DESIGN OF AN ELF NOISE PROCESSOR*

by

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Abstract

Noise processing experiments with ELF (3 to 300 Hz) atmospheric noise and signals in the 40 to 80 Hz range are described. The primary purpose of the experiments was to record and analyze wideband ELF noise in order to design the noise processing portion of a receiver which minimizes the required transmitter power. The application of appropriate theory and extensive simulations led to a noise processor which consists of the following functions: (1) a compensating (or whitening) filter, (2) a prenotch filter clipper, (3) notch filters at frequencies of manmade interference (e.g., power lines), (4) a post-notch filter clipper, and (5) a phase-coherent linear matched filter.

The nonlinear processing provides considerable gain relative to a linear receiver (i.e., a receiver consisting only of a matched filter and appropriate whitening filters). It is convenient to measure system performance in terms of an "effective noise level" which is equal to twice the received signal energy divided by the signal to noise ratio at the matched filter output. For example, the highest effective noise levels observed at 45 Hz with the nonlinear processor were about -134, -131 and -137 dB wrt 1 amp/m $\sqrt{\text{Hz}}$ using Saipan, Malta and Norway data, respectively, compared to 1 percent exceedance levels of effective noise for the linear receiver of about -115, 115 and -130 dB wrt 1 amp/m $\sqrt{\text{Hz}}$ respectively.

*This work was sponsored by the Department of the Navy.