

# The Stanford University ELF/VLF Receiver

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

## Deployment Notes

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July 2006

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The following document is intended to be used exclusively by the Stanford VLF group for deployments of VLF receivers.

### Installing the A/D card

The Ni-DAQ software must be installed first, before the hardware is placed in the computer. The DVD for the software is included in the box that has the card. Follow the on-screen instructions, but you should install “Traditional Ni-DAQ 7”, rather than the newer but more bug-filled version 8. Once the software is installed, shut down the computer, install the card into the PCI slot, and then turn on the computer. The computer should, after a couple minutes, recognize the card and display this fact with a message on the lower right corner of the screen. It may pop up a screen that asks you to find the location of the card, just follow the instructions and tell it to automatically find the drivers, and it will take care of the rest. To ensure that this has been successful, open up the “Measurement and Automations” icon on the desktop. In the screen that pops up, look on the left hand side, where it says “devices and interfaces”, and click on the [+] that is next to it. Among the options that appear below it, one of them should read “traditional Ni-DAQ devices”, and if that’s there, the installation was successful.

### Installing VPN

Download the zipped file to the VLF recording computer. Unzip it. You'll see one file called openvpn-2.0.5-gui-1.0.3-install.exe. Run this program. Click "next", and then "I agree", and you'll come to a screen where you can select components to install. Make sure these boxes, and only these boxes, are checked.

OpenVPN User-Space Components  
OpenVPN GUI  
AutoStart OpenVPN GUI  
OpenVPN Service  
OpenVPN File Associations  
OpenSSL DLLs  
TAP-Win32 Virtual Ethernet Adapter  
Add Shortcuts to Start Menu

Then press the "next" button, then hit the "install" button. This will install a program on your computer that will help us connect to it. Note that you may get an error message that says something like this program is not certified to be comparable with Windows. If you see this message, ignore it and press on the continue anyway option.

When you do this, you should see a new icon appear in the corner of the taskbar, which looks similar to what appears for a network connection. It should have two red squares on the icon, which means it's not yet connected.

Now, take the four files that are inside the "certificate" folder, and place them inside the folder C:\Program Files\OpenVPN\config. Move the actual files inside the certificate folder, not the folder itself.

Next, double click on the autorun file that was included in the attached zip file. Say yes if it asks you if you want to modify the registry.

Find that new icon in the taskbar that I mentioned earlier, and double click on it. You should see a little screen pop up for a few seconds, and then disappear. Once that happens, the two red squares on the icon should turn yellow and then green. In the event it turns yellow but does not turn green, double click on the icons. A screen will pop up that has some text in it. Copy that text and paste it into an email and sent it to me -- it will help us figure out what the problem is. Note that if your computer connects to the internet through a proxy server, this may be the reason why it stays yellow. If that is the case, just let me know the port number and the name of the proxy server, and I will send you a corrected file that will work with the proxy server.

At this point the network connection will be established, but the computer must be enabled for remote access. In order to do this, find the "my computer" icon on the desktop, and RIGHT click on it, then select properties. In the screen that pops up, click on the "remote" tab. Make sure that the box next to "Allow users to connect remotely to this computer" is checked. If it isn't, check that box, and press the "apply" button.

If the computer is already set up with a user account that requires a password, then everything is done. For instance, if when you boot the computer, it takes you to a Windows login screen that asks for username and password, then everything it set up, all you need to do is tell me the username and password, so that I can log on from here. You may also create a new account with a new password if you so choose. After this, you're done.

However, if your computer is currently set up so that it boots straight into Windows without asking for a username and password, then we need to add a password to the account. To do this, click on the "select remote users" button, the screen I last referred to. In the box that pops up, click on the link down below that says "User Accounts". Another window should appear, and in the bottom half it should list one or more accounts, with a name, and each one with a little icon next to it. Click on the account that you will use, and in the screen that appears next follow the links to add a new password. Be sure to write down this password, and tell me the password as well as the name of the account.

### Reboot Recovery

It is important to set up the computer so that it can automatically recover from a software crash, or a power outage, and resume recording without human intervention (such as turning on the computer, starting up the software, or logging in to Windows). The software automatically sets the computer to open up the recording when Windows boots, so this part is taken care of. There are two steps remaining: the first is to ensure it turns back on after a power failure, the second is to ensure Windows boots up without going to the account login screen.

The power failure reboot settings are in the computer's internal settings. This cannot be done remotely through the internet, it must be done in person. The way to get to this is to reboot the computer, and when it is first booting up, look for some message on the screen about going to bios, or setup, or something along those lines. For instance, for most Dell computers, you press F2 just as the computer is beginning to boot up. Oftentimes, delete is the correct button to push, sometimes it is F12, but it should be written somewhere on the screen, though perhaps briefly, right after the computer is turned on.

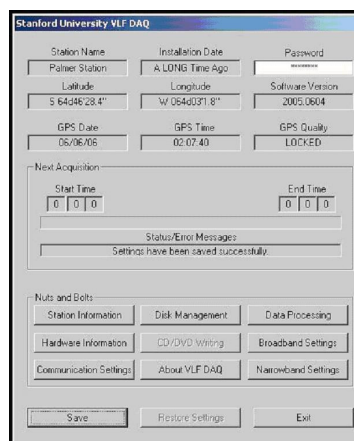
Once that button is pushed, you'll be taken to a setup screen. This is different for each computer, but one of the menus or options should say "power management" or "ac recovery" or something along those lines. Usually there is an option to turn this to "on" or "remember last setting". Make sure this setting is saved and then you exit and boot up the rest of the way normally. To make sure that this worked, yank the computer's power plug while it's on. Wait a few seconds, and then plug it back in. If your reboot recovery is correct, then the computer should turn on and reboot without having to press the power switch.

The second part is to make sure Windows boots up without requiring a username and password. This can be done remotely through the internet, but is worth doing in person because it can't be tested remotely. This should not be done until after the VPN software is installed and working, because that will require setting up and knowing a username/password for a Windows account designated for recording. First, click on the start menu, and then run. In the box that pops up, type in regedit. You'll need to follow the tree in the registry editor to the location HKEY\_LOCAL\_MACHINE → Software → Microsoft → WindowsNT → CurrentVersion → Winlogon. When you click on this location, the righthand side should contain a bunch of variables. Find one whose name is "DefaultUserName". If it exists, check to see that the username matches the one that is designated for the VLF

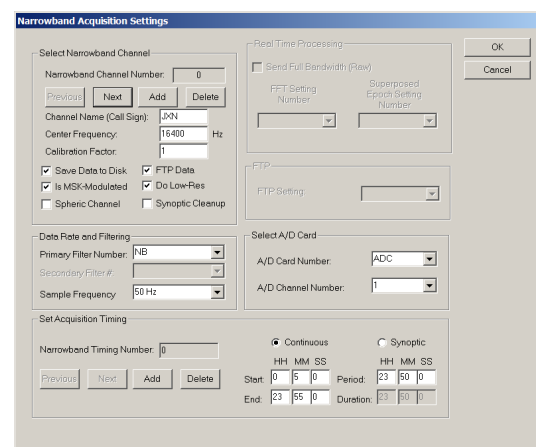
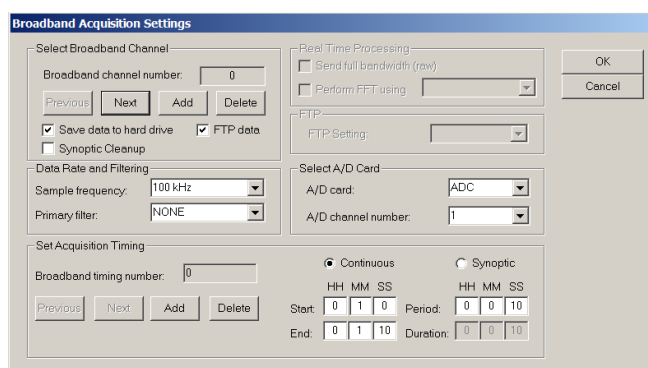
recordings. If it does not, RIGHT click on the name, then hit modift, and switch the “Value data” box so that it shows the same Windows account name that is for VLF recordings. If there is no variable name called “DefaultUserName”, then right click on some empty spot in the variable areas, then go to “new”, and choose “string value”. Type in “DefaultUserName” and then edit it as mentioned earlier. Now, look for a variable that says DefaultPassword. If one does not exist, create one using the same process. Make it’s value to match the password used to log in to the Windows account. Finally, look for a variable called “AutoAdminLogon”. Once again, if it does not exist create it, otherwise if it does, modify it’s value to be “1” instead of “0”. To test this out, reboot the computer and see if Windows boots up rather than stopping and the account login screen.

## Software Settings

The VLF\_Daq software’s main screen looks like the picture below. You will need the password in order to modify any of the settings, or to exit the software. The password is lionroar. This password can be given to the site hosts, since it does not enable access to other Stanford network computers, only to the software settings locally. It is very important to note that any software changes you make are NOT saved unless you press the save button in the lower left corner of the software. In order to implement the changes, you must also exit the software and restart it.



The main settings to control the schedule is under the broadband settings and narrowband settings. The screens look, respectively, like the pictures below

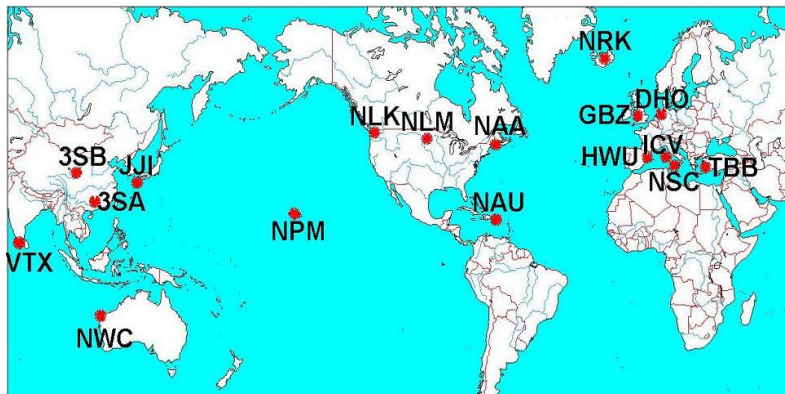


In both windows, you can scroll through the channels using the previous and next button at the top left. In the narrowband menu, changing the call sign will automatically set the frequency if the transmitter appears on the following list. It is most effective to view the data manually, and select the transmitters that appear most strongly by zooming on the a spectrogram. The “ADC Channel number” refers to which antenna is being recorded, be it N/S (channel 1), or E/W (channel 2). The schedule can be set with the boxes in the bottom right corner, with start and end time, plus the length of each chunk of data in a file. For synoptic recordings, the duration will tell the lengths of the files, and the periof will tell how often a synoptic recording is taken (i.e., once per 15 minutes). If you want to add a new channel, the button is on the top left, and you’ll also have to add a new schedule to the new channel by clicking the “Add” button in

the bottom left area. To turn off a channel without losing its setting and having to reenter it, simply uncheck the “save data to disk” box. This is helpful for calibrating and initial – you can set up a channel that records continuously, and saves in 1 minute chunks, and then turn it off using that checkbox. To permanently delete a channel, press the “delete” button on the top left area, though be sure to delete them in pairs (i.e. if you delete the NS continuous channel, you should probably delete the EW one, too).

LAT	Lon	FREQ	SIGN	LOCATION	FORMAT	kW
59.91	10.52	16400Hz	JXN	Kolsas, Norway (NATO)	FSK	45
8.47	77.40	18200Hz	VTX	Katabomman, India	FSK	
52.71	-3.07	19600Hz	GBZ	Anthorn, Great Britain (NATO)	FSK	30
-21.80	114.20	19800Hz	NWC	North West Cape, Australia (USA)	MSK	1000
40.88	9.68	20270Hz	ICV	Isola di Tavorara, Italy (NATO)	MSK	20
25.03	111.67	20600Hz	3SA	Changde, China	FSK	
39.60	103.33	20600Hz	3SB	Datong, China	FSK	
40.70	1.25	20900Hz	HWU	Rosnay, France	MSK	400
20.40	-158.2	21400Hz	NPM	Lualualei, Hawaii, USA	MSK	424
40.70	1.25	21750Hz	HWV	Le Blanc, France (NATO)	MSK	200
52.40	-1.20	22100Hz	GQD	Anthorn, Great Britain (NATO)	FSK	
32.04	130.81	22200Hz	JJI	Ebino, Japan	FSK	200
53.10	7.60	23400Hz	DHO	Rhauderfehn, Germany (DHO)	FSK	800
44.65	-67.30	24000Hz	NAA	Cutler, Maine, USA	MSK	1000
48.20	-121.9	24800Hz	NLK	Jim Creek, Washington, USA	MSK	192
46.35	-98.33	25200Hz	NLM	LaMoure, North Dakota, USA	MSK	
37.43	27.55	26700Hz	TBB	Bafa, Turkey	MSK	
65.00	-18.00	37500Hz	NRK	Grindavik, Iceland (USA)	MSK	
18.00	-67.00	40750Hz	NAU	Aguado, Puerto Rico (USA)	MSK	100
38.00	13.50	45900Hz	NSC	Sicily, Italy (USA)	MSK	

For reference sake, here is a map of the locations of all the transmitters.



It is also important to know the settings to vary the live spectrogram viewing. This is done under the data processing button, and within it is a section for spectrograms. Here you can set whether to create spectrograms once per day, or once per minute, whether to ftp the spectrograms, save them to the hard drive, or both. It is helpful to leave it in daily spectrogram mode, so that a once per day diagnostic tool can be utilized to monitor the site is working. You must, however, make sure that the daily spectrogram does not overlap with the narrowband schedule if the computer is not equipped to do live/simultaneous spectrograms. To fix the time for the daily spectrogram, click on the “disk management” menu in the main VLF\_DAQ program. At the bottom is a place to set “Run daily cleanup at...”. Set this time to be five minutes AFTER you want the daily spectrogram to be recorded, the entire ten minute period around which should be not coinciding with narrowband recordings.

For other software settings, contact support back at Stanford, since it may be more complicated.

#### Data Location and Filenames

All the data will be nominally stored within the directory C:\VLF\_DAQ\VLFData. This folder is divided into several different sections for each of the data types: continuous, synoptic, narrowband, ftp, ftp\_save, and spectrogram.

Continuous, synoptic, and narrowband folders contain data that are not intended to be sent to Stanford via ftp. All files that are intended to be sent by ftp connection to Stanford are placed in the ftp folder. Once those files are successfully sent, it will be placed in the ftp\_save folder. Therefore, it is important that the host does not modify or move files that are in the ftp folder.

The spectrogram folder contains all the archived spectrograms. If the “save to disk” option in the spectrogram menu of the VLF\_DAQ is checked, all spectrograms (whether they be daily or minute by minute) will be saved in this folder. Note that this folder also contains the programs and libraries needed to actually run the spectrogram generation program.

The file naming conventions are as follows.

Narrowband Files: XXYYMMDDHHMMSSZZZ\_ACCT.mat

XX – Station ID (from Station Information Dialogue Box in VLF\_DAQ)

YY – Year

MM — Month

DD — Day

HH — Hour

MM — Minute

SS — Second

ZZZ — Transmitter Callsign

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 low-resolution amplitude, “B” corresponds to low-resolution 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

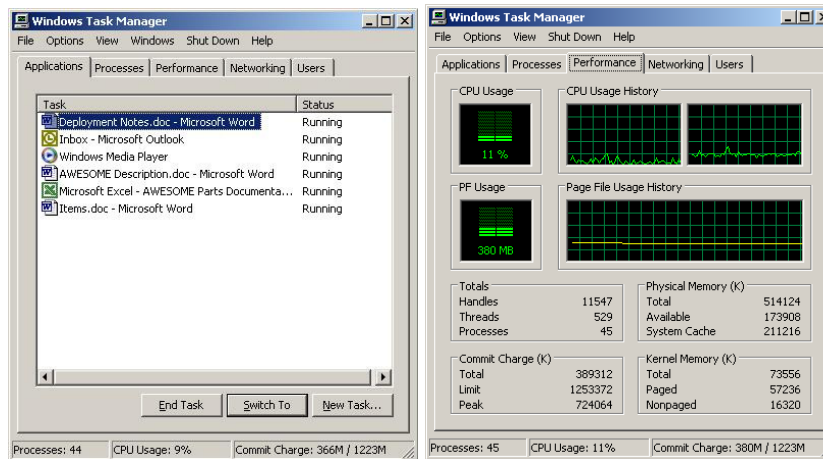
CC— zero-based index of the software channel number that was used.

#### IP Address for FTP Transfer

When the computer is first turned on and connected to the internet, you should find out what the IP address is. The Stanford ftp server that receives the data will block all IP addresses unless it has been to a list of allowed ones. To determine what the IP address is, click on the start menu, then run. In the box that pops up next, type cmd. A black DOS prompt screen should appear, into which you should type ipconfig and press enter. The computer must be connected to the internet during this time.. Look for the line that says “IP Address”, and email this information to Stanford right away so that it can be added to the ftp server. Note that there may be a second one corresponding to the Stanford VPN, which would begin with 10.3.??.??, which can be ignored.

#### Viewing Data Live

Depending on the type of computer, you may be able to generate spectrograms live and view them as the data is recorded. In particular, you need to be using a computer that is hyperthreaded. In order to check for this, press control-alt-delete simultaneously. A screen should pop up like the one on the left, below. Click on the “performance” button near the top, and you’ll see a screen that looks something like the one on the right



Notice how there are two separate boxes in the “CPU Usage History” section. If you see this, the computer is capable of doing live spectrograms while recording. If you see only one rectangle, then the computer is not able to do live spectrograms, and you will have to use Matlab to view the data, as described later.

To enable the live spectrograms, enter the password into the software, and click on “data processing”, and then “spectrogram” in the ensuing window. The two boxes “minute” and “day” determine how often to create spectrograms (assuming the “create spectrogram” box is also checked). You can also vary whether to save the spectrograms to the local hard drive, or ftp them to the internet. If you want to view them locally, be sure not to check the “ftp spectrogram” box.

To view the local data live, go into the C:\VLF\_DAQ , and double click on “sitelive”, and the page will automatically refresh as the data loads.

Be sure to switch the mode to ftp spectrogram, and turn the spectrograms to daily instead of every minute, before leaving the system, unless it is a very very quiet broadband site with a very good internet connection.

### Viewing Data in Matlab

Once Matlab is installed, it can be used to view broadband and narrowband data, by installing a few basic scripts. First, find the directory under matlab called work, and into that directory copy the four files matGetVariable, matReadHeader, vlf\_spec\_m5, and NarrowQPlot, which are located along with the Matlab program on the deployment DVD. Once these four files are in the right place, you’ll be able to easily view data.

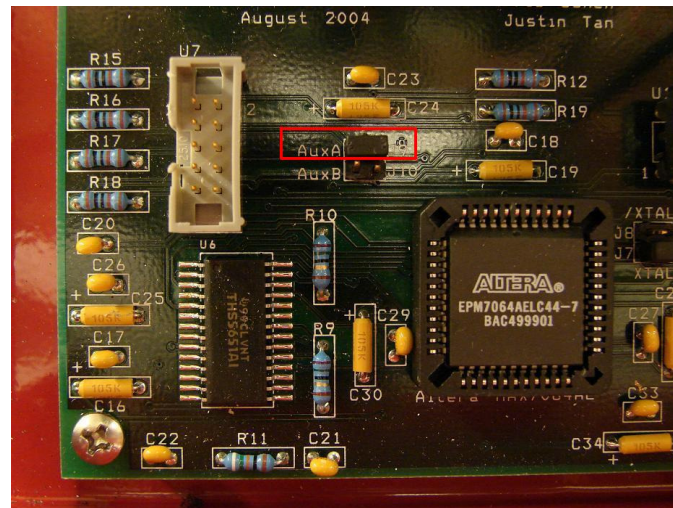
To view broadband, open Matlab, and type in vlf\_spec, and press enter. The screen that pops up will let you load the data that you want to look at, first the N/S channel, then the E/W channel. It will then ask you the length of the spectrogram, the offset from the file’s start, for each of the two channels. These are in seconds, so if you wanted to see seconds 30-40 within the file, you would type in length 10, and offset 30. It is not recommended to make spectrograms longer than 30 seconds using this method, since the memory requirements begins to be too much for the computer to handle in this fashion. This should then pop up two plots: one is a time series plot, with +1 and -1 indicating the A/D card is clipping, and the second is a spectrogram, whose colorbar matches that used by default with the automatic spectrograms (so it can be compared easily). You can zoom in on either graph by clicking on the magnifying glass near the top, and then selecting a rectangle to zoom in on. Also on the deployment DVD is a sample spectrogram from every site for which broadband data could be found, enabling contextual comparison of data at the site to assess its quality. As before, these spectrograms all use the same colorbar, but it is important to pay attention to the background color, as well as the color of the transmitters/sferics, as these both can vary according to antenna size and gain/filter settings.

To view narrowband, open Matlab, and type in narrowqplot5. The screen that pops up will let you load the data that you want to look at, first the amplitude, then the phase. Be sure to use the same transmitter, same resolution, and same day (i.e. the amplitude and phase files must correspond to each other). It is recommended to use this utility strictly with low-res narrowband files (i.e., they have A (amplitude) or B (phase) at the end of the filename).

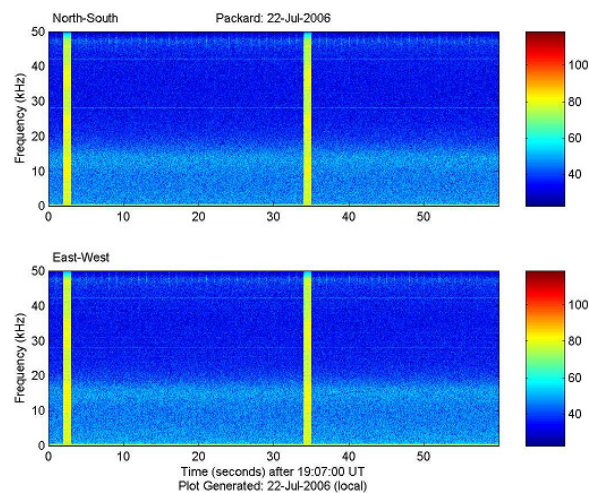


## Calibrating

Calibration should be done with the dummy loop attached to the two antenna inputs of the preamplifier, and should be done after the cable has been routed, and everything else is set up. Make sure that the software is recording continuous broadband, and it is helpful if it saves the broadband in one minute files. It is helpful, if possible, to use the minute-by-minute spectrograms to view the data live, so that you can be sure that the calibration tone appeared. If using one of the older two-channel AWESOMEs, you should find the jumper that is labeled “AuxA” in the line receiver, and attach the horizontal two pins in that row, as shown here. The AuxA jumper is boxed in red:



When this jumper is enabled, a vertical stripe should appear in the spectrograms, of one second duration, once per 32 seconds, and should look something like this



Note down a one minute period during which time the caltone was generated. Retrieve this data and bring it back to Stanford, and leave a copy locally somewhere on the hard drive. Once this is done, remove the AuxA jumper to disable to calibration tone, and of course, plug in the antenna and retrieve the dummy loop.

## Basic Troubleshooting

With any deployment, there will be a finite probability that when the hardware is first plugged in, it will not work, due to not yet having the computer correctly set up, or due to damage to the receiver in transportation. This can be due to one of two problems: either a problem with the software, or the proper signals getting to the software, or it may be a hardware problem that is stopping the signal somewhere in the receiver.

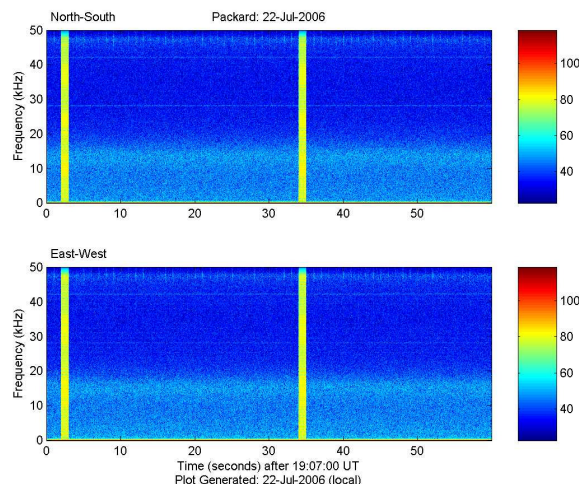
Software problems, of course, will be manifested in obvious ways – the computer crashes. The software has built it into it if it has problems with the computational demands, or if the GPS or serial signals fail, it will force the computer to reboot. For instance, if you start the software while the line receiver is off, or with either the serial or ADC cable missing, this error will occur. This will be evident if the software disappears, and is replaced with a screen that shows a timer ticking down, beginning with :20. When it hits zero, the computer will reboot, unless the program called “ShutdownAbort” is double clicked, which is located in C:\VLF\_DAQ\ folder. It is helpful to place a shortcut to ShutdownAbort on the desktop, so in case this happens, the countdown can be aborted right away. If this occurs, make sure that the receiver is on BEFORE the software starts up. This is necessary because the software activates the GPS module in the line receiver as it starts up through the serial port. Hence, if the line receiver is off at this point, it won’t be activated, and the software will not get timing information, and thus will force the computer to reboot. If software crashes persist, open the file “ADCLog.txt” in the C:\VLF\_DAQ. If there are any codes written there, that may indicate a problem, and for this you should seek help from supporters back at Stanford.

For hardware problems, though, you’ll be able to view data, and you won’t see the computer crashing, but the data won’t look like VLF, all you’ll see is noise. However, viewing the “noise-o-gram” is a quick and easy way to do basic troubleshooting and verification on all or parts of the receiver. This is because several of the main receiver areas introduce a noticeable signature to the noise-o-gram, and so by looking for specific features it is often possible to diagnose problems. If it is possible to use the live spectrograms, set this up, for this will be particularly helpful to watch what happens to the spectrogram as changes are made. If not you’ll have to use Matab.

One of the easiest ways to isolate the problem is, of course, to swap the cards. For instance, if you have one channel that is working and one that is now, switch the preamp cards. If the working channel and the bad channel switches, then the problem must be the preamp card, or else the problem is somewhere else. You can repeat the same for the filter cards in the line receiver.

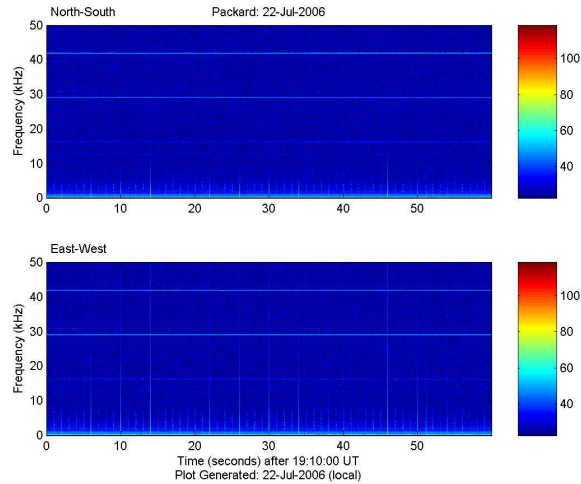
Beyond this, though, it is helpful to look at the noise-o-gram to figure out where the signal break is to understand the problem. The following spectrograms were taken with a dummy loop attached to the preamplifier, and the preamplifier had the 9 kHz filter off, and was at the 10 dB gain setting. The AuxA jumper in the line receiver was also enabled so that a caltone was injected every 32 seconds.

Here is an example of a noise-o-gram from a working receiver under these conditions. You’ll notice a couple key features. Namely, the yellow stripe is the caltone. You can also see some light blue fuzz below about 16 kHz. This is baseline system noise from the transistor amplifier circuit in the preamp card. You can also see some fuzz, and some vertical lines, around 47 kHz. The 47 kHz fuzz is due to the anti-aliasing filter card in the line receiver, and the vertical line superimposed over it is noise from the GPS module (periodic, once per second).

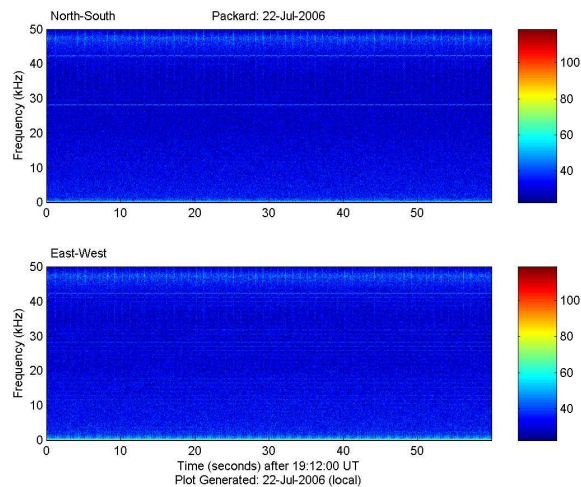


Now, the next spectrogram shows what happens when both filter cards are removed from the line receiver. Notice that the fuzz at 47 kHz, as well as the fuzz at <16 kHz, have disappeared. You can now see some faint vertical and horizontal lines, which are due strictly to minimal amounts of noise from the GPS module. A spectrogram like this usually means the filter cards are in backwards, not in at all, or have stopped working. Because the filter card comes in the line receiver, removing the preamp cards in addition to this has no effect on the noise-o-gram.

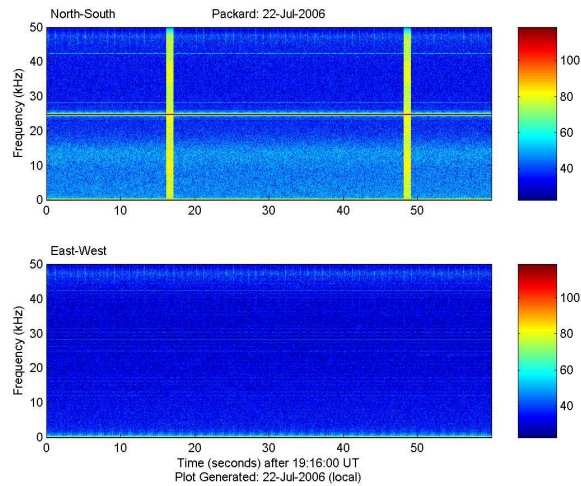




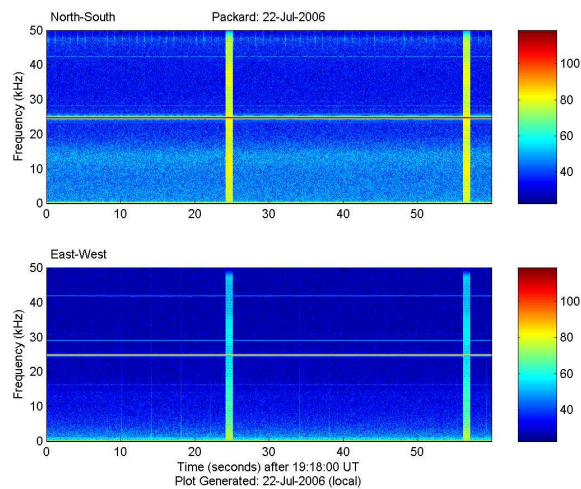
The next spectrogram shows what results if the preamp cards are removed, but the filter cards are working and in place. You'll notice that the <16 kHz fuzz is nonexistent, but the 47 kHz fuzz is there. This is indicative that the signal break is somewhere between the transistor amplifier on the preamp card, and the anti-aliasing filter. Possible problems include a broken or loosely connected Belden cable, a bad output chip U4 on the preamplifier card, or the 9 kHz jumper on the preamp card is set neither to on or off (perhaps the jumper fell out).



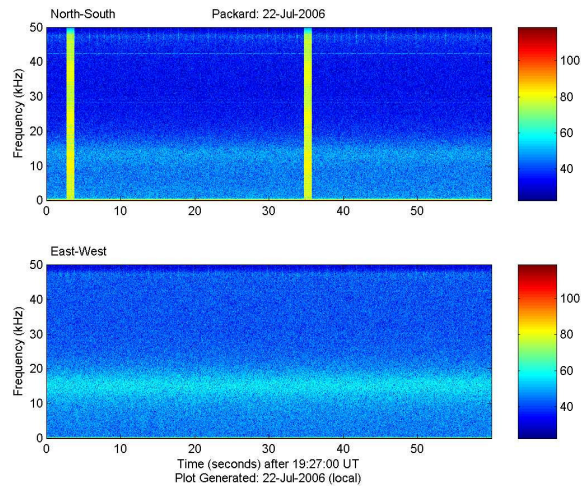
There may be times, of course, when only one channel is working. If so, there are a couple unique features to look for. In the next spectrogram, only one of the preamp cards have been removed. For illustrative purposes, a strong 25 kHz signal has been injected into the dummy loop. You'll notice that the fuzz present in the bottom channel is consistent with the removal of the preamplifier card, because the 47 kHz fuzz is still there. Do take note, however, that neither the calibration signal nor the 25 kHz manual signal appear at all on the bottom spectrogram. In other words, there is no cross talk whatsoever.



In the following spectrogram, however, one of the filter cards has been removed, the other channel is working. As you should quickly notice – this one looks very different. Even though there is no filter card in the EW channel, both the calibration tone and the 25 kHz signal appear on the EW channel. This is deceiving, though, because it might trick you into thinking the channel is working. It is not – the signal present on the EW channel is due entirely to cross talk from the NS channel, evidenced in particular by the nonexistence of the two main fuzz elements, plus the fact that the signals are weakened. The cross talk appeared when the filter card was removed, but not when the preamp card was removed. This is presumed to be due to the fact that the output line of the EW channel becomes very high impedance when the filter card is removed, thus making it pick up small bits of cross talk and radiated signal very easily. Whereas, with the preamp card in place and operating correctly, the line is low impedance and thus does not pick up any cross talk at all.



One final spectrogram may appear in the event that the output center tap conductor of the preamplifier card's transformer (labeled "OutCent") has been detached. This occasionally occurs in shipping because of the thin wires required for this transformer. In this case, you'll see a spectrogram that looks like this



This can be confusing, because the EW channel does display the two characteristic fuzzes, but as you can see, the 16 kHz fuzz is quite a bit stronger, and the calibration signal does not display at all. This is usually indicative of that wire being detached or poorly soldered. There are probably other specific things you might see, and if anything comes up that does not fit one of these patterns, email a spectrogram to Stanford and see if someone can provide some insight.

### Filters and Gain Setting

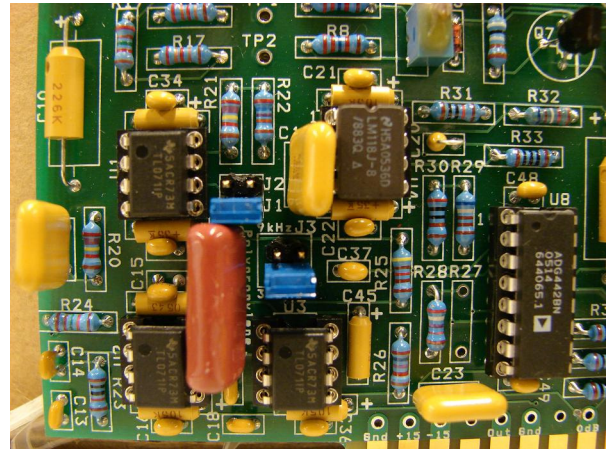
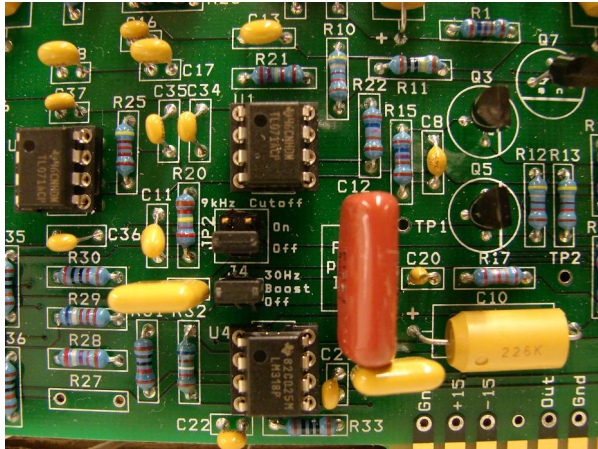
The filtering and gain settings are set manually in the preamplifier. If using one of the older two-channel systems, there will be one very large gain knob in the preamplifier, with lights indicating which setting it is on. Note that the gain knob actually has 12 settings, only four of which are in use, so if you do not see a light, it may be that the gain knob is out of range – try rotating it clockwise all the way to the end, which will set it to 30 dB. The gain setting nominally applies to both channels, but occasionally there may be a situation where it is necessary to have different gains on each channel (such as when you are located close to a VLF transmitter). If so, you can remove the chip U11 from ONE of the preamplifier cards, which is an ADG442. That card will then be fixed at 0 dB gain, and you can use the gain switch to modify the other channel only.

If using one of the newer three-channel systems, you will have individual jumpers for each channel to set the gain, labeled on the board.

The preamp cards also have optional filters to modify the frequency response. Most common will be the 9kHz high pass filter, useful for noisy narrowband sites. On the original preamplifier cards (i.e. ones labeled with serial numbers below 50), there are a pair of jumpers to set the filter either on or off. Note that if the jumper is not attached to either slow, no signal will get through. Below is a picture of the jumpers up close, located in the left region of the preamp card. In this picture, the 9 kHz filter is off:

Nominally, the systems frequency response reaches its 3dB cutoff at ~850 Hz. For especially quiet sites, you might want to flatten the response further. To do this, make sure the 9 kHz filter card is off, and then remove the jumper located below it, labeled “30 Hz boost off”. This will flatten the response down to ~350 Hz. In the below picture (left), the low frequency flattening is turned off.

The new “slimmer” preamp cards, labeled with serial numbers 51 and higher, have an extra setting. The 30Hz compensation jumper now has two settings. Attaching a jumper to J1 adds to compensation, and the frequency response will begin to cut off at ~800Hz. Removing J1 will flatten the response to ~300Hz, exactly as in the older preamp cards. Inserting a jumper in J2, however, and removing J1, will add a “superboost”, which will flatten the response down to ~90 Hz. These settings, however, will only be useful for extremely quiet sites, very remotely located from power lines. The below pictures (right) show the newer preamp card, right region.



### Clip Lights

The two red clip lights on the front of the line receiver are a quick way to determine if the system is working, and/or if the gain setting and filtering is set properly. During normal operation, you should see the lights flicker occasionally, particularly if the lights in the room are turned down. Note that although the light comes on occasionally on strong sferics, the system may not actually be clipping, because the threshold for the clip light as set at  $\frac{1}{2}$  the actual clipping value. The frequency of the clipping should be roughly varied based on location (proximity to thunderstorm centers) and time of day and year, but should at least be occasionally present anytime.

If the clip light is consistently off, this either means that the system is not operating correctly (i.e. the signal is not passing through the receiver), or the gain is set too low. If the clip light is consistently on, this means either that the system is not operating correctly (one of the circuits, probably the filter card, has failed), or the gain is too high, or that the amount of hum is too high, and the 9kHz filter should be turned on if it is not on already.

### Fuse

The fuse is located in the back of the line receiver, next to the power switch. If you hear a short buzzing sound, followed by the blue light on the line receiver turning off, the fuse was probably blown. It can easily be replaced by unscrewing it, pulling out the glass part, and inserting a new one. The preamplifier has no fuse.

### Serial Numbers

Every card and box is labeled with a serial number. Please keep track of which cards end up in which location, and which position, and return the information to Stanford.