

# DASI2 HamSCI Whistler Catcher VLF Reception System

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## Abstract

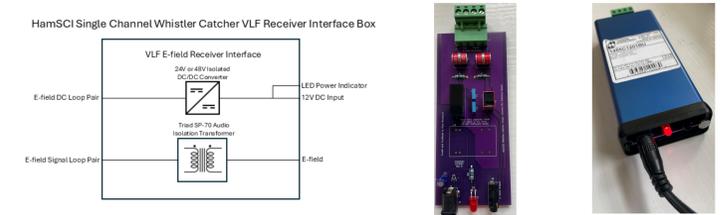
The Whistler Catcher VLF Reception System is a very low frequency software defined radio (VLF SDR) system. It utilizes an open hardware, open software, and open data design and philosophy to facilitate and promote citizen science in the study of VLF phenomena; including the Earth's natural radio emissions, VLF amateur radio transmissions in the 8270 Hz and 5710 Hz bands, and lightning stroke location. The system consists of both hardware and software. The hardware consists of VLF Active Antenna along with a VLF interface box to supply power and interface the signal; a GNSS interface box to provide a pulse per second (PPS) signal for the purposes of frequency calibration and timestamping; a Behringer UMC202HD USB audio interface for data acquisition, and a thin client PC with serial port. The designs of the VLF Active Antenna, VLF Interface Box, and GNSS Interface Box are all open hardware. The software includes vlfrx-tools, an open-source software toolkit primarily for the application of VLF signal capturing, calibration, timestamping, filtering, storage, live listening, retrieval, visualization, EbNaut amateur mode decoding, and other signal processing functions in over 30 individual program utilities. It was written by Paul Nicholson G8LMD [SK], a passionate VLF enthusiast to which the Whistler Catcher VLF Reception System is dedicated to.

## VLF Active Antenna



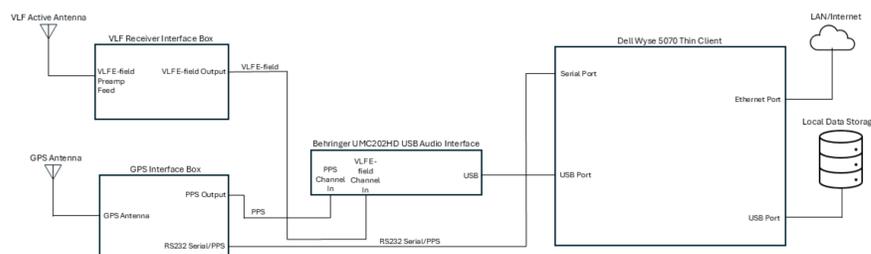
The VLF Active Antenna consists of an antenna element and VLF E-field preamp encased in a PVC pipe. The antenna element is copper tape applied to a foam insert. The foam insert fits snugly into the PVC pipe and is used to dampen microphonic vibrations due to wind. The preamp circuit contains a high impedance AD723 frontend, some filter networks, and an LT1010 line driver. It's powered via an XP Power IP2415S isolated DC-DC converter and includes a Triad Magnetics SP-70 audio isolation transformer to maintain both power and signal feed isolation.

## VLF Interface Box



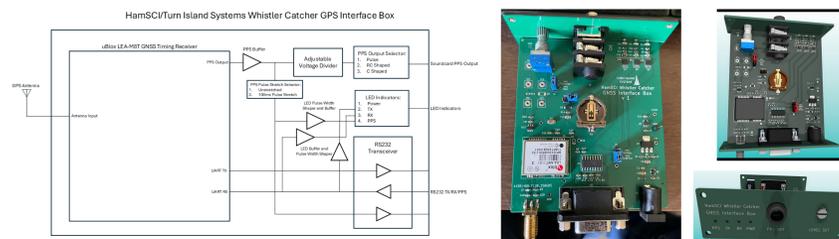
The VLF Interface Box connects to the feedline of the VLF Active Antenna. It provides 30VDC power via an XP Power IP1215S isolated DC-DC converter to power the E-field preamp. It also provides an interface for signal output via a Triad Magnetics SP-70 audio isolation transformer. Power is provided by a 12V linear wall wort supply and signal is routed via a 1/8 phono jack. A power LED is used as a power indicator. The signal output connects to channel 2 of the UMC202HD USB Audio Interface.

## System Overview



The hardware consists of a VLF Active Antenna comprised of a VLF E-field preamp and antenna element enclosed in a PVC pipe; a VLF Interface Box to provide power to the VLF Active Antenna and a signal output feed; a GNSS interface box that contains a GNSS timing receiver which provides a PPS output and RS232/PPS interface; a Behringer UMC202HD USB Audio Interface with the GNSS PPS connected to channel 1 and the VLF signal connected to channel 2 that performs data acquisition; and a Dell Wyse 5070 Thin Client with the GNSS RS232/PPS Interface connected to the serial port and the UMC202HD connected to the USB port. The thin client PC runs Debian Linux as well as vlfrx-tools software, GPS Daemon, sox, gnuplot and other supporting software. Data is captured and analyzed as well as streamed over the Internet/LAN and stored locally on a USB drive.

## GNSS Interface Box



The GNSS Interface Box utilizes a uBlox LEA-M8T GNSS timing receiver and provides a buffer driven pulse per second (PPS) output via level-adjusting potentiometer to a ¼ phono jack which connects to channel 1 of the UMC202HD USB Audio Interface. vlfrx-tools software uses the PPS in the audio stream for both frequency and stream timestamp calibration. It also provides an RS232 interface with PPS on the DCD pin that connects to the serial port of the thin client. GPS Daemon communicates with the GNSS timing receiver via serial and provides access to live GNSS information. It also uses the PPS serial driver to provide PPS to ntp daemon via shared memory driver. ntp steers the system's time of day to the PPS reference which is needed for best accuracy in vlfrx-tools vcard. The circuit, PCB, and case was designed in conjunction with Paul Elliott WB6CXC of Turn Island Systems and donated to the project. The project authors want to recognize and thank Paul Elliott WB6CXC for his amazing contributions.

## Project Dedication and Gratitude



The HamSCI Whistler Catcher VLF Reception System is completely and solely dedicated to Paul Nicholson G8LMD [SK], a passionate VLF enthusiast whose contributions to this project and the VLF Community are innumerable. Paul pioneered VLF reception techniques at home for the VLF Community which allows the VLF radio amateur, student, researcher, and anyone else who is passionate and interested to produce science-grade data and observations of VLF phenomena. Paul's biggest contribution, in addition to VLF reception techniques, is vlfrx-tools, an open-source tool kit of 48 individual utilities that allows the use of high-quality commodity hardware and GNSS receivers to make these high-quality, science-grade observations of VLF phenomena, including automated detection of whistlers and dawn chorus, a mains hum tracking filter, and sferic time of group arrival for lightning location calculation. Paul's other biggest contribution, the hardware and software for the Indian Lightning Detection Network (ILDN), is the biggest inspiration of this project. Paul's contributions simply cannot be understated, and this project's goal is to not only continue Paul's work, but to make the world a better place because of it, as Paul always did.