

Telefunken E 1501 Adventures

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2/13/05

For some time I have been wanting one of the fine German communications receivers to play with. First I thought I wanted a Rohde & Schwarz EK 070... until I found out how much they cost. I am sure they are fine receivers, but in terms of performance I don't believe they can equal my #1 ranked venerable R-390A's, or my #2 ranked highly modified IC-746Pro's, or even my #3 ranked NRD-525's or #4 ranked WJ-8711A (which is actually marked WJ-8711 HF Receiver). I could have another WJ-8711A for less money than an EK 070 would cost me! Or 5 more near mint EAC R-390A's!! Next I thought I might try an EK 056/4... until I found out how much it weighed. Then I was somewhat tempted by an EK 071, which is an EK 070 with push button tuning, for a fairly reasonable \$1300 (more or less)... but thinking about all that button pushing to tune it turned me off. Having considered every R & S that interested me, I started thinking about Telefunken. But if Rohde & Schwarz receivers are difficult to get information about, Telefunken are well kept German secrets. And if high end R & S receivers are merely costly, high end Telefunken receivers are outrageously expensive. Depending on who you talk to, used E 1800/3 (1985 vintage) receivers may go for anything from \$7,500 to \$15,000. Gasp!!! And they are not DSP. Even lowly E 1501 (1979 vintage) receivers generally go for around \$1400 on eBay Germany. The Siemens CHR 531 also struck my fancy, but I have not been able to learn much about it, except that prices vary wildly.

It seems to me that the E 1501 has a somewhat reasonable price to performance ratio compared to the other fine German receivers. So with barely enough information to be dangerous, I thought I might bid on an E 1501 on eBay Germany. Sure enough, one showed up after a few weeks. Or did it? It looked like an E 1501, but it was advertised as an E 1500. I really wanted to bid on it because it had just the BW's I wanted, 6 and 3 AM, and 3 USB and LSB, and 600 Hz CW. But I got cold feet because I was unable to determine whether it was an E 1501 or an E 1500, much less what the difference was. Fortunately (?) my friend Bjarne was waiting in the wings and started bidding when I retreated. And he was the high bidder at only 611 Euros. I was really envious at him getting it for such a low price... until we began to learn about the problems. Bjarne is a MW DXer, and his "new" E 1501 was quite deaf in the MW band based on sensitivity measurements by his (and now my) friend Rolf, who picked it up in Germany. I think Bjarne may have been dejected, but I regard such problems as typical of receivers I buy on eBay (USA). Apparently eBay Germany is no different. "It works great" means "we plugged it in, turned it on, and it seemed to work" on both sides of the Atlantic. I told Bjarne to send it to me and I would fix it. So he did. And I did. The following is an abbreviated account of what happened.

Bjarne's E 1501 arrived shortly after New Year's Day 2005. It looked similar to the photo below, which I borrowed from www.swl.net/oe1002419/E1501/E1501.htm. For specifics on Bjarne's E 1501 go to www.kongsfjord.no/, read his description, and see his photos. Basically Bjarne's E 1501 had a larger and heavier tuning knob, one less filter, and some of the plastic nut cover inserts on the knobs had been roughed up by a previous owner. As you can see, there is a gap (90 mm, about 3 inches) between the front panel and the plug-in modules. The front panel can be completely removed and (with an appropriate cable) operated remotely from the main frame. In addition to the tuning knob, there are 6 small rotary switches, 8 larger toggle switches, and one smaller ON/OFF toggle switch. The analog S-meter is large and easy to read. The LED frequency display is bright, sharp (the blurred display in the photo is due to the photo, not the display), and easy to read. The RTTY tuning indicator to the right of the frequency display also

serves as a tuning indicator in AM mode. There is a standard headphone jack, and two banana plugs also for headphones. There is a toggle switch inside the (removable) power supply module which selects 110 or 220 VAC operation (+/- 10%).



I removed the power supply module, toggled the AC power to 110 VAC, re-installed the power supply module, and fired up Bjarne's E 1501 using a VARIAC set to 110 VAC. Then I used an N to BNC connector adapter to connect it to my antenna array. Sure enough, it was quite deaf in the MW and LW bands using the <1.6 MHz antenna input and became progressively more deaf as I tuned below 1400 kHz using the >1.6 MHz antenna input. No surprise here... this is what Bjarne and Rolf had already told me before it was shipped to me. However, it seemed to work quite well above 1.6 MHz... excellent recovered audio, excellent sounding filters, and excellent sensitivity.

I have never understood why receiver designers desensitize the MW and LW ranges of their receivers. Usually they just add an attenuator for those bands. But Telefunken used two separate mixers, one for >1.6 MHz and one for <1.6 MHz. Switching between the two mixers is supposed to be done automatically using a diode switch. For whatever reason, there was no switching voltage at the diode switch when the E 1501 was tuned below 1.6 MHz (as there should have been). I was not really interested in finding the cause of the diode switch voltage failure because the <1.6 MHz sensitivity was 7 dB worse than the >1.6 MHz sensitivity according to the E 1501 manual. Instead, I planned to use the >1.6 MHz signal path for all frequencies by removing the 1.6 MHz cutoff high pass filter which was designed into the >1.6 MHz signal path, and to modify the RF amp and mixer if necessary for improved MW and LW sensitivity.

Bjarne's E 1501 was resensitized by the end of the day of its arrival. Here is what I wrote Bjarne late that night. Sensitivity (6 kHz nominal BW, usual parameters) varies from 1.0 uV at 200 kHz to 1.3 uV at 500 kHz to 0.7 uV at 1700 kHz to 1.0 uV at 10 MHz. Throughout most of the MW band sensitivity is about 0.7 to 0.8 uV. Excellent. The 1st LO is extremely clean. There are no (= zero) spurs in the MW band. I found 3 weak spurs between 250 and 200 kHz and one around 170 kHz. Excellent. Intercepts: 3rd order is about +13 dBm in the MW band. Not great, but not bad either. I doubt you will hear any 3rd order intermod at your location with the E-1501. 2nd order is not as good, about +35 dBm, so you may hear some 2nd order intermod on the European frequencies at your location. But I don't believe the low 2nd order intercepts would have any serious impact on the vast majority of your MW listening. If it did, you could always use one of my super duper MW filters.

The resensitization mod is described below, but first here are some other important receiver

measurements for the E 1501... Selectivity measurements: 6.2/8.0 kHz at -6/-60 dB for the 6 kHz nominal symmetric BW for a 1.29:1 shape factor, 3.0/4.7 kHz at -6/-60 dB for the 3 kHz nominal symmetric BW for a 1.5:1 shape factor, and 3.0/4.2 at -6/-60 dB for the 3 kHz nominal USB and LSB BW's for 1.4 shape factors. Excellent filter BW's and shape factors. Phase noise measured using the 6.2 kHz BW filter at 10 kHz offset was -122.9 dBc/Hz. Excellent. I also measured the phase noise at 20 and 30 kHz offsets and got -129.9 and -134.9 dBc/Hz respectively. I repeated the measurements with the 3.0 kHz BW filter and got -123.7, -130.7, and -135.7 dBc/Hz. These measurements showed that the 6.2 kHz BW filter stopband attenuation is at least 85 dB, and the 3.0 kHz BW filter stopband attenuation is at least 89 dB. Excellent 1st LO phase noise, excellent filter stopbands.

E 1501 Resensitization Details

As mentioned above, resensitization of the E 1501 below 1.6 MHz is, for the most part, removal of the high pass filter in the >1.6 MHz signal path. I don't understand why Telefunken put a fixed (non-switchable) high pass filter inside the E 1501 for the >1.6 MHz signal path. Crazy. It should at the very least have been made switchable (mechanically) by a switch on the rear panel. In the E 1800 series they used a single mixer and (automatically) switched 1.6 MHz high and low pass filters. That could also cause problems if the automatic switching failed as it did in Bjarne's E 1501.

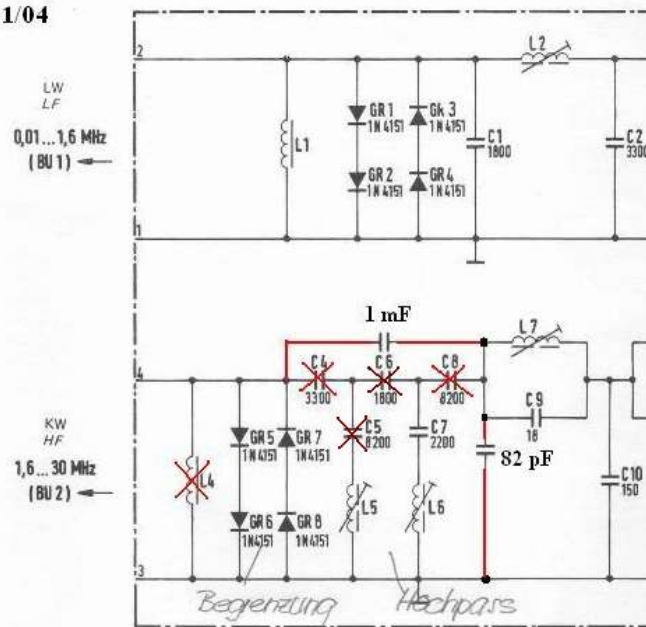
Conceptually, removal of the high pass filter is routine, as can be seen by inspecting the partial schematic here. Two more capacitors are removed than is necessary to make space for the added 1 mF 50 volt capacitor.

This is apparent from the photographs which follow. After completing the high pass filter removal and removing R19 (in case the automatic switching somehow started to work again), I measured the modified E 1501 sensitivity at several MW and at LW frequencies down to 100 kHz. Then I replaced the original RF amp input transformer with one designed for flat response to well below 100 kHz (you can see the replaced transformer in Figure 3... it is white).

No further improvement in sensitivity down to 100 kHz was observed, suggesting that the transformers in the >1.6 MHz signal path are good to at least 100 kHz. I did not measure sensitivities below 100 kHz.

E 1501 High Pass Filter Removal

DL 12/21/04



E 1501 High Pass Filter Removal

DL 12/21/04, rev. 2/7/05

The antenna, ground, and signal feed through connections are unsoldered so that the PC board can be removed in order to remove the five capacitors and the toroid inductor. This includes (1) - (4) the ground wires and center

conductor wires of the antenna connectors, (5) the blue capacitor from the center conductor of the >1.6 MHz connector to ground, and (6), (7) the wire with ferrite bead and the mini coax which pass through the bulkhead (they should

be "destructively" removed and replaced by new wire and mini coax when the filter board is reinstalled). The four black capacitors and green toroid inductor are removed after the PC board is removed.

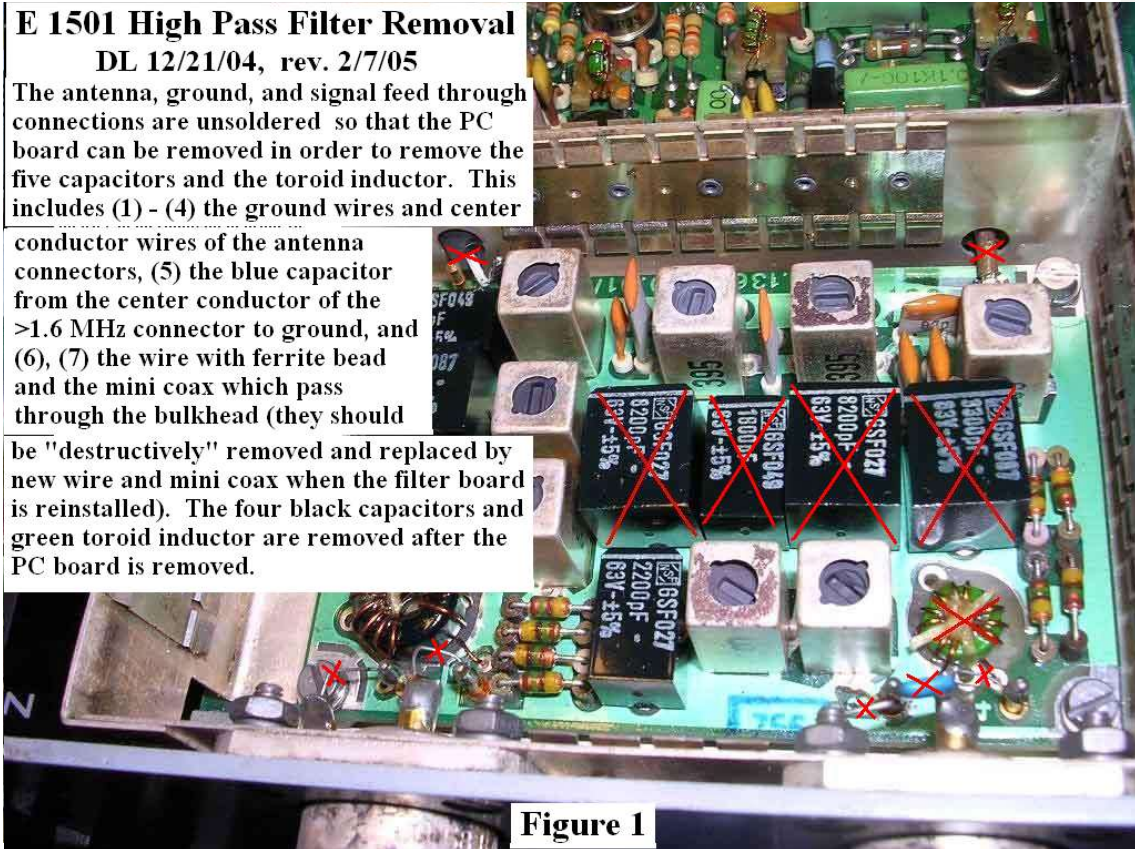


Figure 1

E 1501 High Pass Filter Removal

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After the PC board is removed, the 5 capacitors and toroid inductor are removed, the 1 mF and 82 pF 50 volt capacitors are installed as shown, and the PC board is reinstalled. A new short length of mini coax is fabricated and installed. Reinstallation of the wire with the ferrite bead is moot because the <1.6 MHz signal path is not used.

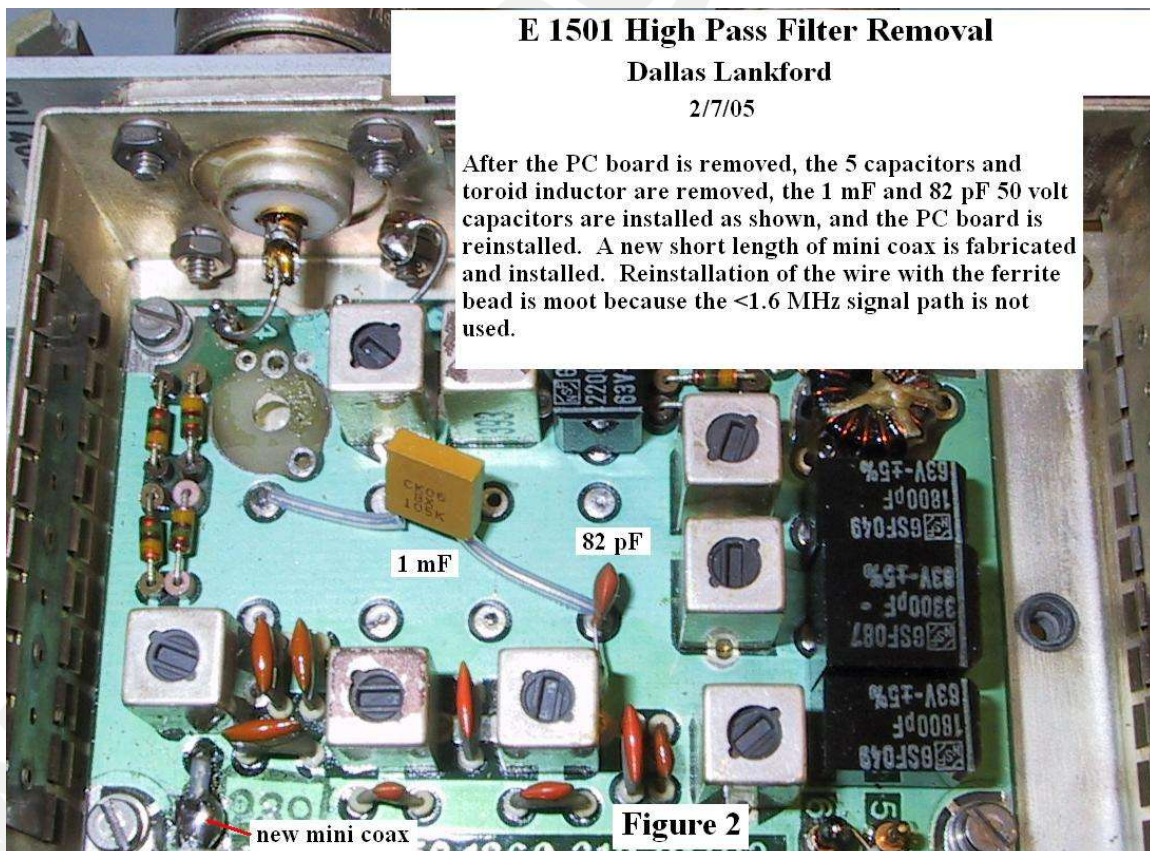
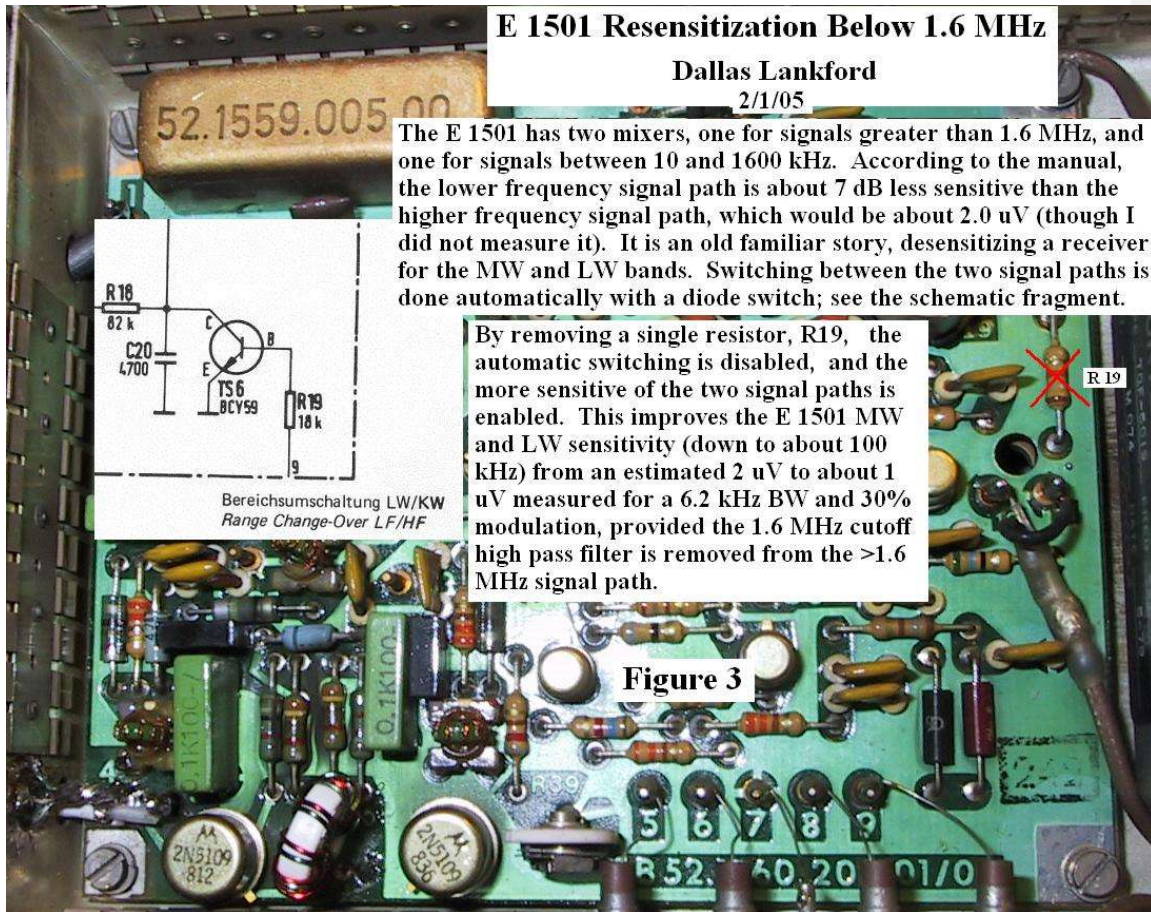


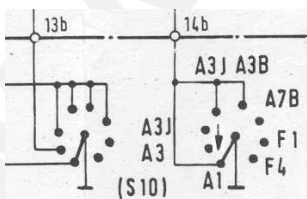
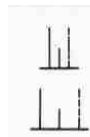
Figure 2



With these changes, the E 1501 is quite sensitive in the MW and LW bands. Some intermod, presumably 2nd order, was observed at night on clear frequencies below 200 kHz. I am sure these could have been eliminated with a 500 kHz low pass filter. No intermod was observed in the MW band at my location, though it would probably be observed in high level RF environments. But as I said above, a good tuned MW band filter would fix that.

AGC Mod

In AM mode there is only one AGC release time, fast. This means the recovered audio when using AM mode is less than good for graveyard MW signals and strongly fading MW and SW signals. That's the bad news. The good news is that one of the RTTY toggle switches, the third switch from the right (right hand switch of the 2nd pair from the right), can be used to provide fast and slow release times for AM mode. The icons on the switch are shown at left. If I remember correctly, there are two wires going to the switch. I removed both wires, trimmed off the bare ends so that they would not make contact (so the switch was turned off), and tied both of them to a nearby wire bundle with nylon cable lacing. Then I visually found the lug of the mode switch which enabled the slow release AGC in CW mode, indicated by the down pointing arrow at left, and ran an insulated wire from that lug to the center lug of the toggle switch, and another wire from the lower lug of the toggle switch to a grounded lug on the switch. With the toggle switch down, all modes are normal; with the toggle switch up all modes are slow release. With these changes, the E 1501 is a really



fine receiver, right up there with the best of them.

The only down sides I found with the E 1501 were its knobs, front panel removal, and battery. The shafts are 6 mm, not 1/4 inch diameter, which means knobs available on this side of the Atlantic won't fit properly. In addition, the knobs are attached to the shafts by lock nuts (like pot shaft lock nuts) which are hidden behind press fit plastic covers. The nut covers of Bjarne's E 1501 were damaged, indicating that the knobs had been removed at some time in the past by someone who did not know what they were doing. Also, the nuts required a special thin wall 10 mm socket with little or no lip which you won't find at your local auto parts dealer or hardware store. I fabricated one by grinding down the wall and lip of a standard 10 mm socket and polishing it to a smooth finish. Front panel removal (to replace switches and headphone jacks, etc.) requires that all knobs be removed, a non-trivial task. The battery (so that the receiver comes on at frequency it was turned off at) is non-standard (5.6 volt 500 mAh mercury) and discontinued; there are no substitutes as far as Bjarne and I have been able to determine. However, the receiver works fine without a battery; Bjarne's merely comes on at 1223 kHz. Curious. RA6778C's I have had with dead batteries or no batteries came on at 00 000.00 kHz. But other receivers with dead batteries won't operate at all. So I don't know if other E 1501's will operate with dead or no batteries. If need be, I believe that I could come up with some kind of mod so that other batteries could be used with the E 1501.

As I said above, an E 1501 is right up there with the very best communications receivers provided (1) the AGC is modified to allow front panel switchable fast and slow AGC for AM mode, and (2) the high pass filter is removed, and (3) the automatic diode switching is modified to enable the >1.6 MHz signal path at all frequencies. The AM and ECSS filters with ideal (in my opinion) BW's, excellent shape factors, and excellent stopband attenuation are outstanding, and sound like it when using the E 1501. The excellent 1st LO phase noise (or perhaps I should say composite noise) and almost total absence of spurs are wonderful (and necessary to enjoy the full benefits of the excellent filters). And there is no (N O no) microprocessor crud. Recovered AM audio in both AM and ECSS modes is simply great. The E 1501 is quite stable; that together with the excellent filters makes ECSS reception excellent. Bjarne observed to me, and I agreed, that AM mode sounds more like AM synchronous detection than ordinary AM detection. The E 1501 manual states that the AM detector is an envelope detector. When I looked on the appropriate schematic, I did not see an ordinary diode detector, but what appears to be a full wave rectifier AM detector. As pointed out by K2CU in his article on full wave AM detectors (see www.amwindow.org/tech/htm/alowdisdet.htm), these detectors have less intermod distortion than ordinary diode detectors. This seems to explain why the E 1501 AM detector sounds so great. For AM DXing I would definitely put the E 1501 right up there with my top 3, my R-390A's, my IC-746P's, and my NRD-525's. At that level it is difficult to place one ahead of the others, and in fact there will be situations where any one of them will edge out the other two. I did not have Bjarne's E 1501 long enough to observe it edging out the other 3, but I suspect it eventually would have in a few difficult listening contests. Bjarne's modified E 1501 gets two thumbs up from me.