# Re: help with navtex/medium wave receiver sensitivity and decoding

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- *From*: Tim Wescott <tim@xxxxxxxxxxxxxxx>


- *Date*: Mon, 12 Feb 2007 15:48:48 −0800


bigorangebus wrote:

> On 12 Feb, 19:13, Tim Wescott <t...@xxxxxxxxxxxxxxx> wrote:
>
> > bigorangebus wrote:
> >
> > > Does anyone have any tips on increasing sensitivity for a medium wave
> > > receiver trying to distinguish navtex 170Hz phase shifts on a low
> > > power carrier at 518kHz?!
> >
> > Ive been on and off trying to do this project for my boat for a year.
> > I say off and on, its become most frustrating! I can't use a loop
> > antenna because its just too big and too directional for use on a
> > boat. So I'm currently using a Nasa Marine active aerial (it is just
> > a small plate attached to a standard fet common source driver
> > circuit). I have that going down some coax through capacitive
> > impedance transformer and inductor creating some extra front end
> > selectivity, to the input of a 612 mixer, getting 6kHz IF (after being
> > mixed with a lo). I'm driving the 612 differentially, as its a slight
> > improvement over single ended. From here Ive tried using several op
> > amp filter circuits, and they all perform adequately.

Heres my problem, the receiver just picks up too much noise. Everything interferes with it, even the scan on my oscilloscope. Even
without this, taking the aerial out of the room, the actual noise in
the system is too high to pick up anything but the strongest navtex
signals (which are decoded). Of course AM radio broadcasts are way
above the background noise, and navtex signals are much lower power.
And AM radio has the help of our ears to tune out the noise.

It works better when closer to the transmitter of course, but the
navtex spec says you should be able to pick up stations 400 miles
away, and i'm only just decoding the local one 100 miles away.

So my question is, does anyone know of any special techniques on the
RF side that can improve my noise handling/signal integrity? (my
expensive sony worldband receiver seems pretty good at it on SSB).
And....does anyone know how the upper market receivers get such a good
signal? My receiver just samples the input frequency (as does the
Nasa low end I think), so is very susceptible to any interference.

Grateful and very interested to hear views on this.

Many Thanks
Andy

In spite of the rich detail you've given us, this is still a problem with many interesting dimensions.

Atmospheric noise is very strong at MF, so even with a capacitive probe antenna such as yours it should still dominate. I would start by measuring your signal strength at IF or baseband with the antenna connected, then with the antenna replaced by an equivalent impedance. Ideally you'd see an increase in noise level from 3 to 6dB −− much less than that and your system's inherent noise is your limitation, much higher than that and you've got too much gain ahead of the mixer, which will make it susceptible to distortion.

If its practical I'd do a similar test with the antenna. I'd calculate the antenna's effective capacitance to ground, then replace it with a capacitor of that value from ground to the FET gate. You should see the same 3−6dB increase in noise with the antenna vs. the noise with just the cap connected −− if you don't, then your performance is being limited by the antenna.

After noise, the next thing you need to worry about is distortion. If your active antenna or your mixer are being overwhelmed by strong signals (such as AM broadcast signals) then your desired signal will either be blacked out, or the strong signals could combine in your electronics to generate a signal at your desired frequency. Building low distortion front ends is worth several pages if not a whole book, but the gist of it is that you want to limit your signal's bandwidth as much as you can, and you want to use intelligent design practices. Your active antenna can't do much before the signal hits the FET gate, but you can take Jan's suggestion and put a filter between the active antenna and the mixer. I'd put in an elliptical filter that had good attenuation in the AM broadcast band, to give your little Navtex signal a fighting chance.

Assuming that you're limited by atmospheric noise at the output of your IF, the only thing you can do is to improve your signal processing. I'm not familiar with Navtex signaling, so I can't give you more than general guidance, but here goes:

The nature of the atmospheric noise at MF is _not_ Gaussian. Noise in that band is predominantly from electrostatic discharges both near and far. It has a noise density that is more like a Cauer density, in that for all practical purposes it has an infinite variance. Any sort of signal processing scheme which is based on an assumption of Gaussian noise will be compromised by that assumption.

The best way to deal with MF atmospheric noise is to take advantage of the fact that it tends to occur as 'crackles' or 'hits' that have a high−amplitude, wide spectrum characteristic. In general what one does is to use 'side information' to detect when a discharge event has happened, then discount the data that's collected during that event. This is what noise blankers in communications radios do.

If the Communications Gods are smiling on you then there are clear

channels adjacent to your signal, or Navtex uses forward error correction. In the case of the clear adjacent channels, you can use an IF that's wider than your signal and use a noise blanker. Your signal will go quiet during the crashes, but that non−information is demonstrably better than having huge signals get into your demodulator's filters to mess things up. In the case of FEC, you can demodulate the signal as usual, then look for unusually large filter outputs. When this happens you replace the demodulated bit with an erasure and forward the whole shebang to an error correction algorithm that can benefit from the erasures (and some do, to a significant degree).

I hope this helps.

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Posting from Google? Seehttp://cfaj.freeshell.org/google/

"Applied Control Theory for Embedded Systems" came out in April.
See details athttp://www.wescottdesign.com/actfes/actfes.html

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Further to this...I think I will need to get my hands on a spectrum analyser. My scope is just not set up to read the small signals pre−mixer and is probably just showing its own interaction. Its on max sensitivity reading the output of the mixer, so pretty sure its not being overwealmed. I did once try amping pre−mixer as Ive heard the 612 is not the best noise performer, but i just ended up creating a feedback oscillation randomly! Navtex does have error correction , in that it interleaves the transmitted bytes to detect burst errors, and the spec requires you to receive both before you commit that character to the screen. The problem is the shift is so small 170Hz that you have to have your detection in synch with your local oscillation, which means trying to measure the waveform period (as I do) or using some heavy DSP (which has a theoretical solution for this solution Ive heard). All you need is a little noise, or even a miniscule bit of mains humm to raise and lower the signal and the period measurement goes out of the window. This easily detects burst noise, by presenting periods outside of the expected measurement window.

What is interesting is that the noise as appearing on the scope in time domain at any rate looks the same but bigger when I hold the plate antenna. Of course that could be a red herring as I have no idea what other frequency components there are in there, but the general shape of the background noise in the time domain remains the same.

Ive heard of someone using a large hoop antenna to clear up the

> signal, though thats too directional for my application.
> Presumably with the dominance of the background noise making the
> antenna bigger wouldnt work, but narrowing the bandwidth could.
> However if I narrow it any more I wont be able to pick up the adjacent
> 490kHz local navtex signal (the active antenna is supposed to be dual
> frequency, but only by virtue of having a loose enough Q).
>
> I wonder if there is a better active antenna circuit than the simple
> fet circuit in the active antenna.
>
> Really appreciate your input
> Andy

Demodulating FSK using center crossing really isn't very optimal. If that's what you're doing you'll pick up quite a bit of range just using the two filters method or a discriminator.

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