Natural Radio

News, Comments and Letters About Natural Radio

June 2001

Natural Radio Activity Is Up April and May were good months for Natural Radio. It seems that as soon as the coordinated listening weekends were over, lots of activity started happening. Shawn Korgan E-mailed same good recordings and Jim Mandaville had good results on April 16-17.(See correspondence)

I usually head out to my nearby quiet site when the K_p Index goes over five. Whistlers are scarce here, but this is probably due to the fact that I can't get into any of my listening sites before 8 am. But the amount of chorus I hear makes up for the lack of whistlers. On May 12, I was able to make some good recordings of some very loud chorus with risers and jet-plane type sounds. My latest reading on the causes of chorus indicates that much of it is generated around the geomagnetic equator on the dayside of the earth. There also seems to be a direct relationship between the intensity of the chorus and the amount that the magnetosphere is being compressed by the solar wind, which is a factor of its speed and density.

The correlation between solar wind and chorus was made by space based observations and my be different for observations on the surface of the earth. I am going to try to correlate future observations with solar wind speed and meanwhile do some more reading on the latest research. For real-time information on the solar wind, go to the *Space Weather Now* website at http://www.sec.noaa.gov/SWN/index.html.

I will be heading off to Canada shortly after you read this and hope to get some good listening in as our camp is about 20 miles away from any commercial power lines. With a little luck, the weather will be dryer than last year and we won't be wading through ankle deep mud.

Receiver Design Scott Fusare sent in an addendum to his article on receiver front-end design which will also be available on the club website. Dave Ewer is also working on an article and some new ideas for front end design. See the correspondence section.

Dayton Hamvention I just returned from the Dayton Hamvention this past weekend. My son Jeff was exhibiting a new Webpage editor so we had Exhibitor passes which included on-site parking and also a booth to sit down in to rest once and a while. Friday produced massive rain that pretty much closed down the outdoor sales. Saturday and Sunday were without rain and allowed one to indulge in hardware overload at the massive outdoor flea market. I saw hardly anything related to LF Radio, other that the Radio Society of Great Britain was there with their new LF publication, as well as all their others. I didn't even see any LF Radios in the outside flea market.

However, for those of you who are into construction projects, Debco electronics was selling cast aluminum project boxes at a good price. They have three sizes and they are available over the web at http://www.debco.com/db_online/index.htm. If you don't have web access write them at Debco Electronics, 4025 Edwards Road, Cincinnati, Ohio, USA, 45209.

Your Much Appreciated Correspondence

• **Scott Fusare, N2BJW (sfusare@adelphia.net)** As life with baby has started to fall into a routine I have been able to devote a bit of time to the natural radio hobby.

I want to thank everyone who fed back comments on my article, they are all much appreciated! In particular I want to thank Dave Ewer for all the correspondence and testing he has done. Dave is a one man R&D department, tirelessly building and testing new designs. His work has pointed up a big error in my bootstrapped follower approach.

Dave reported an elevated noise floor with the follower when compared side by side with the common source front ends he normally works with. After building up a receiver that allowed rapid switching between multiple front ends, I found exactly the same. I have spent some time trying to educate myself on the topic of low noise design and this is what I have come away with as a quick and dirty explanation of the circuit's performance. The bootstrapping does raise the input impedance to very high levels and as such has great signal recovery ability. Unfortunately it exhibits voltage gain as far as the thermal noise of the gate resistor is concerned. The resistor I added to prevent this from occurring with the signal, R8, does nothing to prevent gain peaking as far as this noise is concerned. Additionally the overall noise contribution of the gate resistor is made much larger by my efforts at holding shunting capacitance to a minimum. It all adds up to an inferior signal to noise ratio, almost by an order of magnitude. I wouldn't now recommend using my circuit as presented. The article is otherwise, to the extent of my knowledge, correct but bootstrapping is not the answer. I think I have a better approach, but I'll withhold any further rambling until more careful work has been done on my part.

(Editor's note: Here is the addendum to Scott's original article that was published in the February issue of *The Lowdown*.)

<u>Addendum 14.05.01</u>

Correspondence received after this paper was published has brought to light a major flaw with the boot strapped follower approach. Dave Ewer has kindly shared the results of his extensive field-testing and careful side by side comparisons of different front end topologies. His work shows the boot strapped follower to have a poor noise floor as compared with the common source front ends he normally uses. After taking more care in my own testing (simultaneous comparisons were not originally done), as well as educating myself better on the issue of low noise design, this is what I have come up with. Yes, the bootstrapped follower has wonderfully high input impedance at the signal frequencies of interest, recovering nearly the entire signal. Unfortunately the gain peaking mentioned in the text also applies to the thermal noise generated by the

gate resistor. This results in a noise gain peak near 1 kHz. Making matters worse, the phase shift network used to smooth the signal response has no effect on the noise gain. The final nail in the coffin is my attempt to hold shunting capacitance to an absolute minimum, which, quite unintentionally, raises the corner frequency of the Johnson noise contribution from the gate resistor. All of this results in a noise floor that is an order of magnitude (or more depending on the approach) above that encountered when moderate amounts of shunting capacitance are used with no boot strapping. The paper is otherwise correct as far as I know. My goal of recovering as much signal as possible, while not paying attention to noise, is however a grievous error in the signal to noise department which is always the final arbiter. The circuit presented should perform better if the feedback is removed (R8 and C1), the gate resistor value raised to 22M and some 20 to 30 pF of shunting capacitance added to the input (after R9). Additionally R9 should be only as large as is needed to control interference or, if possible, eliminated entirely.

On another topic, I have had some correspondence in which the observation was made that terrible broadcast band and short-wave interference was experienced when using this circuit. Upon further inquiry it became apparent that the output of the follower was being run into a high gain audio amp with no filtering. I must emphasize that the follower, as presented, is meant only as a front end device – not as a complete receiver. Bandpass filtering for the frequencies of interest must be used prior to any substantial voltage gain. The response of this circuit, especially without R9, extends well into the HF bands and perhaps higher. It will happily pass along powerful AM and short-wave signals that will end up being demodulated somewhere along the line only to completely obliterate the natural radio signals we are after.

- **Dave Ewer (vlfun1@aol.com)** I had an unfortunate setback on the proposed frontend article to suppress AM demodulation. just when I thought all was nailed down tight the worst LORAN hit me I've seen here in over 2 years. I couldn't run the stage wide open without all the first order gate input filtering nor could I get the stage to deal LORAN a beating with just 100 or 200 pf after a 10K series resistor on the input. it took a full 1000 pf to shut it down and the funny thing is it only lasted two days -- after that I was back to no capacitance to ground again. I've been talking with Scott Fusare about this project and lots of other projects since February. My proposed stage didn't turn out to be a solve all problems stage for all reasons but certainly an improvement. I'll work that caveat in and get it presentable for a future article.

- **Jim Mandaville (zygo@azstarnet.com)** A newly acquired Sony Minidisc recorder sent me back 16-17 April to the quiet site visited in March in the northeast corner of grid square DM32. (Referred to earlier as Exit 140 on Interstate 8, but which I'll henceforth call by its older and more romantic name, Lost Horse Peak.) Equipment again was the Forgey Mk 3 E-field receiver, using the cabtop 12-ft vertical with an added 20-ft extension off the tip, tied to a cholla cactus. Things looked rather dismal at first, with dense sferics noise and no sign of whistlers.

Things started to come in after midnight, however, and I recorded almost continuously beginning at 0100 LT and on through sunrise, filling two discs (close to five hours in mono mode). All the whistlers were moderately diffuse, and as the background quieted

through the recording period it became evident that they were originating in strong, chunky, non-tweaking sferics, indicating two-hop events originating nearer my end of the conjugate path. There were quite a few multiples, and a few strong enough to produce clear echoes. As sunrise approached, things quieted enough to turn up the gain to the receiver's noise floor. By this time propagation of the causative sferics was lost, (probably through absorption on surface paths) although some whistlers, benefiting from duct propagation, continued to be remarkably strong (and now clearer against the quieter background). The whistlers also became more discrete near and after sunrise, an effect I'd noted before. The last good whistler was recorded 20 minutes after local sunrise, and the second disc ran out 8 minutes later.

Natural Radio Log

Month Day	Time UTC	What Heard (whistlers/hour where applicable)	ID Grid Sq.
04/17	0801-0903	weak diffuse whistlers c. 1/min	JM-DM32
	0924-1008	weak diffuse whistlers, 1-2/min	JM-DM32
	1009-1049	weak - strong diffuse whistler, 1-2/min.	JM-DM32
	1049-1112	weak - strong diffuse whistler, 3/min.	JM-DM32
	1113-1150	weak - strong diffuse whistler, 4/min.	JM-DM32
	1151-1159	weak - strong diffuse whistler, 5/min.	JM-DM32
	1200-1229	weak - strong diffuse whistler, 3/min.	JM-DM32
	1230-1317	weak - strong diffuse whistler, 1-2/min.	JM-DM32
	1318-1326	weak whistlers, <1/min	JM-DM32
05/09	0800-1300	Chorus and many strong whistlers	SK-DM79
05/12	1350-1435	Strong chorus with many interesting sounds	MK-EN52

MK - Mark Karney, N9JWF, Barrington, IL. Equipment - WR-3, LF Engineering loop, homebrew receiver with 60” whip and -24db/octave hi-pass active filter, 350 Hz. cutoff.

SK - Shawn Korgan, Gilcrest, CO. Equipment **-** Homemade e-field receiver I refer to as the SK-1 with 500 feet of antenna wire.

JM - Jim Mandaville Equipment - G.W. Forgey Mark III receiver.