisingly, the 38 kHz oscillator and the 19 kHz peaking coils were all way off.

However, even after all of this repair, the multiplex unit persists in having intermittent problems that throws it out of alignment when the chassis is flexed. I have found a solder blob and 2 cold solder joints so far, but I'm still chasing this down. More worrisome, the multiplex unit is much touchier alignment-wise than it should be. I remain puzzled by this, and on a practical note, I hope the alignment survives shipping back to its owner.

UPDATE: The chassis is corroded and this apparently messed up the ground, which depends on rivets to the chassis. I ran a series of ground wires around the multiplex unit and resolved the intermittent. The touchiness was related to the incorrect value capacitor replacement in the 38 kHz oscillator circuit. Unit is much more stable now once it warms up, however the thermal stability is not good. It takes some 30 minutes for the unit to stabilize and yield a good low distortion stereo image.

7.3 Section Summary

1. The multiplex unit required a large amount of unplanned restoration and repair work to return it to a functional state.
2. Three of the modifications prevented obtaining a correct alignment and were removed, although the clipped wire was probably inadvertent.

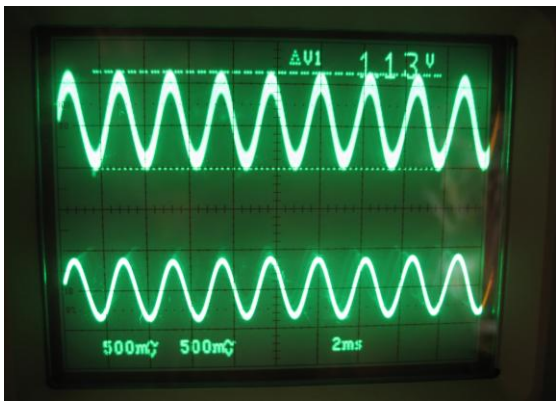
8 Validating the work –The equipment test results

My usual test setup is to instrument the outputs with a dual trace scope, an audio amp with a preamp buffer/volume control stage, and the Audio Precision analyzer. In the case of a tuner, the AP's signal generator modulates the FM stereo signal generator. The signal generator I use (a modified Sencore SG-165) has a maximum separation of 40 dB, adequate to align and measure the typical 30 dB separation of Scott multiplex units. I also refer to a set of modern FM tuners to ensure my lab setup is performing correctly.

8.1 What's at the output jacks?

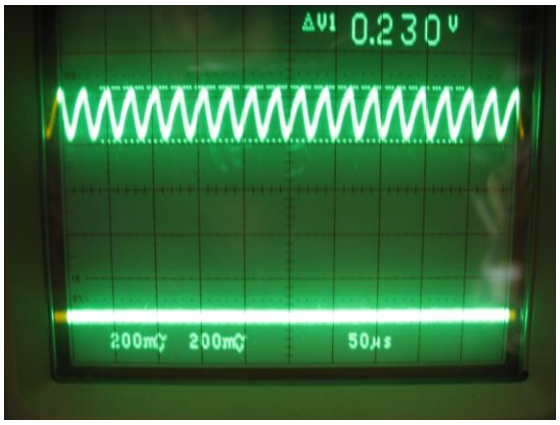
8.2 Levels

The first thing I noticed was the output level between the two units was different. The stock tuner was about .75 volts PP (bottom trace); the audiophile modified tuner was about 1.1 volts PP (top trace). As this difference was within the range specified in the service note, I paid it no further attention. It is mentioned here as a fact to remember when comparing the two units in the scope photos and the charts later. Also observe the top trace (the audiophile modified tuner) is blurrier, indicative of some noise in the signal. But what is it?



8.3 A closer look at the noise

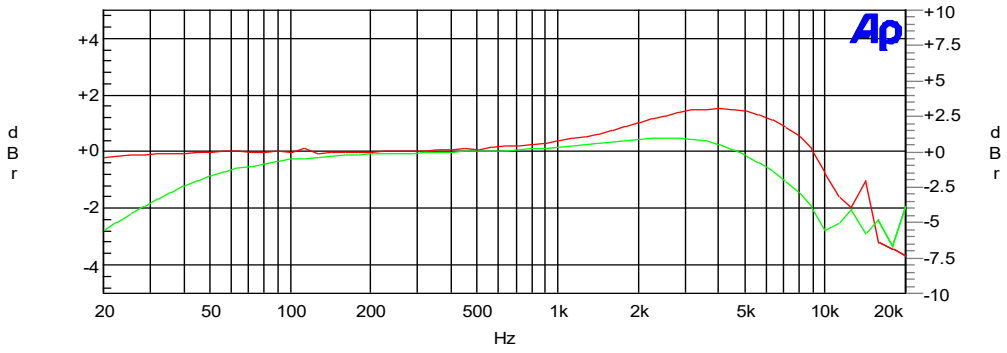
The noise turns out to be some 200 mV of a 38 kHz saw tooth. As the signal is not present in mono, it can only be switching noise from the multiplex unit. The lower trace in this scope shot is the stock tuner. Observe the ultrasonic noise is not present.



Further investigation showed the output filter circuit had been removed from the audiophile modified tuner, permitting the 38 KHz signal to exit the tuner.

8.4 Frequency response comparison

FarMedia FREQUENCY RESPONSE 03/24/06 12:55:24



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	1	Anlr.Ampl (2-Ch.)	Left	
1	2	Green	Solid	1	Anlr.Level B!Normalize	Right	

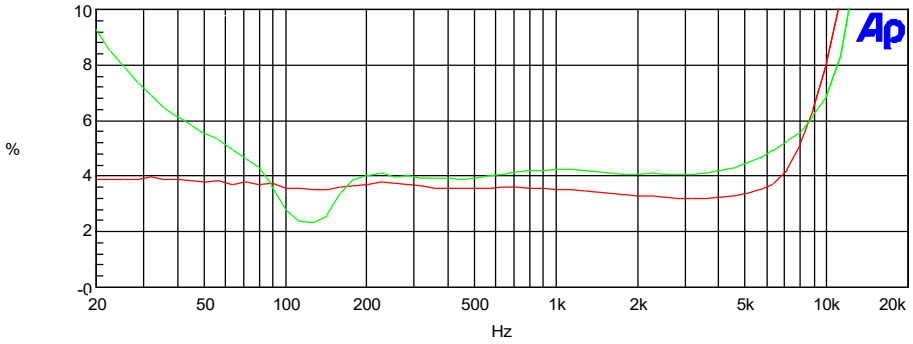
Sencore SG-165 into Scott 370 TUNERS
Frequency Response 20 - 20K
stereo signal, FM stereo, 10% pilot, left driven
RED - hot rod
GREN - ref

FM FREQ RESP HOT ROD AND REF.at1

The audiophile modified tuner has a much flatter bass response than the stock tuner, although the slight high frequency boost around 4 kHz is odd.

8.5 THD comparison

FarMedia FREQUENCY RESPONSE 03/29/06 15:57:06



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	1	Anlr.THD+N Ratio	Left	
2	1	Green	Solid	1	Anlr.THD+N Ratio	Left	

Sencore SG-165 into Scott 370 TUNERS
THD vs Frequency Response 20 - 20K (filter at 22 kHz to filter switching noise from hot rod)
stereo signal, FM stereo, 10% pilot, left driven
RED - hot rod
GREN - ref

FREQ vs THD - HOT ROD AND REF.at1

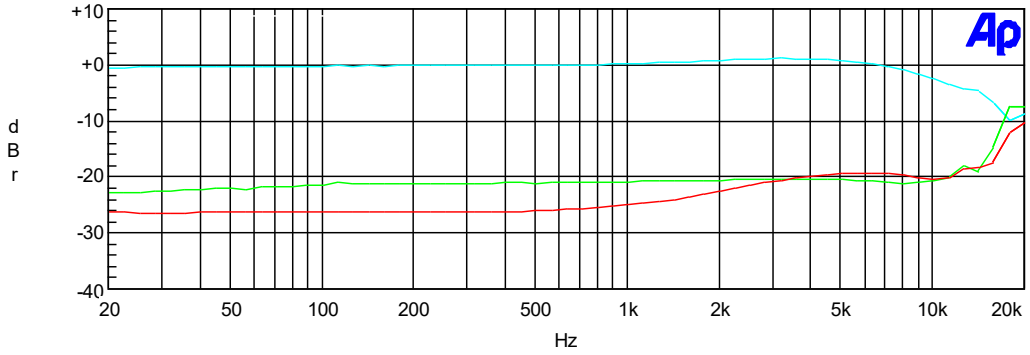
This measurement is the most problematic one I made. For one thing, the overall amount of distortion from both units is higher than a typical Scott tuner; even the mono readings are still around 1.5 %. However, the two tuners are consistent with each other, aside from the odd low frequency rise in the stock tuner. This measurement coupled with the previous one suggests I need to take a closer look at my tuner to see what its problem is in the bass region.

8.6 Channel Separation

Separation was measured over the entire frequency range of 20 – 20,000 Hz, even though FM stereo only goes to 15 kHz. The extra bandwidth reveals the activity of the filter for the 19 kHz pilot. Separation was determined by driving and plotting the left channels amplitude vs. frequency as the reference point, and then driving the right channel and again analyzing the left channel. Scott tube tuners average 25 dB, and hit 30 in the midrange. There are typically differences in L to R vs. R to L separation of a few dB.

8.6.1 Audiophile modified tuner, channel separation

FarMedia FREQUENCY RESPONSE 04/04/06 18:11:57



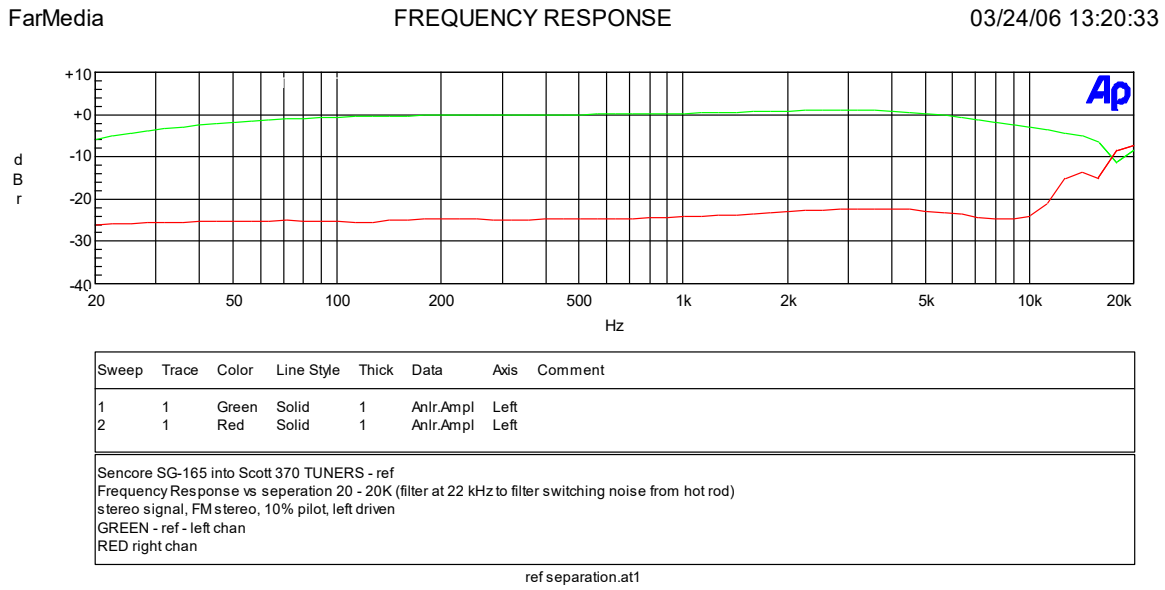
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Cyan	Solid	1	Anlr.Ampl	Left	
2	1	Green	Solid	1	Anlr.Ampl	Left	
3	1	Red	Solid	1	Anlr.Ampl	Left	

Sencore SG-165 into Scott 370 TUNERS - Audiophile modified
Frequency Response vs separation 20 - 20K (filter at 22 kHz to filter switching noise)
stereo signal, FM stereo, 10% pilot, left driven
cyan - ref - left chan
RED Left separation from right
GREEN right from left

HOT ROD separation day 2.at1

The audiophile modified tuner has the typical Scott frequency vs. separation curve in the bass and midrange of about 25 dB. However, the high frequency separation is a bit worse than usual, reducing to 20 dB around 3 kHz.

8.6.2 Stock tuner separation



This is the typical Scott separation curve, 25 dB over the bulk of the audio spectrum (20-10kHz), as exhibited by the stock tuner.

8.7 Hum

I was unable to measure the hum levels; however the audiophile modified tuner is considerably quieter to the ear. I would estimate some 10 dB or so of reduction. **Update:** After some experimentation, I was able to measure the hum by plotting the spectrum via a narrow band-ass filter. The modified unit has a 10 dB improvement at 60 Hz and a 5 dB improvement at 120 Hz over the stock unit.

8.8 Section Summary

- The audiophile modified tuner has a flatter low end frequency response.
- The THD of the two units is similar, although a bit high on both. This could be due to the narrower bandwidth of the cost reduced detector used in the low end LT-111 and 370 tuners.
- The audiophile modified tuner's stereo separation at high frequencies is a tad reduced. I was unable to adjust the multiplex unit for better operation.
- Hum is considerably reduced.

1. Since I do not have before and after measurements for the audiophile modified tuner, I am unable to state definitively whether it is an average sample or not. Other than the reduced hum level, I am also unable to state whether the modifications are themselves responsible for the differences between the two units.
2. I remain concerned by the ultrasonic hash and its possible adverse side effects on the rest of the audio chain.

9 Listening tests

9.1 Listening notes

I originally was going to do a quick alignment and then the lab and listen tests on this tuner. Since the audiophile modified tuner required significantly more work and time to make it operational than I had allocated for this project, I was only able to perform a few short term casual listening tests on a few of my systems.

The first listening test of 30 minutes was done after about 10 hours of operation, insufficient for any break in to occur if needed.

The second was after about 30 hours of operation; again it was fairly short term, about 30 minutes.

9.1.1 Brief comments 10 hour break-in

- The reduced hum level was quite apparent and very welcome.
- The reduced high frequency separation was perceived as a slight reduction in the amount of air in the sound stage of classical music, this was not apparent with pop music.
- The low bass was tighter and more apparent over the stock tuner, but sounded the same as a LT-110 I had handy. This backs up the concept that my stock tuner unit has a bass problem that needs to be investigated.

The audiophile modified tuner otherwise sounded much like the stock tuner to me.

9.1.2 Comments from 30 hour break in

The multiplex flaked out again after moving the chassis from the shop to my house. It was repaired and readjusted prior to this test. The multiplex locks in much better and the tuning action is improved. The unit appears more stable now, but I'm still crossing my fingers. I do not hear anything different from the first listening test, although the client states he expects a 500 hour break in period.

10 Commentary on the audiophile modified tuner

- Some modifications make immediate logical sense. Replacing capacitors with new ones that aren't leaky, adding capacitance to the B+ filter stages, and generally reducing hum are all good concepts. However, the craftsmanship is not to my liking, and the capacitor mounting that prevent access to the doghouse is a poor plan.
- Several modifications prevented the tuner from functioning correctly in stereo, and needed to be removed or repaired. Since the modifier did not have the correct test equipment to align the unit, it follows they could not have tested it either. Still, it is disturbing to find so many issues in one unit.
- Some of the modifications strike me as downright dangerous. The removal of the AC line fuse, and a power supply with the B+ leads floating around in mid air spring to mind as examples of this.
- Some of the modifications, like the purist AC wiring changes and the replacement signal leads are highly dependent on the resolution of the rest of the system, and the ears and belief of the listener to be able to discern them. I also note that some of the replaced capacitors are not actually in the signal path, which would imply a minimal, if any, effect on the sound. In short, I was unable to confirm these benefits, nor was I able to determine whether the audiophile capacitors made a significant difference over Orange Drops. However, I did not have the unit long enough to go through the lengthy "break in" period that the audiophile capacitors may have required.
- One modification, the removal of the ultrasonic filter, permits a fair amount of 38 kHz ultrasonic signal to leave the tuner. Whether this is detrimental to downstream components (amps, tape recorders, or your ears) is dependent on their bandwidth, but I don't think it's a good idea.
- The modifications also render the unit questionable for resale. What will the next owner do if there is a problem?
- Finally and surprisingly, there are some typical mods and fixes that were **not** performed. These include adding rubber feet for the unit's safety and cooling, fixing the tuning dial, and adding a 75-ohm F-connector and balun either external or chassis mounted. **UPDATE:** I added some feet to the unit, and a rubber bushing to the tuning dial. I mentioned the balun issue to the client, I will be supplying one.

10.1 Conclusion and closing statement

1. As I do not have a 4310, I cannot state how the audiophile modified unit compares to that one. I personally did not hear anything special or attributable to the modifications as improvements over my stock 370, save for the reduced hum. The client stated he expects a 500 hour break-in period; this is more time than I will have the unit.
2. The fact that the multiplex is much more touchy than usual is a detriment. However, I can't say the modifications are definitively the cause of that problem. **UPDATE:** The capacitor value change (see the multiplex discussion) was affecting the 38 kHz oscillators stability; so one of the modifications was indeed detrimental.
3. I find the concept of the modifications interesting and potentially worthwhile, but I personally would start with a known correctly working baseline and make the modifications slowly and with greater attention to detail and safety. I do not know the cost of the modifications, but it would certainly be a factor to determine whether the cost was justified in such a project.

11 Authors experience

Professionally, I'm a Software Engineer and Technical Writer, specializing in computer audio systems. I've written device drivers for Windows, product specifications, engineering specs, test and validation suites, requirements specifications, and numerous white papers. I've presented a paper on USB audio at WinHEC, the Microsoft sponsored symposium for Windows hardware vendors, and sat on numerous industry computer audio committees and symposiums.

Personally, I have some 50 years of hi-fi experience. I'm also an electronics hobbyist. I dabble in vintage audio gear, mostly Scott, Dynaco, and Heathkit. I have rebuilt some 25 tube amps and about 10 tuners in the last few years. Although I'm not a commercial rebuilder of tuners, my interests and the general lack of information inspired me to write a 60 page document on Scott tuners, their history, care and feeding, and how to align them.

Along with my various tube hi-fi systems, I also enjoy a home theater system, which uses a THX certified Onkyo Dolby Atmos preamp, 11 channel Crown power amps, and a high def front projection video system.

12 Measuring

12.1 FarMedia Shop Equipment

FarMedia is my company for doing sound related business. I'm quite proud of the test equipment roster, as it represents a nice test and analysis suite for audio equipment, both modern and vintage. Here's a shot of the main equipment rack, festooned with the usual cables.

4. The crown jewel: An Audio Precision System One, Dual Domain, model 322 with options for A & C weighting filters. The "AP" is *the* industry standard for audio measurements, and is NIST traceable. Using a computer interface, it can measure and log frequency response, THD, S/N, power bandwidth, RIAA phono and FM eq accuracy, noise spectrums, IMD, and much, much more. It's the boring looking beige box at lower left, and is driven by the notebook computer in the center.
5. Oscilloscopes:
   Tektronix 2465A 350 mhz, 4 channel, and Kikusui DSS 6521 2 channel digital storage scope
6. Signal generators:
   B&K 4040 20 mHz generator/frequency counter w sweep and AM/FM modulation
   Sencore SG165 RF AM, FM, FM multiplex stereo generator, modified for external audio sweeps.
   Leader LSG-231 FM Stereo multiplex signal generator
7. Meters:
   2 Tektronix TEK 254 DMM's. These are 4.5 digit, High accuracy, true RMS meters

Kelvin Pro 400 3.5 digit DMM
Cen-Tech P35761, 3.5 digit DMM, a cheapie
Micronta FETVOM #22-208A
Micronta VOM, #22-204C 25K/ohm per volt
Various purpose built meters: 0 500V, 0-100 mA, 0- 20A DC, 0-5A AC, etc
Fluke 80TK Temperature probe

8. Capacitor testers
   Sencore LC-53 capacitor and inductor measuring
   Heathkit IT-28 - mostly used for reforming these days
   EDS Capanalyzer 88A (finds bad electrolytics in-circuit)
9. Tube testers
   Hickok 600A
   B&K Model 700 - measures both halves of dual envelope tubes at once
   EICO 635 cheapie go/no go tester.
10. Shop speakers
    RS Minimus 7
    ADS L100 (4 ohm)
    NHT M-10 studio monitors
    Sony MDR-7506 headphones
11. Shop Amps
    NAD 3020
    Dynaco Model 70
    Scott LK-72B, 222-C
    Crown D-75A
12. Misc.
    2 Custom built 250 watt 8 ohm speaker loads and watt meters
    Weller WTCPN soldering irons, temperature regulated, anti-static, 700 and 800 degree tips

12.2 AC power

For precision lab testing, it is imperative to have a clean source of power with a good ground. Since the power company does not supply clean power, great care must be taken to create and maintain it. To this end, the test bench has 2 dedicated 20 amp circuits that feed an industrial grade Marway filtering and distribution box.

- Circuit A is the electronics circuit. The shop electronics and the unit under test are all attached to circuit A through a GFI. The unit under test is plugged into a custom built AC power line monitor box w voltage and amperage metering, fast blow fusing, and a DPST AC isolation switch, which is in turn plugged into a General Radio W10MT3 Variac –(0-140VAC @10 amps), which is in turn plugged into a secondary filter stage to isolate the unit under test from any ac line noise from the test equipment..
- Circuit B is for lighting, soldering irons, drills, and other electrically noisy equipment.

This circuit separation helps prevent local noise from being injected into the electronics and unit under test.

13 Listening

13.1 Musical preferences

I listen to jazz, folk, classical (chamber, big orchestra, some opera) classic rock, world, celtic, new age, and blues. Actually, I listen to almost anything except country & western, rap, or heavy metal.

Some perennial favorites are Dire Straits, Allison Kraus, Ha-Na Chang, Clanad, Enya, C.S.N., Judy Collins, Manheim Steamroller, Steely Dan, Eva Cassidy, Diana Krall, Cowboy Junkies, The Byrds, Miles Davis, Roy Orbison, and Eric Clapton. I'm particularly fond of the new RCA "Living Stereo" releases on SACD.

13.2 Listening equipment list

13.2.1 Speakers

Sound Dynamics SDS 3, NHT M-10, Cambridge Soundworks Newton M-50, Alesis Monitor Ones and Point Sevens, Infinity Primus 150, ADS L100, Minimus 7's, Sony MDR-7506 headphones

13.2.2 Amps

- Rebuilt Dynaco Model 70, rebuilt Dynaco Mark IV monoblocks, rebuilt Scott 222-C, rebuilt LK-72B, Hafler SE-120, NAD 3020, rebuilt Heathkit AA-100. With a few exceptions, I prefer tube audio amps for their lack of listener fatigue and all around pleasant sound.

13.2.3 Preamps

- Rebuilt Dynaco PAS-3, Technics SU-9070, Nikko Beta 30

13.2.4 Signal sources – Analog

13.2.4.1 Tuners

- Antenna system

  A multi element roof mount antenna on a rotor feeds the RF signal through quad shield RG/6 to my distribution amp. The DA then feeds the house splitters and the house RG/6 quad shield network. I use a rebuilt Scott LT-112B and a Sony tuner as reference units to monitor signal quality and multi-path conditions.

- Scott tuner roster: LT-112A & B, LT110A, 370-B, 330-D
- Other tuners: Sony, Yamaha, Rebuilt Dynaco FM-3, Heathkit AJ-32
- Radio Stations – High Quality

  KBOQ classic (@ 95.5 FM) - they transmit a high quality signal.
  KUSP broadcasts some live performances from the local college (UCSC) concert hall.
  I also run my own sources into a Leader LSG-231 FM stereo signal generator to enable A/B comparisons with known media.

13.2.4.2 Vinyl

Sherwood ST-874 Turntable with a Micro Acoustics 2002e cartridge

13.2.5 Signal Sources - Digital

- CD Players: Sony CDP 515, Sony CDP-361
- Other digital sources, Denon DVD-1920 (plays everything, CD, DVD, DVD-A and SACD); Pioneer DV-563A (another multi-format player); MP3's ripped at 256 kbps or higher, typically played through a Motu 828 MkII Firewire interface; Apple iPod*

14 Authors Audio Philosophy

Here's a favorite quote:

"If it measures good and sounds bad,--it is bad.

If it sounds good and measures bad,--you've measured the wrong thing".

(Widely attributed to Daniel R. von Recklinghausen, Chief Research Engineer, HH Scott Company)

It is important to understand that fancy test equipment is best used as a metric of quality, a gauge for repeatability, and finally, as a way to ensure a unit is performing as when it left the factory.

On some occasions a unit will measure great and sound poor. That is where listening tests come in. There are subtle characteristics that measurements may not catch, but will be apparent to trained ears. Unfortunately, listening test are quite subjective, and must not be relied on exclusively either. Only when you use a combination of lab and listening tests are you likely to get to the heart of the matter.

So, my philosophy about audio gear is pretty simple. The gear should operate smoothly, safely, and be reliable. It should be free of noise artifacts, measure well, and last but not least, sound great.

I typically only make very minor modifications for safety or modern convenience reasons, and I tend to take a dim view on modifications that require new holes, especially in the faceplates.

14.1 A few words on parts

Once a part meets all basic criteria for safety and reliability, there is often the wish to use the "right" part to achieve musical nirvana. I feel most such claims are over inflated, but to be fair it is because I can neither hear nor measure their supposed benefits. Here is a summary on my views on the usual highly contested parts.

14.1.1 Capacitors

I can hear a difference between polyester and polypropylene capacitors; the former sound harsh to my ears. However, I don't typically use boutique capacitors; as I don't hear a difference between them and good quality mass produced ones… and I can't afford the boutique ones anyway. I tend to use Orange Drops, Solens, Xicon, and Illinois Central capacitors in my rebuild work.

14.1.2 Resistors

I usually use carbon film in the signal path, metal films in places where thermal stability is critical. I do not hear significant differences in resistor types, other than noise caused by defective resistors.

14.1.3 Wire

I do not profess to hear the difference between fancy stuff and generic copper wire, so I just use 600 volt rated copper wire on my rebuilds. In some cases, I use Teflon coated for its heat resistance.

14.1.4 Cabling and connectors

I do not profess to hear subtle differences between high end cables and standard good quality cables, a statement that applies equally to power cables and speaker cables. I do, on occasion hear differences in low level signal cabling; but I believe all such cases have been related to RFI, AC hum, and handling noise. In other words, a good quality low noise interconnect is important for small signals. Large signal connections mostly need reliability, durability, and low resistance.

With that in mind, I use:

A variety of standard grade cabling for line levels, mostly generic RCA patch cables. I like gold plated connectors for their corrosion resistance, not because I hear a difference between gold and tin.

- 14 or 12 gauge stranded copper wire for speakers, typically with dual bananas.

- I see nothing magical in IEC AC cords and jacks. They are merely convenient ways to manage power cords for shipping, international, and maintenance work.
- I find it difficult to understand how 6 feet of magic AC cord can overcome the effects of dozens of feet of AC power Romex, circuit breakers, line noise &hash, and all other assorted household wiring elements.