The Stanford University ELF/VLF Receiver

A tmospheric
W eather
E lectromagnetic
S ystem for
O bservation
M odeling and
E ducation

Data guide
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The following document is intended to describe how to find, read and manage the data generated by the AWESOME receiver.

There are two types of recordings made by AWESOME. The first is broadband. Broadband saves the waveform received from antenna exactly as it was digitized, at the full 100 kHz sampling rate. It thus includes information at all frequencies between the systems cutoffs (300 Hz – 47 kHz). Broadband data is very large, however, taking up 1.5 GB per hour. As a result, broadband data is usually saved in a limited format. For instance, the "synoptic" format can capture selections of broadband on a periodic basis, for instance, one minute out of every 15. However, for larger scale broadband recordings during special campaigns or experiments, the "continuous" option can be used to record entire chunks of data.

The second type of data is called narrowband. This simply involves taking the amplitude and phase, separately, of a single narrow frequency range, specified in the software, and usually corresponding to the frequency of a VLF transmitter. Such data is generally saved in two different resolutions, hi-res (50 Hz), and low-res (1 Hz). Narrowband data takes up a much smaller amount of room, ~1MB per hour, per transmitter, and for this reason most of the day can be recorded in a continuous fashion, even when as many as 15 transmitters are being monitored.

During recording, all the data is placed in the VLF_DAQ folder, under the VLFData section. This is then divided into folders for each of the data types: Continuous, Synoptic, Narrowband, FTP, FTP_Save, Spectrogram. Continuous, Synoptic, and Narrowband recordings contain data that are being stored locally, and not sent over the internet. However, the FTP folder contains data that is intended to be sent over an ftp channel to the specified server. It is thus important that this folder be left unmodified, that the data not be moved, else the ftp transfer will not be successful. The FTP_Save contains data that has already been sent over FTP, and thus is available to be taken elsewhere.

The files are named as follows:

File Naming Convention

Narrowband Files
XXYYMMDDHHMMSSZZZ_ACCT.mat

XX – Station ID (from Station Information Dialogue Box in software)
YY – Year
MM — Month
DD — Day
HH — Hour
MM — Minute
SS — Second
ZZZ — Transmitter Callsign (from software)

A — zero-based index of the ADC card that was used
CC — zero-based index of the software channel number that was used.
T — Amplitude/Phase or Lo/High Resolution. A corresponds to Lo resolution (1 Hz sampling rate) amplitude, B corresponds to Lo resolution (1 Hz sampling rate) phase, C corresponds to high resolution amplitude, D corresponds to high resolution phase.

Broadband files
XXYYMMDDHHMMSS_ACC.mat
XX – Station ID (from Station Information Dialogue Box
YY – Year
MM — Month
DD — Day
HH — Hour
MM — Minute
SS — Second
A — zero-based index of the ADC card that was used
CC—zero-based index of the software channel number that was used.

The files are saved in a Matlab-ready format. They can be loaded directly into Matlab, though it should be noted that broadband files larger than a minute may be too large and will overload the system memory.

The format, though, is simple enough to allow data to be retrieved even if you don't have Matlab. The file simply contains a list of variables, one after the other.
Here is the list of variable names, case-sensitive, in the order that they are placed
in the file:

VERSION
station_name
station_description
antenna_bearings
antenna_description
computer_sn
gps_sn
hardware_description
adc_type
adc_sn
adc_channel_number
Fs
filter_taps
is_broadband
call_sign
Fc
is_msk
cal_factor
is_amp
latitude
longitude
altitude
gps_quality
start_year
start_month
start_day
start_hour
start_minute
start_second
data

The last variable, 'data', has the actual data in it (be in broadband or narrowband), and are saved as float.

The basics: For each variable, we start with 5 integers, followed by the variable name (characters), followed by the \0 character, followed by the value of the variable.

The 5 integers that precede the variable name, respectively, represent the data type of the data, the number of rows, the number of columns, whether it is complex, and the length of the variable name. Our VLF data, however, always has one column, and is always real. The data types are encoded like so: 0=double, 10=float, 20=int, 30=short, 40=unsigned short, 50=char.

Those five integers are followed by the name of the variable, in characters, with length given by the last of those five integers. Immediately after that is the \0 character, followed by whatever is in the variable.

To facilitate the retrieval and viewing of data in Matlab, the software includes three utilities inside the "Matlab Work" folder within C:\VLF_DAQ. The first enables retrieval of data from within the files. For this, it is easiest to put the two files matgetvariable.m and matreadheader in the work directory within matlab, or The matgetvariable command can be used in Matlab as follows:

Output = matGetVariable ('filename', 'varName', length, offset);

Which will with draw the variable named varName (single quotes around it), from 'filename', with the specified length, starting a length of offset into the variable. So, for instance, if you want the third minute of a 100 kHz broadband file, length would 100000*60 (one minute's worth of samples), and the offset would be 100000*60*2 (first two minutes skipped). The variable withdrawn will be available and called Output.

For quick viewing of broadband files, use the "vlf_spec" command, which also requires use of matGetVariable and matReadHeader in the same directory (or in the work directory within Matlab). Follow the instructions in order to produce a spectrogram and time series plot of narrowband plot, with the lengths specified in seconds. Displaying more than 60 seconds of broadband data may overlead Matlab. For narrowband data, use the NarrowQPlot, again following the instructions to display amplitude and phase. In the case of NarrowQPlot, the entire file will be plotted.