

# Natural Radio

*News, Comments and Letters About Natural Radio*

**September 2000**

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Thanks to everyone who sent in correspondence this month. Michael Mideke and John Davis have some great information on receiver design that builds on last month's discussion. Michael also discusses some Ideas for getting your antenna away from trees and bushes, which as I found last month, may make the difference between hearing and not hearing whistlers.

I still get inquiries from people who are not having much success hearing whistlers. I would appreciate hearing from anyone who has compared loop antennas to E-Field receivers and E-Field receivers with short whips to those with long wires under conditions where whistlers are being heard. Hopefully, I will have the presence of mind to bring out the loop the next time I hear major whistler activity on the E-Field receiver.

***Go West Young Man ...*** Our much anticipated trip out west has come and gone. I'll have to admit at this point that we were probably over ambitious, putting 4500 miles on the van in 12 days. We did enjoy ourselves, though, and food from Navajo Tacos and Indian Frybread to a Chuckwagon Breakfast cooked on the rim of Palo Duro Canyon in cast iron Dutch Ovens.

The "radio expedition" part of the trip didn't meet expectations, however. If I rated the trip in "whistlers per mile" the number would be .0004! Of course part of the problem was our travel schedule, but I found that being in the Southwest doesn't free you from the VLF listening problems of the Midwest. In Texas in Palo Duro Canyon, AC was running down the Canyon and into the campsites. The E-field receiver was useless. However my loop receiver worked well in nulling out the hum, unlike at home. There were thunderstorms in the area both nights and sferics and tweeks were all that was audible.

I had arranged the trip so that we would get to the Very Large Array Radio Telescope Site late in the afternoon so that I could shoot some video footage for the library. We arrived near sunset in a violent thunderstorm. We did get into the visitor center, but I thought it prudent not to take the walking tour. I shot some quick video of the dishes in the sunset, which was visible under the storm, but the proximity of lightning strikes got us back into the car quite rapidly.

The next camping night was at Red Rocks State Park near Gallup, NM. We were more in the open here, but had the same problem with AC. The loop did a good job of removing the hum but only sferics and tweeks were all to be heard.

The site on the South rim of Grand Canyon was a little better removed from AC and I was able to use the E-Field receiver. I heard two diffuse weak whistlers on the first

night and nothing on the second. Again, thunderstorms were in the area and sferics activity was heavy.

We spent our last couple of days in Durango, CO, staying in a hotel rather than camping. I didn't get a chance to do much listening, but we did get into Mesa Verde on the Friday that it opened after being closed for weeks because of the fire. The ruins are awe inspiring. We left the park at 5:45 PM. They closed it to the public at 6 PM and evacuated it at 7 PM because of another fire.

The amount of thunderstorm activity in desert and drought stricken areas was amazing. Thunderstorms can produce much lightning with little rain. A ranger at Mesa Verde told us that the park often endures 100 strikes per day. Thunderstorms out west also seem to just develop and then not move a lot. They don't appear on the horizon and then move rapidly through as they do in the Midwest. At least not the ones we observed. I have quite a different picture of desert climates after this trip.

***Getting Ready For the Fall Listening Season.*** As the fall season approaches we are entering probably the best time of the year for Natural Radio listening. Thunderstorms are on the decline in the Northern Hemisphere and on the rise in the southern. There are still enough beautiful fall days before the snow flies to do some listening. Also as we approach the peak of the sunspot cycle there is a strong chance for geomagnetic storms so check either the web or WWV. I almost missed the storm on August 12. If I had checked the web on Friday, I might have gotten out at sunrise instead of 10:30!

With my two trips this summer I have organized my LF equipment into a field case that I keep in the car so its ready to go at a moments notice. You might want to think about getting your equipment organized as we approach the fall coordinated monitoring dates. Currently, I am carrying all this stuff in a soft case which I realized is a bad idea because inevitably the switches on the equipment get bumped to the "on" position. Of course, then I have to replace a set of batteries. I am currently looking for a hard padded case that will hold all the equipment and not break the bank. To give you some ideas here is a list of equipment I carry.

1. E-Field receiver
2. Portable shortwave radio for receiving WWV.
3. Cassette recorder and cassettes with labels on them.
4. Interconnecting cables
5. Extra batteries ( Very Important)
6. Headphones
7. Ground wire and pointed short ground rod
8. Roll of antenna wire.
9. Notebook
10. Small flashlight
11. Screwdriver to open receiver for battery access.

Expand or modify this list to meet your needs. The point is to be ready if conditions get good or an unexpected opportunity for listening arises.

***In Praise of Radio Shack*** There is a benefit to designing equipment with Radio Shack parts. Early in our trip out west I had my receiver packed in the aforementioned soft case and managed to break off the whip antenna. (Another reason to get a hard case) I went through a few minutes of panic thinking that this was the end of my Natural Radio listening for the trip. Composing myself and realizing that I had built the unit with a Radio shack whip, I headed for the van. I drove out to the Canyon, TX Radio Shack, procured another antenna and was back in business within the hour. Both of my sons came up with some odds and ends they needed, prompting another trip to Radio Shack the next morning. My wife commented that next year we could just vacation at a Holidome near home a make our daily trips to Radio Shack from there.

***Coordinated Monitoring for Fall Equinox (Note Date Change)*** The Fall Equinox falls on September 22 this year. The monitoring dates are September 16 and 17 and September 23 and 24. Please note the date changes – I didn't look closely at the calendar last month, and don't want to exclude those who may be celebrating Rosh Hashanah, so we will be monitoring a week earlier. Sorry for any inconvenience. As a minimum, please monitor and record, if possible, the first six minutes of the hour beginning at 6:00 AM local time. This should be very close to local sunrise. I encourage you to monitor up to three hours before and two hours after local sunrise.

If you are recording, begin each segment with an announcement of your name, date and location. Follow the announcement with a recording of WWV or CHU with their top-of-the-hour time announcement and marker tone. Then without stopping the recorder, transfer the recorder input to your VLF receiver and let it run through the start of minute 6. If you have a DAT, mini-disk, or stereo cassette recorder, it's OK to record the time signals on the alternate channel -- but test the setup for crosstalk first.

If you are not recording, it is important to keep an accurate log. The data will be most useful if it is timed accurately. Use WWV time signals and a stopwatch. Prepare a sheet of lined notebook paper with time and date indicated at the top. Allow 3 or 4 lines for each of the six minutes and mark them from 0 - 5 in the left margin. Start your stopwatch on the hour mark from WWV. Starting at the beginning of the "0" line, record the second at which each event happens followed with a abbreviated description of the event such as "W" for whistler, "T" for tweek, and qualifiers such as big, hissy, long, many, etc. Continue down the line, but remember to move to the next section when minute "1" comes up. Leave space on the right for to indicate chorus, hiss, or any other signals that continue throughout the session. Don't try to log every sferic unless you can write very fast and very small.

If you've recorded, please log your tapes in the manner indicated above.

Send in a copy of your log (please don't send originals). If I receive enough logs to establish some coordination between them, I'll publish a composite report in a future issue of *The Lowdown*. If there doesn't seem to be any coordinated activity, or if the ionosphere doesn't cooperate, I'll publish the highlights of individual results.

***Headphone Limiters and More.*** Shawn Korgan turned me on to a site that is very interesting. The site is named headwize and is devoted totally to headphones and headphone listening. The address is <http://www.headwize.com>.

The site is non-commercial and there is a wealth of information and DIY projects. He sent me the information in response to my comments about putting a limiter in my receiver to knock down the level of the sferics. There is a whole section on limiters at [http://www.headwize.com/projects/limiter\\_prj.htm](http://www.headwize.com/projects/limiter_prj.htm). If you have internet access, this site is worth visiting. There is also information on headphone amplifiers, product reviews, a discussion of safe listening levels to avoid hearing damage and much, much more. Thanks Shawn.

## *Your Much Appreciated Correspondence*

•**John Davis, Warm Springs, GA ([johnhdavis@lwca.org](mailto:johnhdavis@lwca.org))** Dave Laida's notes are an excellent summary of strategic considerations in whistler listening. However, one of his statements strikes me as being a broader generalization about whistler receiver front ends than is always supportable: "Op amps with their active current sources are too noisy and the white noise will mask weak whistlers."

Whether an op amp is suitable or not depends on the particular type of device. Obviously not all will be suited to the task, but when I was involved with professional audio recording, I worked with op-amp based mic preamps that were every bit comparable to discrete designs in noise performance.

Active current sources don't have to be significantly noisier than similar values of resistors, and their effect depends on where they're implemented in the amplifier topology. The noise of a common current source feeding an input transistor pair, for instance, is attenuated by the common mode rejection ratio of the overall device. A current source shouldn't be used as a load, though, until later in the circuit.

Fortunately, it is not that difficult to find acceptable ICs. There are members of the SSM family (now from Analog Devices) that are entirely suitable for low and medium impedance loop receiver inputs; e.g., direct and transformer coupled, respectively.

As for e-field receivers, even an IC as "ancient" as the TL072 may sometimes be OK, though there are better ones now. The limiting factor for most e-field designs is the big honkin' multi-megohm input resistor. Even using the lowest noise resistor you can find, its plain old thermal noise will swamp the IC's internal noise sources, just as it does with a discrete FET. Yes, it's possible to design a discrete input that will be quieter than a typical IC input of the same gain if you short their inputs. But if you remove the short and resistor noise overwhelms the amplifier noise, then what have you gained by going the longer route?

It's worth noting that dynamic range consists of more than signal-to-noise ratio. It also relates to how well weaker signals can be distinguished in the presence of stronger ones, and this depends in great part on amplitude linearity. Op amps make this much easier to achieve.

Impulse noise can be so great that transient response becomes an issue for op amps, but by the time that happens, most discrete designs are out of their linear range anyway. To

the ear, this may make little difference, but it has consequences when one is doing spectral analysis. Input voltage limiting is sometimes a viable option (it can help save your hearing as well!), and there are op amps now with transient response characteristics that are hard for the home builder of discrete circuits to match.

(For the record, I don't recommend IC designs for ELF/SLF monitoring. All but a tiny handful of ICs have subsonic noise that will adversely impact one's work.)

• **Michael Mideke, WB6EER , Benson, AZ (mideke@theriver.com)** There were two concerns dictating the high-end rolloff of the RS-4 whistler receiver. Omega was the first and foremost. However sferics and, I suppose, the upper components of whistlers, passed without rolloff into recorders are capable of producing an earful of fuzzy distortion in the recording but, in the case of cheap or non-professional recorders, not on the monitor. The objective was to produce a receiver that would yield at least semi-clean results in conjunction with any and all cassette recorders. (I experimented with a lot of them.) Even with Omega gone this concern remains. Folks who are building receivers for recording purposes should experiment with their particular equipment and pick a rolloff that leaves headroom for exceptional conditions.

Often the tree and brush problem can be solved with height. Every foot helps and if the whip can be gotten above treetop level just a little bit, the improvement is dramatic. The practical way to do this is to split the receiver into preamp and output units with coax in between. Existing receivers can be modified to accept an external preamp. Then you need some kind of mast. I've made several of these by determining what length of 1x2 I can fit in the vehicle I'm using. Make a bunch of sections that long, drill them top and bottom for 1/4-20 bolts, get a bag of bolts and wingnuts and some lightweight cord for guys and that's it. Works pretty well up to about 25'. If there is a climbable tree handy you can boost the antenna above its top, often with just a couple of the mast sections. Lash the mast to the tree and you're set. Taller, stronger A-frame masts can be assembled the same way. The outboard preamp also gets the antenna away from motor and digital noise sources in the vicinity of recorders, etc.

If you're stuck in the woods and can't get the probe over the top, substitute however much wire it takes. Hum, mechanical noise and AM broadcast overload are powerful arguments against this approach but sometimes it works. I've had best luck when spanning a small canyon or streambed do that a good part of the wire is high and clear and contact with limbs and brush is minimized.

I spend a couple weeks in June in the Eastern Sierras, shooting video and getting from place to place, no strength left over for whistlers. I did have a good day with Steve McGreevy in Lone Pine, heard his new soon-to-be-released whistler CD, which is very nice indeed, especially the auroral chorus from northern Alberta. He's back up there now, going for it in stereo.

• **Shawn Korgan, Gilcrest, CO (Korgans@webtv.net)** I was very pleased to receive a copy of your last article from Steve Ratzlaff that you published in the LOWDOWN about natural radio. I have been listening to and taping natural radio signals for almost

two years now. After receiving the article from Steve I sent off my subscription to receive the LOWDOWN. I can hardly wait for more coordinated listening sessions!

I use a homemade e-field receiver I refer to as the SK-1. I'm part of the INSPIRE team and come in as team #32. If you receive the INSPIRE journal you no doubt saw a few articles about some of the things I recorded last year.

My best recording spot is atop Trail Ridge Road at a height of over 12,000 feet with no trees anywhere and miles from any nearby power. I get up there usually around 3:00 a.m. or so depending on the lightning level which I check before leaving. I use 500' of wire as my main antenna when I'm on Trail Ridge. Up there every lightning strike is a tweek during the night hours.

I see that we are in a major magnetic storm right now. I will have to try and head up right when the storm ends to see what I can catch in the way of vlf activity.

I must have started listening to vlf right when Omega went off the air because I never had a chance to hear Omega except once about twelve years ago when I was fourteen or so and was hooking an amplifier to a wire running up our tree. I had no idea at that time that a person could listen to the whistlers I had read about in a magazine by just what I was doing ... hooking a long wire to an amplifier. I did not find that out until almost ten years later.

As far as I'm concerned right now the best activity for me (unless I love lots of chorus) is when the Boulder K is below 2 and/or possibly when the Boulder A is very high (above 50) because when the Boulder A is high everything (rule wise) might possibly be thrown out the window and then again maybe not. Don't know for sure because I have not listened during many magnetic storms. Possibly the same rules apply that if the Boulder K is around 4 then whistlers stop and chorus begins no matter how high the Boulder A is reading. I do remember when I was listening that day with Steve McGreevy that the chorus and whistlers were coming and going in waves of activity about every 30-45 minutes. The whistlers would start as soon as the hiss/chorus had stopped and the whistlers would stop as soon as the hiss/chorus had started again.

I believe what I was hearing was the Boulder K as it was rising and falling throughout the day. I don't remember what the levels were at. That was several years ago now. Since then I have always heard the same thing happen. As soon as the chorus or hissband begins the whistlers are nearly gone entirely and as soon as the hissband or chorus disappears the whistlers come out of the woodwork. The other day when I heard my first whistler shower on the ground (in my hometown) was when the Boulder-K was at either level 0 or level 1.

• **Jon Wallace, Torrington, CT (jwallace@mail1.nai.net)** I read your comments about wanting someone in the northeast - I just got back from my trip to Acadia Nat'l Park in Maine with no electricity and figured I would let you know that I struck out on whistlers and only heard chorus for a very brief time one evening. I have been listening for about 10 years (in Torrington, CT) on an infrequent basis using, at first, the INSPIRE radio of Michael Mideke, but that needs to be at my quiet site about 20

minutes away, so I got a radio built by Brian Lucas in the UK that allows me to listen near the house. It works great but I read the next year he improved it to hear whistlers from the house so I just bought that one as well.

I have been listening at least once a week for months, near sunset and no whistlers. When my wife and I decided to go to Maine I brought the radio along to try. Wow was it nice without the AC hum!!! Clear sferics and tweeks but again no whistlers (from the 7<sup>th</sup> to the 12<sup>th</sup> anyway). I listened for several minutes about 7 AM every day then for 30 minutes or more (continuously) during the afternoon and about the same near sunset. The intensity/activity was incredibly strong near sunset as compare to the daytime.

## Natural Radio Log

Month Day	Time UTC	What Heard (whistlers/hour where applicable)	ID Grid Sq.
07/28	0600-0630	Strong sferics, tweeks (Canyon, TX)	MK-DM94
07/29	0630-0700	Strong sferics, tweeks (Canyon, TX)	MK-DM94
08/01	0530-0600	Sferics, tweeks (Gallup, NM)	MK-DM55
08/02	0700-0730	Sferics, tweeks, 2 diffuse whistlers (Grand Canyon, AZ)	MK-DM36
08/03	0700-0730	Sferics, tweeks (Grand Canyon, AZ)	MK-DM36
08/06	1130-1206	Strong sferics & tweeks	JL-CN87
	1141	Strong Whistler above hum level	JL-CN87
	1147	Strong Whistler	JL-CN87
	1155	Strong Whistler	JL-CN87
	1206	Weak Whistler	JL-CN87
08/12	1630-1700	Chorus and hiss under strong sferics, this was at the end of a geomagnetic storm.	MK-EN52

**JL - John Lauerma, Issaquah, WA.** Equipment - Homebrew VLF Receiver, 300 Hz - 20 kHz. Homebrew ELF/ULF/SLF Receiver 0.03 to 300 Hz., 47,000 turn loop.

**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.