



Space Weather Monitors

SID Users Manual

Solar Sudden Ionospheric Disturbance Monitor

<http://solar-center.stanford.edu/SID>



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We are pleased to welcome you to the Solar SID Space Weather Monitor program developed by Stanford University's Solar Center. These instruments were designed and tested by educators for educators. We understand that a successful program is one that is powerful yet robust and simple to use. We hope that you find this instrument easy to set up and integrate in your classroom. We want to hear from you about your experiences and suggestions on improving and incorporating our monitor into your educational institution. Thank you!

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Chapter 1 Overview

In this section we will introduce the SID concepts and monitoring technology



The Space Weather Monitoring Program

Stanford's Solar Center, in conjunction with the Electrical Engineering Department's Very Low Frequency group and local educators, have developed inexpensive space weather monitors that students can install and use at their local high schools. The monitors detect changes to the Earth's ionosphere caused by solar flares and other disturbances. Students "buy in" to the project by building their own antenna, a simple

structure costing anywhere from \$10-\$40 and taking a few hours to assemble. Data collection and analysis is handled by a local PC, which need not be fast or elaborate. Stanford provides a centralized data repository and blog site where students can exchange and discuss data. Two versions of the monitor exist - one low-cost designed for placement in high schools, named SID, and a more sensitive, research-quality monitor called AWESOME. This document describes the SID monitor.

The United Nations and the International Heliophysical Year



The monitors can be placed virtually anywhere there is access to power. Through the United Nations Basic Space Science Initiative (UNBSS) and the IHY International Education Committee, our monitors have been designated for deployment to all 193 countries of the world for the International Heliophysical Year (IHY), 2007-9.



<http://ihy2007.org/>



What is a Space Weather Monitor?

A space weather monitor measures the effects on Earth of solar flares by tracking changes in very low frequency (VLF) transmissions as they bounce off Earth's ionosphere. The VLF radio waves come from submarine communication centers.

The Sun affects the Earth through two mechanisms. The first is energy. Whenever the Sun erupts with a flare, it is usually in the form of X-ray or extreme ultraviolet energy (EUV). These X-ray and EUV waves travel at the speed of light, taking only 8 minutes to reach us here at Earth.

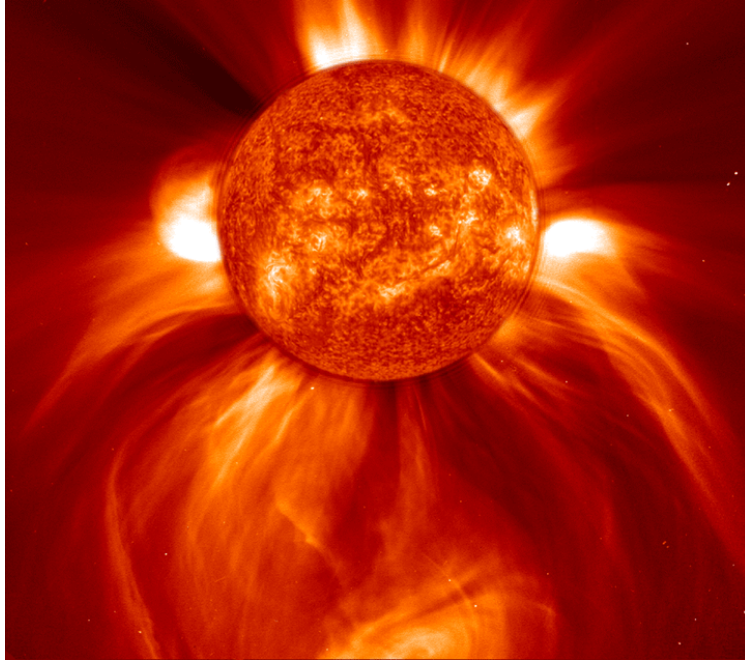


Photo composite courtesy of SOHO consortium

The second mechanism is through the impact of matter from the Sun. Plasma, or matter in a state where electrons wander around freely among the nuclei of the atoms, can also be ejected from the Sun during a flare. This “bundle of matter” is called a Coronal Mass Ejection (CME). CMEs flow from the Sun at a speed of over 2 two million kilometers per hour. Thus it would take a CME 72 hours or so to reach us.

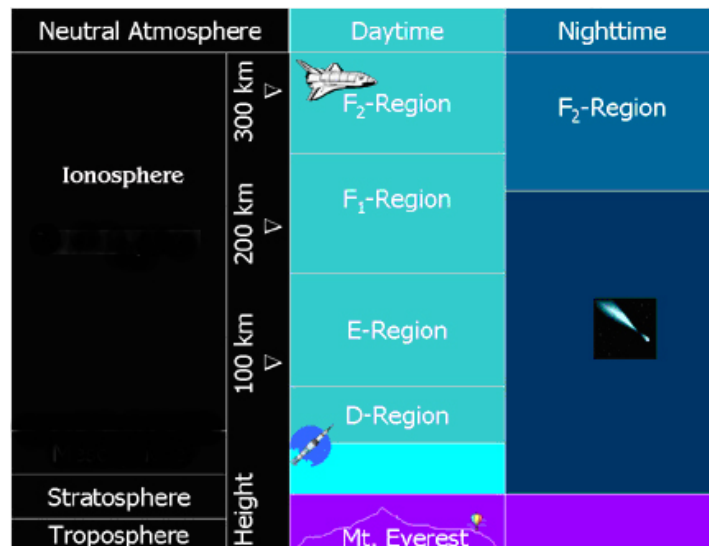
Both energy and matter emissions from the Sun affect the Earth. Our space weather monitors track the **energy** form of solar activity

Energy from the Sun constantly affects the Earth’s ionosphere (located some 60 km above us). When solar energy strikes the ionosphere, it strips off electrons from their nuclei. This process is called ionizing, hence the name ionosphere. The ionosphere has several layers created at different altitudes and made up of different densities of ionization. Each layer has its own properties, and the existence and number of layers change daily under the influence of the Sun.

During the day, the ionosphere is heavily ionized by the Sun. During the night hours there is no ionization caused by the Sun since it has set below the horizon thus there is a daily cycle associated with the ionizations.

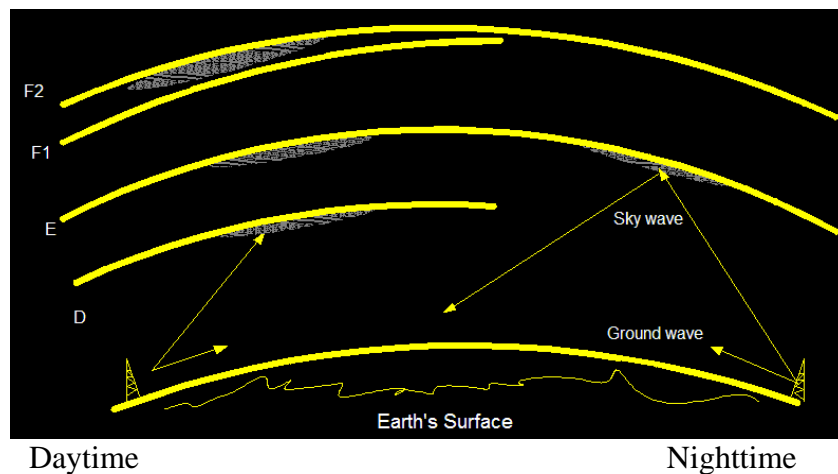
In addition to the daily fluctuations, activity on the Sun can cause dramatic sudden changes to the ionosphere. When energy from a solar flare or other disturbance reaches

the Earth, the ionosphere becomes suddenly more ionized, thus changing the density and location of layers. Hence the term “**Sudden Ionospheric Disturbance**” to describe the changes we are monitoring.

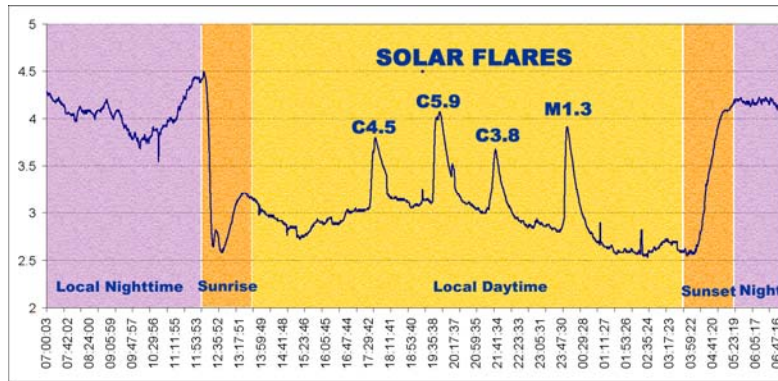


It is the free electrons in the ionosphere that have a strong influence on the propagation of radio signals. Radio frequencies of very long wavelength (very low frequency or “VLF”) “bounce” or reflect off these free electrons in the ionosphere thus, conveniently for us, allowing radio communication over the horizon and around our curved Earth.

The strength of the received radio signal changes according to how much ionization has occurred and at what level of the ionosphere the VLF wave “bounces” from.



The space weather monitor data graph below shows the changes to the signal strength caused by sunrise, sunset, and 4 solar flares. (The solar flares are classified by strength, from low to high as A, B, C, M, or X. These will be described later.)

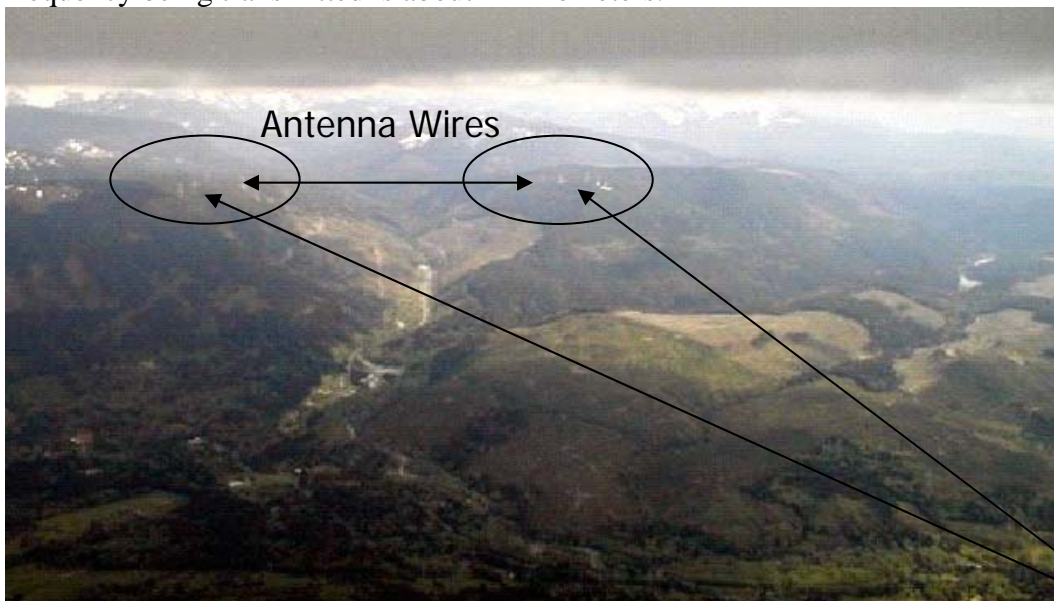


Where do the “bouncing” VLF radio waves come from?

Conveniently for us, several nations use VLF (very low frequency) waves to communicate with their submarines. There are transmitters scattered around the world. The VLF signals bounce off our ionosphere from many kilometers away and can be picked up almost anywhere. Each SID monitor comes with a frequency board that is tuned to a particular transmitter station. A list of known stations is in our Appendix and also maintained by the American Association of Variable Star Observers (AAVSO) at <http://www.aavso.org/observing/programs/solar/vlfstati.txt>

Although most sites can receive many stations, it is advantageous to choose a station at roughly the same longitude as the monitor site, where your sunrise and sunset phenomena will occur at roughly the same time.

The transmitter stations are usually very large, covering many kilometers. The site in the picture below is the US Navy Radio Station in Jim Creek, Washington, USA. Note that the antenna wires span from mountain top to mountain top, since the wavelength of the frequency being transmitted is about 12 kilometers.



“NLK” 24.8 kHz US Navy Radio Station, Jim Creek, WA
wavelength 12 km (7.5 miles)

Transmission Towers

How did we get our SID Monitors?

To monitor a VLF signal, we need a radio receiver that can “tune” to very low frequency stations, an antenna to pick up these VLF signals, and a computer to keep track of the data. Since most consumer radios cannot pick up the very low frequency signals, we needed to design our own radio receiver and antenna. This combination of receiver and antenna we call a Solar Sudden Ionospheric Disturbance Monitor (SID).

People in the American Association of Variable Star Observers (AAVSO), *remember that our Sun is a variable star*, have designed and been using for years a radio receiver to pick up the VLF signals we need to track. Their website

<http://www.aavso.org/observing/programs/solar/sid.shtml>

tells how to build the AAVSO inexpensive model. Although the electronic circuit is easy to assemble, it requires a good deal of expertise to debug and tune.



Through the Stanford Solar SID Project, we teamed up with educators and electronics experts to design a more robust and easier to use monitor that comes preassembled and pretuned. To use it, students need to build their own antenna (quick and easy), hook the monitor to a small computer (old and slow is ok), and start taking data! Our SID monitor was designed to do research in a classroom environment – its goal is for simplicity and its focus is on detecting solar events. More information on the SID monitor program is available at:

<http://solar-center.stanford.edu/SID/sidmonitor/>

In association with Stanford’s Holographic Array for Ionospheric Lightning (HAIL) project and under the direction of Professor Uman Inan, we have also designed a research-quality monitor that will track not only solar effects on the ionosphere but night time ones as well. Nicknamed AWESOME, these monitors function similarly to the SID monitors though with more sensitivity. AWESOME monitors produce data that are useful not only to students but also researchers studying the physical nature of changes in the lower ionosphere produced by thunderstorms and lightning discharges. More information about the AWESOME monitors is available at:

<http://solar-center.stanford.edu/SID/AWESOME/>

The SID and AWESOME Monitors

SOLAR SID (Sudden Ionosphere Disturbance) Monitor

- Classroom use
- Inexpensive
- Monitors only one VLF station
- Primarily tracks solar SID's
- Easy to set up and use
- Antenna simple to build and low cost
- Can use an old and slow computer



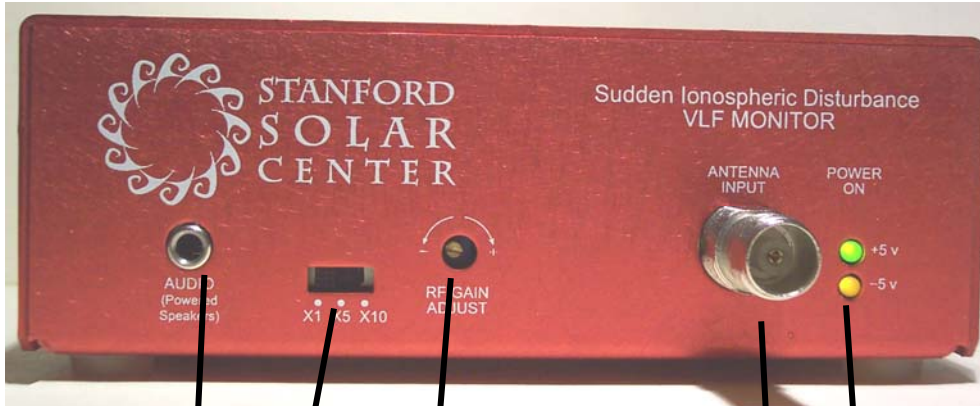
AWESOME Monitor

Atmospheric Weather Electromagnetic System for Observation Modeling and Education

- Student and researcher use
- Moderate cost
- Receives all VLF stations and covers frequencies 30Hz -50 KHz simultaneously
- Hi-resolution 16-bit
- Accurate timing via GPS
- Monitors solar SID's, lightning, GRB's, ionospheric phenomena, etc.
- Requires 2 antennas: N/S and E/W and a location such as a field to set up.
- Requires a computer with processing power to keep up with high-speed data stream and FFT calculations.



The AWESOME monitor is not described in this document. However, many of the same concepts apply.

Identification of SIDMON Hardware Features

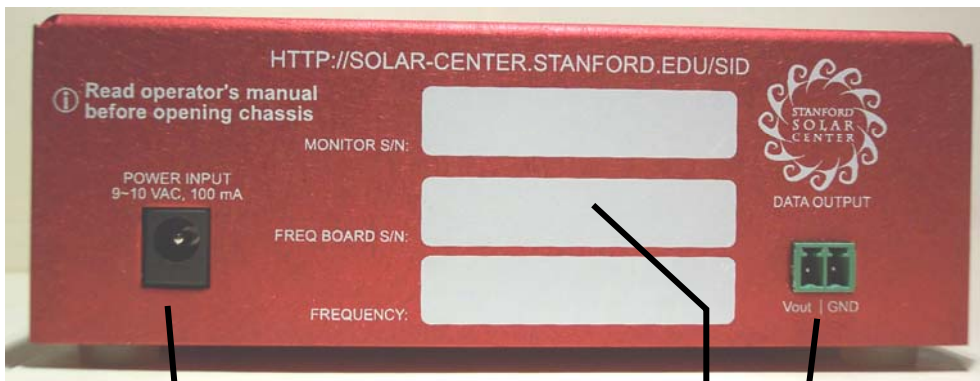
Jack for Powered Speakers

Post Amp switch
(typical x1 setting)

RF Gain Adjust
See instructions how to set

Power Supply
Green = +5, Yellow = -5
Both LED's need to be on

Antenna Input
(BNC or TNC Connector)



Serial #'s and Identification

9-10 VAC Transformer input

Data output: Goes to DATAQ or
other A/D Converter

Chapter 2 Installation



Required to Host a SID Monitor

1. Access to power
2. **Surge protector** and other protection against a lightning strike
3. A SID monitor from Stanford, plus instructions on how to install it
4. An analog to digital converter (e.g. DATAQ, provided with the SID kit)
5. A PC computer with the following minimal specifications:
 - Hardware:
 - Serial port or USB port plus USB-to-serial adapter
 - Ethernet connection (desirable)
 - If no Ethernet, then read/write removable media such as a CD or zip drive for transferring data (optional)
 - Standard keyboard, mouse, monitor, etc.
 - Sufficient CPU to run a Windows operating system
 - Speakers are desirable but not necessary
 - Software:
 - MS Windows operating system (Windows 98 or up)
 - An internet browser (Netscape, Internet Explorer, etc.)
6. An inexpensive antenna that you will build yourself
7. An antenna location that is relatively free of electric interference (please see our appendix on sources of interference); can be placed indoors or out.

You will also need

- Power strip (otherwise known as plug board, power board, power bar, distribution board, or multibox), extension cords, other electrical support
- An assortment of basic tools, primarily screwdrivers

A note on site selection: You will need to locate your antenna in an area relatively free of electric interference. It can be indoors or out, but should be away from generators and other large electric equipment, not under power lines, not in large metal-framed buildings, etc. Unlike a TV antenna, **your antenna does not need to be up high**. Your monitor and computer will need to be relatively nearby, indoors. Place your monitor and computer in a place that can be secured from being tampered with. A lockable closet works well. You will need access to power and, hopefully, an internet connection.

Installation Check-list

- ☐ **Step 1. Get Prepared** (more details following)
 - ☐ Familiarize yourself with SID concepts & hardware components
 - ☐ Find a place for the equipment
 - ☐ Assure you have the necessary safety precautions in place and permissions to use facilities
- ☐ **Step 2. Construct your antenna** (detailed instructions follow)
 - ☐ Decide on small or large loop
 - ☐ Put together a parts list
 - ☐ Obtain wood, PCV pipe, or some sort of structure to hold up a 30" or larger square of wrapped cable
 - ☐ The amount and type of wire selected to wind the antenna can change based on the selection for the antenna.
 - For a small antenna you will need about 50 turns of #26 AWG (American Wire Gauge) wire, approximately 10 ohms. #26 AWG wire is **0.40386 mm** in diameter with 40.81 Ohms/1000ft.
 - For a large antenna you will use fewer turns, e.g. 25 turns of 20 AWG (or **0.8128 mm diameter**) wire.
 - ☐ ~50 feet of RG-58 coax cable
The amount of coax cable required changes according to the site, you may require more or less cable than 50 feet. RG-59 coax can be substituted. However you will need the corresponding BNC or TNC connector since the RG-58 connector is too small for the RG-59 coax.
 - ☐ BNC or TNC connector to connect to SID monitor (provided in your SID kit).
 - ☐ Two insulated ring connectors (crimp on) to connect to the coax cable to the antenna binding posts. Polarity does not matter but be sure to get the right wire gauge compatibility. For the above mentioned wire gauges, it is best to use the red jacketed variety. Below is a photo for clarity.



Insulated ring connector

- ☐ **Step 3. Hardware installation** (instructions follow)
 - ☐ Collect your antenna, lightning protection equipment, DataQ, SID monitor, and computer
 - ☐ Connect your equipment as described below
 - ☐ Check for interference
- ☐ **Step 4. Install your software** (instructions follow)
 - ☐ Install software from the distribution disk
 - ☐ Adjust the SIDMON configuration file for your site
- ☐ **Step 5. Install and align your antenna** (instructions follow)
- ☐ **Step 6. Test and calibrate your system** (instructions follow)
- ☐ **Step 7. Collect Data and Troubleshoot** (instructions follow)

Detailed installation instructions follow:

Step 1 – Get Prepared

- ☐ Familiarize yourself with SID concepts.
 - ☐ What is a SID event?
 - ☐ Why do you need to monitor a VLF station to detect SID's in the ionosphere?
 - ☐ How does the monitor detect them?
- ☐ Familiarize yourself with each SID hardware component
 - ☐ SID Monitor
 - ☐ DATAQ analog-to-digital converter
 - ☐ Cabling for DATAQ to connect to PC
 - ☐ Cabling for DATAQ to connect to SID monitor
 - ☐ Power Adapter (DC transformer and power cord)
- ☐ Find a place for the equipment
 - ☐ Place for the SID monitor & computer (secure)
 - ☐ AC power
 - ☐ Adequate protection against lightning?
 - ☐ Power strip (with surge protector)
 - ☐ Internet connection (optional, but highly recommended for automation)
- ☐ Find a place for the antenna
 - ☐ Place for the antenna. Remember, it does not need to be high, but it must be as far away as possible from electrical interference (*please see our appendix on common sources of interference*), it must also be upright.
 - ☐ Is this place secure? Is this place safe from lightning?
 - ☐ Is permission required to install the antenna there?
- ☐ Double-check that you have the necessary safety precautions in place and permissions to use facilities

Step 2 – Building an Antenna



A SID antenna is called a “**wire-loop antenna**” and is nothing more than a frame that holds up “wraps” or loops of wire. There is no “standard size” or even shape of antenna for a SID monitor. The antenna does not need to be built to precise dimensional specifications nor its wire wound to exact tolerances, nor does it have to be assembled or constructed exactly as shown in this document. You are encouraged to experiment and adjust the construction of your antenna for the parts and supplies you can acquire easily.

You can either build a **small (< 1 meter wide)** antenna with lots of wraps of wire, or a **large antenna (2 or more meters wide)** with fewer wraps. Larger antennas are more sensitive, but they are difficult to carry around and mount outside because of wind, rain, and space requirements. Smaller antennas are easier to build but require more wire to pick up the signal and are not as sensitive as big antennas. The larger in diameter, the better your antenna will be, e.g. 25 turns on a 2 meter frame is better than 50 turns on a 1 meter frame. Your antenna does not need to use the designs or materials we demonstrate. The antenna can be made out of crossed broom sticks or spare wood, anything that is not metal (conductive) is fine. The design schemes we suggest are merely examples of antenna frames that we found to be easy to construct and wind while being sturdy.

Antenna Wire

To wind either the small or large antenna you will need about 120 meters (400 feet) of **insulated** wire. Solid wire makes it easier to wind an antenna than stranded. Magnet wire will work, but be more fragile. You can use anything from #18 AWG (**1.02362mm**) to #26 AWG (**0.40386 mm**) size wire depending on the size of your antenna. The small antenna will require about 50 turns/winds of the smaller diameter wire, the larger one about 25 of the larger diameter wire. We have placed a conversion chart for AWG in the appendix.

Building the Antenna

Making a Large Antenna



Here is a design for a simple large antenna. This design does not require a mast and stands up on its own. It can be placed indoors in an out of the way place (e.g. up against a back wall) or outdoors. If placed outdoors in an area where it will be subjected to the elements (like wind or rain) you may need to anchor it to something sturdy.

We have included another antenna design using a mast in an appendix. Once again these design examples are only suggestions to get you started, they are not necessarily the best or only options for your site.

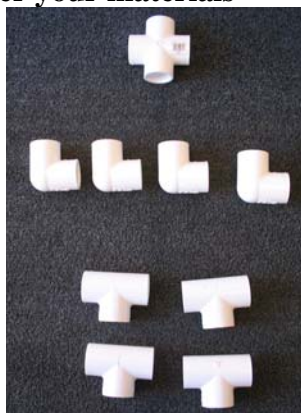
The requirements for an antenna are:

- A wound loop on a frame (although it does not have to be round)
- The wire loop cannot touch the ground
- The wire must be insulated
- The antenna must be upright
- It must be sturdy to resist whatever elements it may be subjected too (wind, rain, clumsy neighbors)

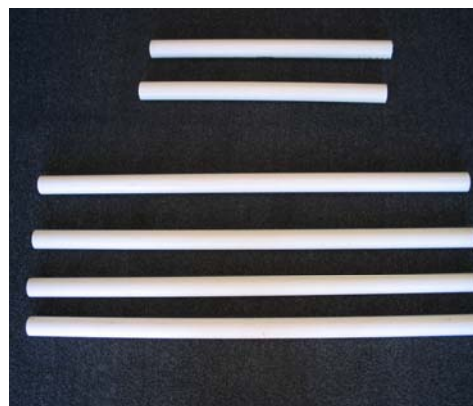
Materials used in this design:

- **PVC pipe:** one inch diameter pipe, cut into **4** pieces of length 2.5 feet and **4** pieces of length 1ft. These lengths do not have to be exact.
- **PVC connectors:** **1** four way connector, **4** elbow connectors, **4** T connectors. *If you cannot locate a 4 way connector, try taking two elbow connectors and duct-tapping them together. Just make sure it is secure!*
- **Tape and/or zip ties:** To make sure the antenna wire stays wound.
- **Antenna wire:** See our section on choosing antenna wire on the previous page

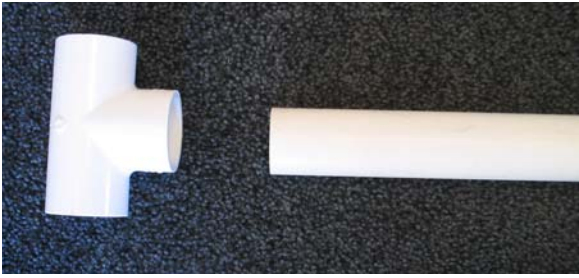
Step 1: Gather your materials



PVC connectors



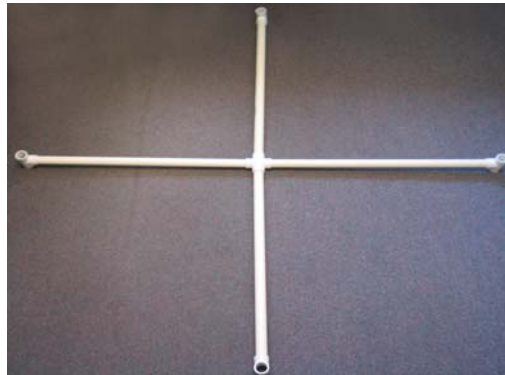
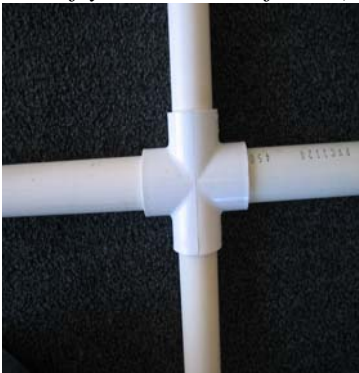
PVC Pipe (should be 4 small pipes)

Step 2: Connect the T connectors

Attach the T connectors to each long length of pipe.

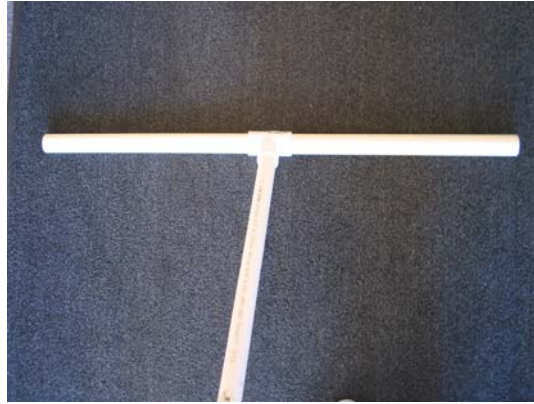
Step 3: Create your frame with the 4 way connector as a hub

Attach the completed T connected lengths of pipe to the 4 way connector (this will be the hub of your antenna frame).



Turn your end connectors so the openings are perpendicular to the 4 way hub (as shown). This is the completed frame, you can work with this design to create “feet” as we did, or affix it to a mast. Mast design examples can be seen in appendix E.

Step 4: Create a base so that your antenna will stand upright. This (and the following) step can be omitted if you are building a mast.



Standing your antenna up, place one of the smaller lengths of PVC pipe in each end of the T connector. **Repeat** this on the other side of the frame that touches the ground.

Step 5: Create “feet” on the base so your antenna is more stable.



Place the 4 elbow connectors on the open ends of the base you created. Now your antenna will stand upright and off the ground.

Now you should have an antenna that looks like a large X with a base. This style of antenna will work best indoors where it won't get knocked over by wind. If you would like to use this design outdoors, make sure it is up against a wall or in a sheltered area. Feel free to make adaptations for stability and safety, just make sure you don't connect it to anything metal.



The completed frame

Here are some photos of a completed antenna of this design. These photos include the antenna wire and terminal to monitor connections. These steps are explained in detail in later sections.



Note the use of zip ties to make sure the wire windings stay together.



This design and antenna was created and photographed by This antenna was designed by Phil Scherrer and built by Sean Liu and Shannon Lee (photos by Shannon Lee)

Winding the Antenna

Step 1: Plan how you will be winding your antenna, depending on your style

Winding the Antenna requires at minimum two people, but three or four people are better. One person makes sure the wire gets wound correctly and the other feeds the spool of wire. If three or four people are available, then one can feed the wire, the second turn the antenna frame and the third person make sure that the wire is taught (tightly tensioned) around the antenna frame. A fourth person should keep track of the number of winds of wire; about 50 winds (or turns) should be used for a small antenna and about 25 for a large antenna.

For the simple antenna design described previously, winding may be cumbersome. We found that if you place the frame on a spinning stool, with someone holding the center down so it doesn't slide off, it becomes easier to wind the wire. Also, we used two swiveling office chairs back to back in place of the stool and winding worked well.

If you are using a frame with a mast, here is another method to wind your wire:



Pictured (left to right): Sean Liu (Senior at Los Gatos High School), Ray Mitchell (Chief SID Engineer and Computer Science Instructor, Cal. State University, East Bay), and Eric Havel (Environmental Instructor, Chabot Space & Science Center)

This is the mast as described in appendix E. Attach the antenna to the mast but do not to tighten the wing nut. Allow the antenna frame to spin while winding the wire. This nut may need tightening (or loosening) as you proceed.

The person holding the spool of wire should insert a screwdriver or rod through the center of the spool and make sure that it is controlled while winding is occurring.

TAKE YOUR TIME... a fast job will produce sloppy results and could break something. Expect that it will take about 20 - 40 minutes to complete this step.

Step 2: Winding

To get started, on one side of the antenna, string out the wire from the center to one of the ends of the antenna frame. Use some transparent or masking tape to hold this wire in place. Be sure to leave enough slack on the end to eventually attach it to the terminal block.

The wire is wound around the frame; about fifty turns on a small size antenna, and 25 on a large antenna, should do. Keep tension on the wire while you do this: the person holding the spool has to make sure the wire is feeding properly and the person winding the antenna needs to assure that the wires are neatly going around in each of the slots.

On the final turn, go just a little further and run the return wire on the opposite side of the arm where you started and to the other side of the terminal block. Leave some excess and snip the wire with wire cutters.

Connecting your Antenna to the Terminal Block

Strip the two antenna wires about 3/8 inch back. Form a “J” hook in the antenna leads (the wire you just wound) with some needle nose pliers in a clockwise direction (the same direction that you are tightening the screw) as shown in figure 1, then place the “J” hook wire onto the terminal screw and tighten the screw as in figures 2-4. Connect the other antenna wire in the same fashion. Make sure they are connected to the same side of the terminal block. Some areas of the world do not allow exposed connections such as these, please be sure to check your local regulations for this equipment. A cover may need to be made or purchased for the terminal block in some situations.



Figure 1



Figure 2



Figure 3



Figure 4



Figure 5

In these photos the terminal block is not permanently attached to the antenna. You will need to make sure your terminal is attached. If your antenna is wood, placing screws in the empty holes will suffice. For a PCV antenna you may need to use zip ties or tape. A dab of glue might help keep the wires from loosening with time.

Installing the RG-58 Coax Cable

Now it is time to prep the coax cable for use. “Coax” is short for coaxial, meaning the cable has two conductors in the same axis, one center conductor, and a ground shield around the center connector. The RG-58* is a standard cable used by ham radio people and is available at electronics outlets (similar to Radio Shack if you are in the U.S.). Determine the length of wire you will need to run from your antenna to your SID monitor, plus some slack. Remember to consider both the horizontal as well as vertical distances when performing your calculations.

Carefully strip off about 2 inches of the outer sheathing of the coax cable with a sharp pocket knife or straight edged blade. Cut only deep enough to pierce the sheathing but **not** any deeper or you will cut the ground wire.



Figure 1



Figure 2

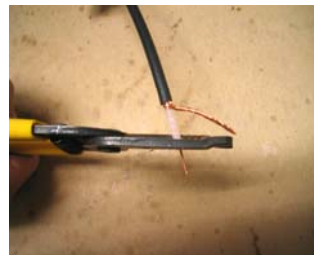


Figure 3

Pull the center conductor and sheathing through the ground wire and twist the ground wire as shown in figure 3. Next, strip the center conductor back about ½ inch as shown in figure 3 and 4. We recommend using spade connectors (figure 4) and a crimp tool to make the attachment to the terminal block easy (figure 5).



Figure 4



Figure 5

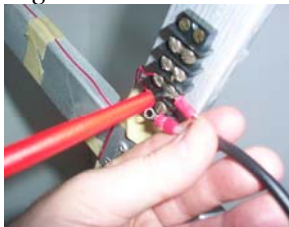


Figure 6



Figure 7

To attach the spade (ring) connected coax wires to the terminal block, unscrew the two screws on the opposite side of the connected antenna wires. Slip the ring over the screw and tighten back down (figure 6 and 7).

* Note: RG-59 could be used as well, although different terminators are needed. The two types have similar electrical characteristics, but different impedance. The RG-59 is used in cable systems and has a 75 ohm impedance; RG-58 is 50 ohms. Again, each needs a specific terminator.

On the other end of the coax you need a BNC (Bayonet Neill-Concelman) or TNC (Threaded N-Compact) connector to mate with your SID Monitor. Early SID monitors used TNC, later ones BNC.

A COAX stripping tool (figure 1) is commercially available to strip the ends to make assembly easier. However, the cost of the tool does not justify a purchase. It is easy enough to strip the end according to the instructions on the back of the package.

Strip the coax about 21 mm from the end. Cut or scrunch the ground wire so that it sticks out about 6.35 mm from the covered coax as shown in figure 2. Next, strip the center conductor about 14.3mm this is also shown in figure 2. Now place the center conductor into the hole in the connector (at the end of the shaft). Twist the shaft in a clockwise direction until screws are tight and covers any exposed ground wire as in figures 3 and 4. *If you are having trouble, cut a little bit off your center conductor and try again.*



Figure 1



Figure 2

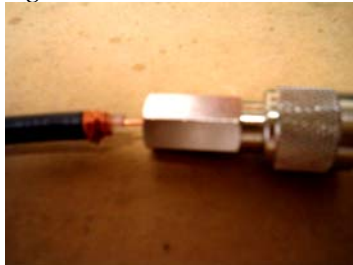


Figure 3



Figure 4



When your connector is finished it will connect to the monitor as shown above.

Step 3: Hardware Installation

Connecting the SID Hardware

Materials:

- Computer
- DataQ A/D converter
- SID monitor
- SID antenna
- Transformer
- AC power strip, connectors, etc.
- Powered speakers, if available
- Lightning protection equipment



Instructions:

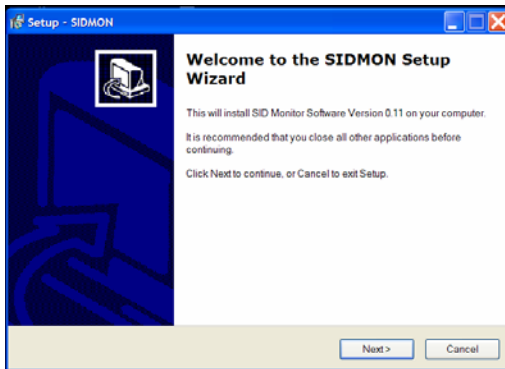
1. Start in the room where the computer is to be located. The VLF signal can penetrate deep into the Earth and seas so it can easily enter the room.
2. Set up your antenna
3. Set up your lightning protection equipment
4. Plug coax cable from antenna into the antenna input on the SID monitor
5. Plug in power to SID Monitor (LED should illuminate)
6. Plug the DataQ into the SID monitor
7. Set up the computer close to the SID monitor
8. Connect the RS-232 cable between the computer and the DataQ
9. If you have them, connect the powered speakers to the Audio Output on the SID monitor and adjust volume control.
10. If you have speakers, listen for a signal. A good signal will sound like a low tone, almost like white noise.
11. If you do not hear a signal, several things can be happening:
 - a. The transmitter is shut off for maintenance (this happens frequently)
 - b. The building is shielding the signal.
 - c. The antenna is not pointing towards the transmitter.
12. Orient the antenna “towards” the transmitter to achieve optimum reception:
 - a. The antenna loop should be standing vertical, not laying horizontal
 - b. Sweeping the antenna by rotating a little over 90 degrees, there should be a point where the signal will sound louder (thus stronger) than any other point. (Rotating 180 degrees makes no difference.)
 - c. In Step 5 we will do much more of a proper orientation.
13. Next test if the computer monitor, room lights, or other equipment will interfere with the signal. The signal will change to a buzzing sound if it is interfering.
14. NOTE: “Clicks” and/or “Pops” are normal sounds to hear. It is okay even if coincident with switching inductive loads (transformers, motors, monitors, etc.) just as long as it is not constantly adding to the signal.
15. If the room has too much interference, repeat this process for each candidate location until a suitable location is found.
16. NOTE: **Once the antenna is located and oriented, the antenna should not be moved!** (otherwise the data collected will be slightly different)

Step 4: Installing your SIDMON Software



Software Installation

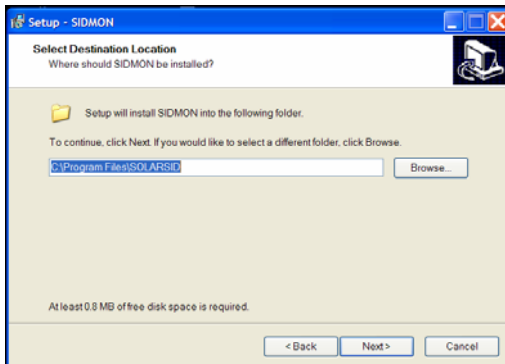
Insert the SIDMON CD. The installation program should pop up and walk you through the process. If it does not, then search the CD and run the “Setup.exe” program located on the disk.



The Welcome Screen

- Note: If you are installing on top of an existing version, be sure to save your configuration file(s) to a different location first! (Then copy them back afterwards)
- Press “Next” to continue →

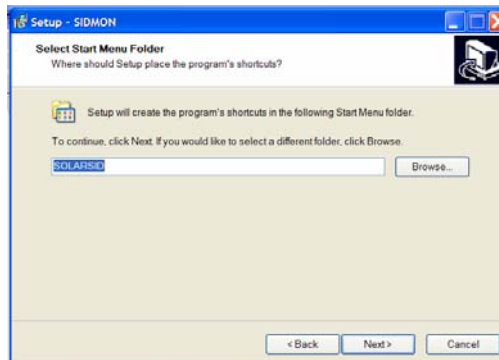
Decide on the Folder to install the application.



- **C:/SOLARSID** is the typical location, however you can install them anywhere. No need to change the default unless you have a good reason.
- Press “Next” to continue →

Select a Start Menu Folder

- The default is called SOLARSID; unless there is reason to call it something different, accept the default.
- Press “Next” to continue →



a

- Press “Install” to continue →



- The installation is fast and should complete in 2 – 4 seconds.
- A “readme.txt” file pops up. You should read this to learn how to customize and configure your SIDMON software.
- Click on “Finish” to exit the installer.

Here is a summary of the directory structure of the installed SIDMON Software:

- \Bin:** Binary files (executable programs)
- \Conf:** (Configuration)
- \Data:** Your data files will go here.
- \Docs:** (Documents): The SID manual, technical documents, etc.
- \EventLog:** ftp and similar computer events are logged here. This is for auditing and troubleshooting if there are problems. The logs are stored in a new file every month. If there are no events, then no log for that month will be created.
- [\ToSend:** A directory where data files will be put if you set up sending of files to Stanford. This file will only exist once you enable FTP.
- NotToSend:** disabled FTP directory]
- \tmp:** (Temporary files) The data logger uses this area to keep track of current data logging activity and for internal logging events. **Do not delete files from, modify, or open files in this directory.**

Start > Programs > SOLARSID > Apps > FTP Sid Monitor Data
 > SID Monitor Application
 Start > Programs > SOLARSID > Folders > DATA Folder

> Documents

[illegible]

Start > Programs > SOLARSID > Config > SID > Edit SIDMON Config File

Start > Programs > SOLARSID > Config > Read Me info

Start > Programs > SOLARSID > _uninstall > Are_you_Sure > Uninstall SID Software

SIDMON.EXE Configuration

1. Find the following pieces of information before you edit the SIDMON configuration file (SIDMON_Config.txt):

- Your site's 3-6 letter Identification: _____
Should be on your packing list
- The SIDMON unit's serial number. It is in the form S-xxxx

This will be written directly on your monitor

- The monitor unit's Station ID and frequency: _____
This will also be written on your monitor
- The latitude and longitude of your site, in decimal form (ddd.ff): _____

You may need to use a good map or the web to find this

To convert your latitude from degrees, minutes, seconds to ddd.ff

North is Positive

South is Negative

$$\text{Latitude} = \text{Degrees} + (\text{Minutes} / 60) \text{ [round seconds to nearest minute]}$$

Example:

N 37 39'

$$= +37 + (39 / 60)$$

$$= +37 + (0.65)$$

$$= 37.65 \quad (\text{it is ok to round to nearest degree})$$

To convert your longitude from degrees, minutes, seconds to ddd.ff

East is Positive

West is Negative

$$\text{Longitude} = \text{Degrees} + (\text{Minutes} / 60)$$

Example:

W 122 7'

$$= -122 + (7/60)$$

$$= -122 + (0.1167)$$

$$= -122.12 \quad (\text{ok to round})$$

Example:

1. Site = WSO
2. Latitude = 38 Longitude = -122
3. MonitorID = S-0001-FB-0010
4. StationID = NLK Frequency = 24.8 KHz

2. Edit the configuration file, by going to the Start menu:

Start > Programs > SOLARSID > Config > SID > Edit SIDMON Config File

(The default location for the file is c:\SOLARSID\CONF)

This will automatically open the file in Notepad. You could use another editor as well, but remember to save your file as ascii (i.e. “.txt”). Initially, the file will look something like:

```
Site = * NONE *, Longitude = 0, Latitude = 0
Device = DI-194RS, Port = COM*
Channel = 1, DataType = SOLAR-SID, StationID = NAA, Frequency = 24.8 KHZ, MonitorID = S-0000, SampleRate=5
```

Your editor will probably wrap the long last line. DO NOT add any line breaks to this line, or any others!

Line 1: refers to the site name and its longitude and latitude. Replace *NONE* with your site name. Replace the ‘0’'s with your own latitude and longitude.

Line 2: Refers to the analog-to-digital device. Currently we are using the DATAQ DI-194RS. “COM*” means to check all communication ports.

Line 3: Sets of keyword=value pairs, starting with the channel of the device.

Change the S-0000 monitor ID above with your own.

Most sites monitor the NAA, 24.8 KHz transmitter in Maine. If you are NOT monitoring this transmitter, change the call letters and frequency to those you are.

[Lines 4-5, if they appear: Actually these are a continuation of line 3. The word wrap causes them to appear as another line. **IMPORTANT: Avoid the temptation to place Carriage>Returns (line breaks) to make the line “fit” on the screen.** The SIDMON program parses these lines and expects information in certain locations.]

Here is a comprehensive set of config file rules:

1. A '#' on a line indicates a comment and the remainder of the line is ignored.
2. The syntax for each line is (in BNF):
`<name> = <value> [, <name> = <value>]* <CR>`
 This means you put a name (keyword) followed by an equal sign, followed by a value. You do not type the angle brackets < and > around the words. You can put as many of these pairs as you need per line.
3. The definitions in this file are per line and can be very long.
Do not separate Site, Device, or Channel keyword name-value pairs on different lines because the end of a line ends the current definition and begins a new one.
4. You can only use permitted keywords (see below). You should not define your own keywords.
5. * DO NOT * put commas (,) between your “value” words. The parser will interpret this comma as a separator for a new name-value pair.
6. **Anything you define with these keywords will appear in the Data Log files this program generates. If you contribute data to the centralized database at Stanford, your information will be accessible to EVERYONE.**

There is a comprehensive list of Config file keywords in the appendix D.

Step 5: Install and Align Your Antenna

You have already tested your antenna. Now it is time to select a location and properly align it (i.e. point it in the proper direction). (You do not need to have the computer or DATAQ attached for this step.)

Note: The VLF transmitter stations generally “go down” for maintenance once a week. These schedules are not published but you will learn their times after using your SID for a while. There is a chance that the transmitting station might be down for maintenance when you try to install and align your antenna. So, if you are not picking up a signal, try again at a different time or day.

- ☐ Go to location where you plan to install the antenna.
- ☐ It is helpful to have the SID monitor at the antenna site while aligning the antenna. So temporary AC power, with at least two power outlets (sockets), is desirable. If AC power is not possible at the antenna site, then run the antenna coax to the SIDMON and use walkie-talkies, cellular (mobile) phones, or other signaling means to communicate.
- ☐ Connect the antenna to the SIDMON antenna input jack using the BNC or TNC connector.
- ☐ Plug in the AC transformer for the SIDMON and connect to the power input jack on the SIDMON.
- ☐ Connect your powered speakers to the “Audio” port on the SIDMON (most likely requires you to connect the power supply to the speaker). The speakers do not have to be stereo; the output will be directed equally to both channels. **DO NOT CONNECT HEADPHONES or speakers that are not powered to the audio output.** (However, if your power speaker provides a headphone feature, it is okay to connect headphones to the powered speaker headphone jack to help you hear the signal better.)
- ☐ Place the SIDMON gain switch on x5, or, if too faint and you’re already on the maximum speaker volume, then try x10. (If the station is down for maintenance you will not hear anything; try again on another day.)
- ☐ Use a map, and possibly compass, to estimate the direction of the VLF station you are trying to receive.
- ☐ Rotate your antenna around to get the strongest (loudest) signal. Counter-intuitively, you do not want your antenna frame to “face” the station. Grab the antenna frame with your right and left hands, holding it flat against your chest. Start by your facing in the direction of the transmitting station. Then turn your body clockwise 90° (if your station is due north, then you will now be facing due east). The left edge of the antenna frame should now “point” towards the source.
- ☐ A good signal will sound like rushing wind. Sometimes there might be tones heard on the signal. Listen to the MP3 samples we provided of the VLF signal so you can identify the sound that you are searching for.
- ☐ Once you find the direction with the best signal pickup, secure the antenna in this orientation.
- ☐ Set gain switch back to x1
- ☐ Remove powered speakers (important!)
- ☐ Route cable to permanent location for SIDMON

Step 6: Calibrate the SIDMON

Immediately after aligning your antenna you will need to calibrate the RF gain input on it. You should have the DATAQ and computer connected at this stage. The computer needs to have the software installed and the SIDMON program configured for your site.

These instructions assume that there aren't any solar flares occurring while these steps are being performed.

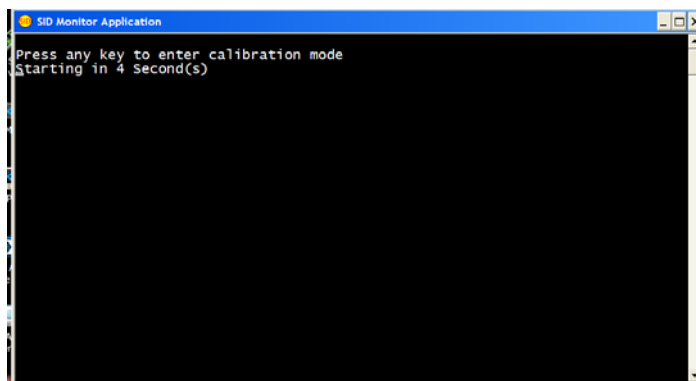
- ☐ Connect the DATAQ data cable with the green connector to the SIDMON.
- ☐ Plug the DATAQ's RS-232 cable to the computer. If the computer does not have an RS-232 serial port then you need a USB-to-RS-232 converter (readily available at most computer stores)
- ☐ Make sure the powered speakers are not connected.
- ☐ Make sure the gain switch on the SIDMON is set to x1.
- ☐ Start the SIDMON program; press a key to enter the CALIBRATION mode.
- ☐ Identify the channel where your SIDMON is connected. By default we have made it Channel #1.
- ☐ Take the provided DATAQ screw driver and adjust the RF gain SLOWLY – and I mean VERY SLOWLY (takes 2 to 5 seconds to register the adjustment) to reach a value somewhere in the range of -1.25 and -1.50. And yes, that is not a misprint – it is a negative voltage.

Time	Estimated Voltage Range
Nighttime	+2.0 to +3.0
Early Morning (After sunrise)	-1.0 to 0.0
Noon	-1.50 to -1.25
Late Afternoon (before sunset)	-2.0

Warning: One user reported that when he wrapped on the R3 (RF Gain adjustment), the signal level on the oscilloscope jumped around. This means if/when a user drops a unit or gives it a jarring shock, the monitor's output level should be checked because it may need its RF level readjusted...

Software

Before starting the software you **must** configure it.



The software welcome screen gives you 5 seconds to directly enter into the calibration mode by pressing a key (e.g. the space bar).

If you do nothing, in 5 seconds the program will enter into the data collection mode per the configuration file.

Below is the main screen:

Modes:
Calibrate or Datalog

Real-time clock

Data Device
COM* = Config file
COM1 = found device

ID = VLF station and serial number

Real-time Voltages

Channel numbers for a DI-194RS are 1 thru 4. Channel 1 is assigned for the SIDMON, it is configured in the config file.

Port	Device	Chan	DataType	ID	Data	MODE	Rate
COM*	DI-194RS	1	SOLAR-SID	NLK_S-0001	+2.441	OFF-LINE	5
ON-Line: COM1		2	Unassigned		+2.441	N/A	0
		3	Unassigned		+2.441	N/A	0
		4	Unassigned		+2.441	N/A	0

Current mode:

There are two modes, Datalog and Calibrate. When the program is in Calibrate mode the data values are not being logged. This mode is necessary to make adjustments to the SIDMON and see the results without saving them as data to a file. Once the SIDMON is calibrated, then switch to the Datalog mode to save the data to a file.

To switch between Datalog and Calibrate modes you go through the menu. Press the ESCAPE key to get the menu, then press 'C' for Calibrate or 'D' for Datalog. A second ESCAPE leaves the menu.

Menu:

Pressing ESCAPE gives you menu choices at the top of the screen

D = Data logging mode (collect data in a file)

C = Calibrate (use this while setting up the SIDMON)

S = Scan for Devices (Analog input devices, such as the DATAQ)

Q = Quit (Exit program)

ESCAPE = leave the menu, go back to previous operation.

Monitor Site:

This is your 3-or more letter identification of your site. For example WSO stands for the Wilcox Solar Observatory, SLHS is for San Leandro High School. A site ID will be

assigned to you to prevent same ID's at various sites. You will need to set this value in the config file.

UTC:

This is a real-time clock according to system time. The MS Windows clock is notorious for drifting and being too far off. This can cause problems in data comparison with other SID / AWESOME sites or GOES satellite data. There are methods for keeping the time synched to UTC. The most inexpensive is to install a program that gets a time served from the Internet. Using WWV time reference and GPS timestamp are also options. Or, everyday you could check and set the clock manually.

Port:

The computer needs to know the port, or input plug/location, where your SID monitor and DATAQ are connected to the computer. This has two lines of data. Line 1 has the name of the port from the config file. We use the default value of COM*, which means the computer should look for the DATAQ on communication ports 1 thru 20. When the actual location is discovered, Line 2 will report both the port discovered and the status. In the example it was discovered on COM1 and it is on-line.

Should the cable be disconnected for any reason, just plug it back in to the computer (on any valid port – and it does not have to be the original port). The system will automatically recover and resume the operation of the current mode (e.g. Data Logging).

** Caution: in the rare situation should your site be using more than one DATAQ device (that implies more than 4 SIDMON / instruments) you cannot use port definition COM* and thus the COM ports would no longer be interchangeable.

Device:

This is the analog-to-digital converter (ADC) device. Currently we only support the DI-194RS from DATAQ Corp.

Channel:

This is the channel number on the analog-to-digital converter (ADC) device. The DI-194RS from DATAQ Corp. has only 4 analog channels, numbers 1 through 4. As default, we ship Channel #1 connected with the data cable.

Data Type:

This is the type of data being collected. Your SID monitor produces SID-DATA type. If nothing is assigned then the channel shows as “Unassigned.”

ID:

This is the data collection's unique ID. It is the combination of the VLF station being monitored plus the SIDMON serial number. The general form is

vvv_S-nnnn

where vvv = the VLF station such as NLK, NAA, etc.

nnnn = the 4 digit SIDMON serial number.

Data:

This is the real-time data voltages for all channels (whether assigned or not).

Mode:

This tells you the status of the channel. The possible messages in this space are:

OFF-LINE	Data logging will not occur for this channel. If the mode were changed or started up, this message might appear until the sample rate updates the message
ON-LINE	All is well with the channel and it is ready to perform logging
LOGGING	The data is being written to the data log file
FILE WRITE ERROR	An error occurred while attempting to write to the data file. This could be a result of the disk being full or if a data file is opened by Excel in the /tmp directory (a no-no)
COM LINK OFF	This tells you that the DATAQ has been disconnected

Rate:

Rate is “sample rate in seconds” of the SID monitor. Currently we sample once every 5 seconds. The value is an integer that can range from 1 to 3600 (once every hour), should that be necessary. It cannot be made to sample less than one sample per second.

Note: If done with care, the unused inputs on the DATAQ could be used for monitoring other quantities if appropriate sensors are available. Examples might include outside temperature or other weather conditions.

Step 7: Collecting Data and Troubleshooting

Once your hardware, software, and antenna are installed, you are ready to try to get your system to work. The Data Handling and Analysis section will detail several ways to get a graph. The easiest is to use a little tool that should have been installed with your distribution (if the SIDPlot directory is not there, copy it to this location from your SID distribution disk):

C:\SOLARSID\SIDPlot\plot.bat

To obtain a SID graph from your data, use your mouse to drag a properly formatted SID data file icon onto the “plot.bat” file icon, and a graph will pop up in a new window. For example, drag the SampleData-1.txt file icon, in the above directory, onto the plot.bat icon. (The chapter on Data Analysis will give more details.)

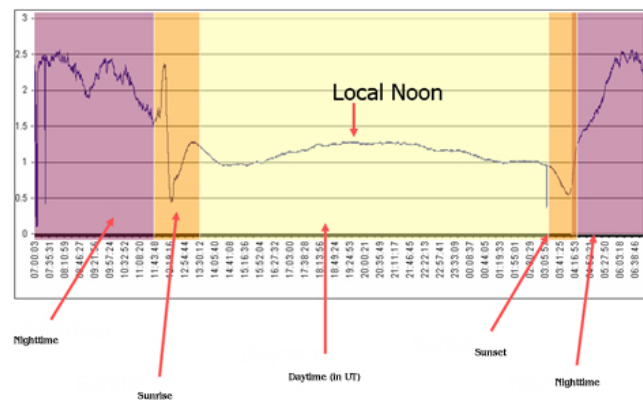
Once you start generating them, your SID data files should be located in:

C:\SOLARSID\Data

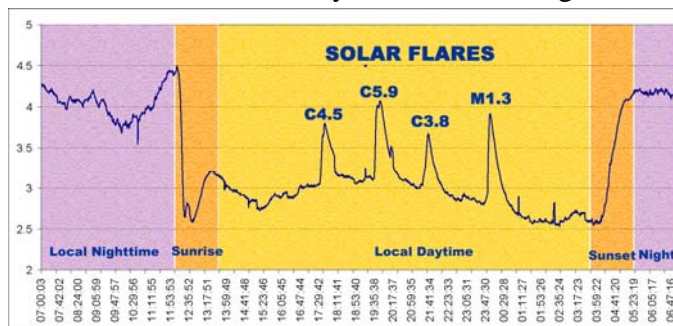
Much can go wrong when trying to set up your SID monitor. The best way to diagnose the problem is run the data log for at least 24 hours to see if you get the sunrise and sunset effects. When you can consistently pick up your sunrise-sunset effects, you are ready to trouble-shoot, if necessary.

Your initial goal is to produce a data graph that looks roughly like this, a normal day without any flares:

Normal 24 Hr. Day (No flares)



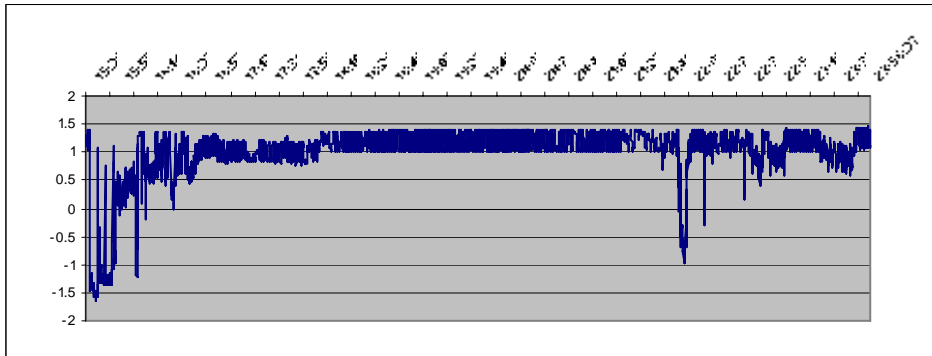
We added the colors, arrows, and labels to help you understand the chart. The chart below shows a similar day but with 4 strong flares:



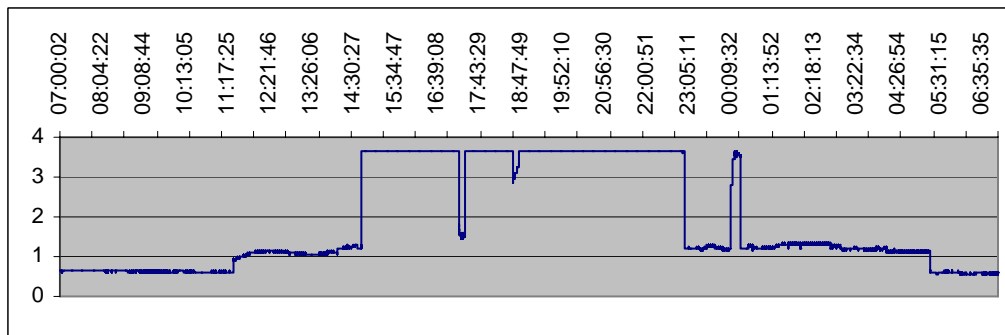
Note the characteristic change in signal strength, usually a drop, at sunrise and a subsequent return to night values (i.e. rise) at sunset. The spikes on the above graph show ionospheric response to solar

flares. However, spikes can also occur due to electrical interference, we will discuss interference in the next section. Also, please see our list of common sources of interference in the appendix.

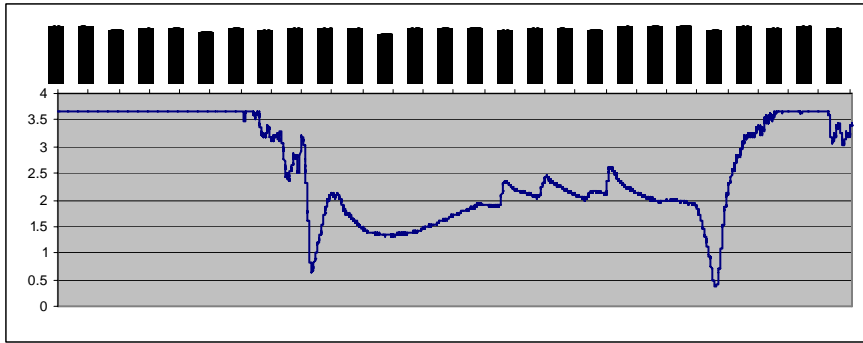
Trouble-shooting your Data



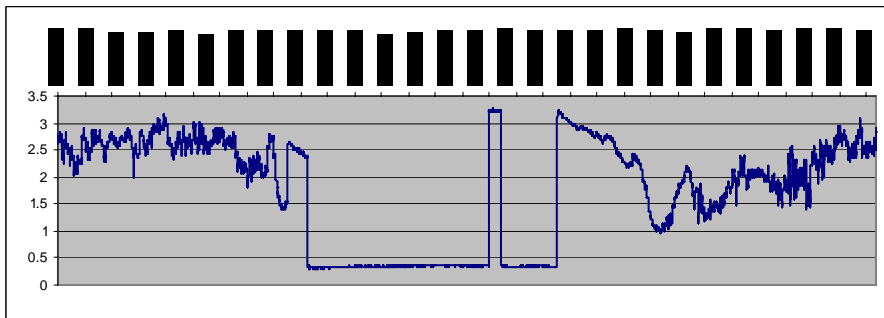
Above is a graph taken from a very “noisy” environment. Its problem is interference from some local electric device(s). Whatever is causing the noise, it completely swamps out the sunrise / sunset effects. Solution: Move the antenna to a new location. Try to get it outside. At this particular site the noise source was determined to be old fluorescent light ballasts. We could not put the antenna outside so we moved it to another location.



Here is a graph taken from an uncalibrated SID monitor. The graph is hitting an upper limit called the “voltage rail,” meaning the output’s range has been exceeded to display the data. (This particular graph came from an earlier SIDMON version at 3.6 volts; the recent SIDMON models have their rails at ± 5 volts.) Solution: Decrease the RF input gain control by follow the directions in “How to Calibrate Your SIDMON”



Here is another graph that's better than the previous graph, but suffers from the same problem. At least the sunrise and sunset is visible and we see a few flares on the graph. However the nighttime data is still hitting the upper voltage rail. The solution is to reduce the RF input gain as above.



This is a normal graph for when the transmission station is shut down for routine maintenance, which most stations do weekly. When a station goes down for maintenance, you simply wait until it returns. If in doubt, contact another SID user monitoring that same station to see if they are getting similar results. In the rare case where a station stops sending signals for a long period of time, contact the Solar Center and ask for a different frequency board.

Data Log Files

When the software is in "Datalog" mode, it will produce data files. Usually these are for 24-hour stretches, but they can often be shorter when you are configuring or changing your setup. For each station listed in the configuration file, the software will produce a separate data file in the data directory.

Information is stored both in the data files and in their names. A sample filename is:

20051230_010200_NLK_S-0001.CSV

Parsed as this:

Year	Month	Day	_	Hour	Min	Sec	_	Station ID	_	Serial #	.	CSV*
2005	12	30	_	01	02	00	_	NLK	_	S-0001	.	CSV

*CVS stands for “Comma Separated Values.” Calling a file .CSV makes it easy to open it as an **MS Excel**[®] file. However, you can use any data graphing / processing program you like including ones that you write yourself!

The filename is based on the timestamp for the first entry in the data log file. On rare occasions there might be multiple data log files for the same day if you do any of the following operations: restart the SIDMON software, leave then re-enter the “Datalog” Mode, rewrite or save changes to the configuration file.

The file format is as follows:

All header lines start with a ‘#’ and act as a comment. The header consists of several comment lines

<Header line 1>

<Header line 2>

< Etc. info... multiple lines depends on number of items in the configuration files>

After the header is completed there will not be any more comment lines, then the data follows:

<Timestamp 1>, <Data 1> [<New Line>]

<Timestamp 2>, <Data 2> [<New Line>]

<Timestamp 3>, <Data 3> [<New Line>]

etc.

Example snippet from the file: “**20051015_000000_NLK_S-0001.CVS**”

```
# Site = RDM
# Longitude = 37.67
# Latitude = -122.08
#
# UTC_Offset = -07:00
# TimeZone = Pacific Standard Time
#
# UTC_StartTime = 2005-10-15 00:00:00
# StationID = NLK
# Frequency = 24.8 KHZ
# MonitorID = S-0001-FB-0010
# SampleRate = 5
2005-10-15 00:00:00, -1.934
2005-10-15 00:00:05, -1.895
2005-10-15 00:00:10, -1.895
2005-10-15 00:00:15, -1.836
2005-10-15 00:00:20, -1.87
... and so on
```


Step 8: Send your Data Files to the Stanford Data Repository

When you are sure your monitor is set up and your data being accurately recorded, you can arrange to send your data files to the Stanford data repository, where students all over the world can share each other's data:

<http://sid.stanford.edu/database-browser/>

1. Edit the FTP configuration file

Using the Windows Start Menu:

START > Programs > SOLARSID > Config > FTP > Edit FTP Config file
(Or you could directly edit the file C:\SOLARSID\Config\ftp_cmds.TXT)

2. Inside the file replace MY_SITE_NAME with your appropriate site name:

```
lcd ToSend\Sending
cd incoming/SID/MY_SITE_NAME <<< replace with your site name
mput *.csv
quit
```

3. Enable the FTP directory.

Via Windows Start Menu:

START > Programs > SOLARSID > Config > Enable FTP Directory
Or, from the command line or a folder browser:
rename "NotToSend" to "ToSend"

This creates a sub directory called "ToSend". At the end of every UTC day (00:00 UTC) the day's worth of data is copied to this directory.

4. To send the data, you have two choices:

- a) Set up a script to automatically send your data daily. In WindowsXP, this is the "Scheduling Task" tool. You must have administrator privileges to set this up.
- b) Launch the script manually every day (necessary for Win98 systems). You can do this by

Windows START > Programs > SOLARSID > Apps > FTP SID Monitor Data
or from the command line or folder browser:
C:\SOLARSID\BIN\SIDsend.bat

The best time to FTP your data is a little while past 00:00 UTC time, since the data logger begins new files at that point. However, you can ftp your data any time and as often as you like. The data logger will keep track of where it is and regenerate any needed files. Those files will eventually replace any partial files that you send mid-day.

Chapter 3: Safety and Maintenance



Photograph by Alan Moller
NOAA / NWSFO

You are responsible for safety in the installation of the antenna and securing the antenna so that it cannot cause damage should it be blown around or the cable yanked by a curious person. If you cannot ensure a proper installation, then find someone who can professionally install your antenna for you.

Lightning and Antenna Placement

You **must** consider these issues on your antenna installation:

1. What would happen should the SID antenna be **struck by lightning** – would anyone get hurt? Unfortunately should the antenna be struck by lightning, the SID detector will be damaged beyond repair. Place the antenna in a location least likely to be struck and add whatever safety devices are necessary for your location.
2. The antenna should be placed in a location where it will not be disturbed. If the antenna were blown around or off a roof would anyone get hurt or would property get damaged? Take extra steps to secure the antenna. The cable should have some strain relief to prevent the coax from being pulled or tugged.
3. Does the coax cable cause you to have an open window or door? Does this pose a security risk of a break-in, or outside weather from entering the building?

4. What wiring codes or policies does your local government have? The antenna wire is passive and itself does not have any power on it, but still, there might be some rules to observe. For instance, the exposed terminal block may need to be covered according to your local laws.
5. And last, but not least, use common sense – each installation will be unique and of course we can't cover everything you may encounter, but you should take the time to research and plan this installation.

Antenna Maintenance

Your antenna needs very little maintenance if construction and installation are done properly. Periodic checks of the antenna should be made for signs of corrosion or deterioration. If the signal should suddenly drop out, the antenna should be checked to make sure it has not been moved or turned. Note: VLF stations periodically shut off the signal for maintenance.

If any maintenance is to be done it is important to mark the location and orientation of the antenna with something such as paper, tape, or chalk before touching the antenna. This will assure that the antenna can be returned to the exact same orientation and will produce similar results as before.

Monitor Maintenance

You should not need to adjust your monitor. Its internal adjustments were not designed for student use. If you have a problem with your monitor, contact the Stanford Solar Center for help:

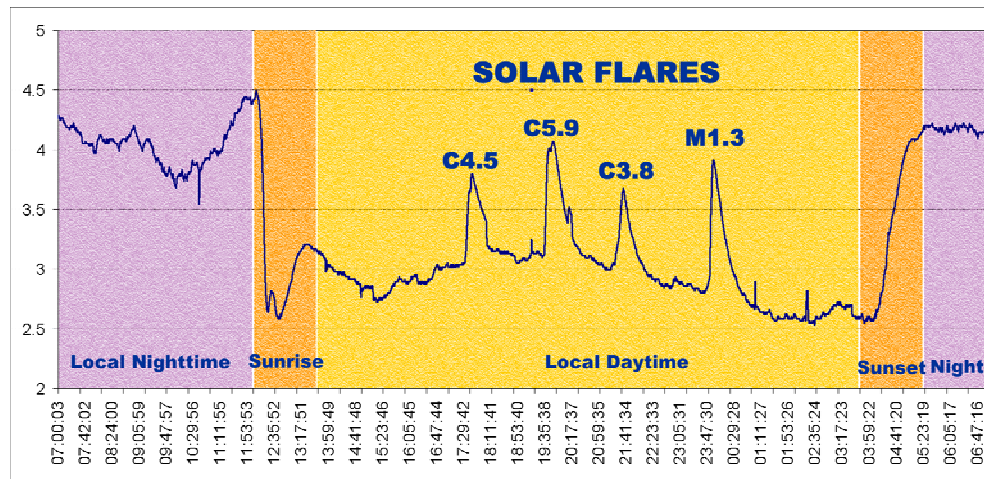
SID@sun.stanford.edu

Frequency Board Replacement

Your monitor was shipped with a frequency board tuned to pick up a particular station. If you would like to experiment with receiving different stations, you can request additional frequency boards from the Stanford Solar Center. There may be a small distribution charge:

SID@sun.stanford.edu

Chapter 4 Data Handling and Analysis



SID data can be thought of as similar to seismograph data – a tracking of signal strength over a period of time. The data format is little more than a timestamp and a signal strength value. These can be easily fed into tools like gnuplot Excel to automatically produce a graph such as the one above (NOTE: we added the labels and colors to the graph ourselves.)

In the graph above, note the characteristic sunrise and sunset shapes. You will see these every day with your own monitor.

The 4 large peaks in the graph are 4 events caused by solar activity. The two smaller peaks in the “daytime” represent unknown events, which may either be produced locally by interference, or something else. Research will be needed to help determine the source of these events.

If you wish to share your data with others, and/or view others’ data, the Stanford Solar Center provides a centralized data repository accessible via the web:

<http://sid.stanford.edu/database-browser/>

The repository supports a collect of SID user data as well as direct links to the GOES satellite data that is monitoring solar activity from space.

To View Your Data With Our Tools (gnuplot)

Your SID distribution disk contains a little graphing tool that will take a file’s worth of SID data and immediately plot it for you. Once you copy the files off the distribution disk, **to obtain a SID graph from your data, use your mouse to drag a properly formatted SID output text file icon onto the “plot.bat” file icon, and a graph will pop up in a new window.**

These files should have been installed on your system into:

C:\SOLARSID\SIDPlot

If they have not, then copy them from your distribution disk to this location.

Contents of the SIDPlot folder:

plot.bat	a Microsoft Windows script that will invoke the wgnuplot.exe program to plot your SID data.
SampleData-1.txt SampleData-2.txt	Sample SID data files
plot3.7.2	Plot settings file
wgnuplot.exe	The three wgnuplot files are to execute graphing and to help understand the program called GNUplot.
wgnuplot.GID	
wgnuplot.hlp	

To test the program, drag the icon/name of one of the two sample SID files we provide (above) onto plot.bat. You should see a graph pop up right away. Plot.bat calls up the GNUplot software to do the graphing, using the settings dictated in the file plot3.7.2. There is no installation procedure other than copying the files to your system.

GNUplot is a flexible graphing program based on open source software. We chose it for its simplicity, its flexibility, and because you, the user, could modify and improve the settings if desired. We hope that as you become familiar with GNUplot, you will find it easy to work with, and strong enough to grow with your research.

In order for GNUplot to plot your SID data successfully, it is important that you give it a file it will understand. Look at the examples provided with your distribution disk for comparison. Your SID software should produce properly formatted SID output text files. Look for them in C:\SOLARSID\Data.

The settings and information for how the plot will appear on your screen (color, length, tick marks, et cetera) can be found in the file named “plot3.7.2”. We encourage you to change that file to your own preferences if you wish. (Save a copy of the original as a backup, in case you decide you need the original later.)

For information on each setting in the plot3.7.2 file, view the plot3.7.2 file and then consult the help file for GNUplot: wgnuplot.hlp.

There is no need to open or edit plot.bat unless you wish to learn about it or modify it. (If you decide to change plot.bat, we strongly encourage making a backup copy first.)

Some settings that you might change in plot.bat are :

- 1.The plot window settings. That is referenced in line 3. In the default case the window size is 1:3, and has no title (hence the “” after the word title).
- 2.The name of the settings file “plot3.7.2”. You may wish to use your own settings and even set up a few different “plot.bat” files with name variations. For example, you may have plot_a.bat that references “plot.abc” as the settings file, and plot_b.bat that references “plot.xyz” as the settings file, depending on what you wanted to see from your SID plots.

If you make changes to the settings file, or make improvements to plot.bat that you feel might be helpful to the SID community, we would love to hear about it. Perhaps we could build an online library at the SID website to facilitate graphing in our community. You are part of that community, so please contribute any helpful programs via email to **sid@sun.stanford.edu**.

To Collect and View Your Data With Microsoft Excel

1. Retrieve and save one of your data files: Typed commands are in bold, do not type quotes.

Open Command Prompt

- Start Menu → Run → **cmd**
- or Start Menu → All Programs → Accessories → Command Prompt

Find the data file

- Type '**dir**' to see file directory
- To select a folder, type '**cd**' and then the folder name

If necessary, change the file type to **.csv**

- Type '**rename *.* *.csv**'
- Type '**exit**'

2. Open your file with the Microsoft Office Excel program

Select column A and B

Open chart wizard (Alt-I-H)

Select chart type: Line

Select chart sub-type: Line

Click <Next>

Click <Series>

Select Category (X) axis labels: Select column A

Click <Next>

Click <Next>

Click <Finish>

Right-click on Y axis

Click <Format Axis>

Click <Scale>

Set Minimum: -6

Set Maximum: 6

Set Category (X) axis Crosses at: -6

Click <Ok>

To save the graph in Excel format, select "File→ Save as"

Interpreting Your Results

After importing your data into a graphing program as explained above, you should have a line graph that looks a little like a seismograph. These graphs yield information about the Sun and how it is affecting the Earth. You will also find other more "local" events that interfere with the solar data but also provide us with information that is useful. Finally, you will be confirming

your data with the GOES satellite data found in the Space Environment Center (SEC) online database. If you wish, you can even track the event you located back to the sunspot or active region that produced the flare!

Reading Your Data

Look at graphs from several days at first to see what patterns emerge. Every day should have a distinctive sunset and sunrise pattern. For solar tracking, we are only concerned with the day time hours. Notice how the graph is sloped sharply downward at sunrise and sharply upward at sunset. The area between them is where we will be doing our flare hunting.

Comparing a few graphs, what patterns in the data can you see? Is there a sharp spike every day at the same time or is the graph really spiky all the time? Get a “feel” for what your SID monitor is like. Sometimes data is more rounded and sometimes it spikes sharply, it depends on what other “noise” your detector is picking up. Noise can’t always be helped so it’s a good idea to see what the background signature of your SID monitor is.

Are there places in your data where the graph “flat lines?” If you have several weeks of data, you might see a pattern to the timing of those flat lines. Each of the VLF transmitting stations goes down for maintenance about once a week, usually on a regular (albeit unpublished) schedule (though the schedules frequently change). After a few weeks of data collection, you should see a pattern that responds to your station’s maintenance schedule.

The next step is more fun, rather like a treasure hunt. Look at your graphs to see if there are any large spikes in the data. The spikes will rise very steeply, come to a peak, and then taper off. These are possibly flare signatures. For SID monitors, our nemesis is “noise”, interference from sources other than the Sun. Sometimes noise is very clever and tries to look like a flare but there is a way to know for sure. We have to check our data with the data from the GOES satellites. They don’t get the same interference that we do because they are in space. Note that the GOES satellites are tracking emissions directly from the Sun, while your SID monitor is tracking the Earth’s response to those emissions.

If you don’t have access to the internet, skip the next section.

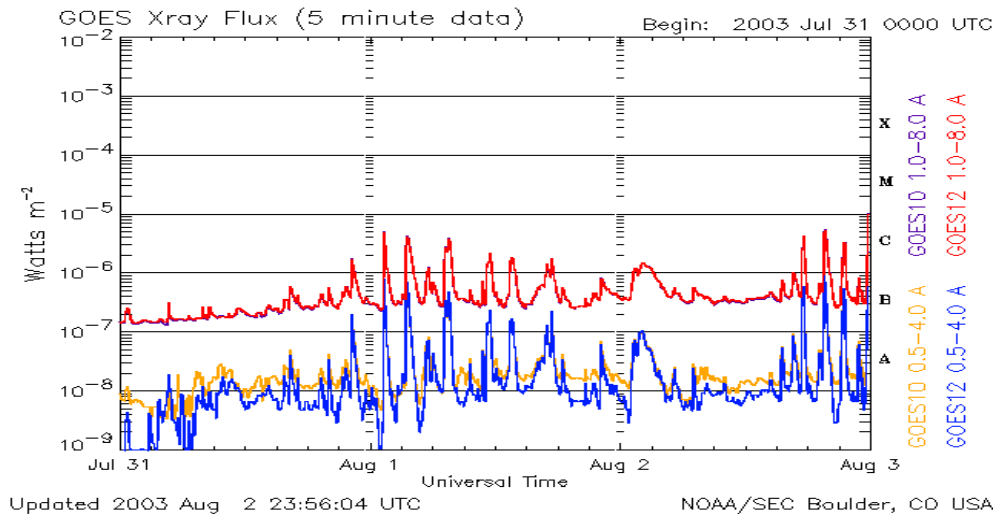
Did you pick up solar flares?

If you think you are seeing a flare happening right now, or in the last few hours, check:

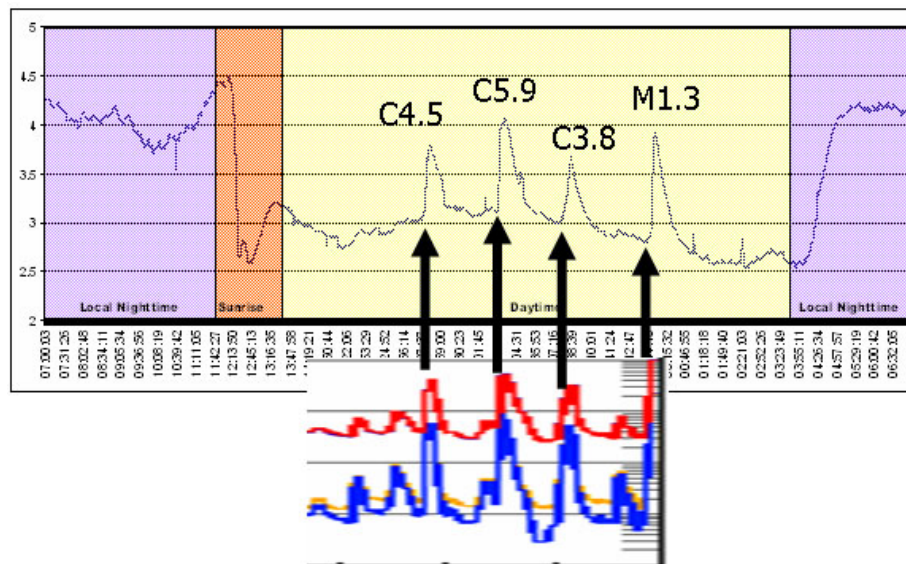
http://www.sec.noaa.gov/rt_plots/xray_5m.html

This site shows data similar to yours, though taken from the GOES series of satellites that constantly monitor the Sun’s X-ray output. The graph usually shows data for the last few days (note that the times are given in UT time). It is updated every 5 minutes, so if a solar flare is happening, you can see the changes in the graph!

A sample GOES graph is below. The different colored lines represent data from different channels and different satellites. You only need to pay attention to the uppermost line.



Now you can compare your graphs and match up potential flares with those taken by GOES:



You can find GOES data graphs for previous days at:

http://www.lmsal.com/SXT/plot_goes.html?goes=Access+GOES+Data

However, if more than a couple days have passed since a potential flare showed up on your graph, you can check the GOES catalog of flares at

<http://www.sec.noaa.gov/ftpmenu/indices/events.html>

(Above the dates you will see links to *Top-level directory* and *To parent directory*, that take you to other data pages on the SEC site. You might enjoy exploring these.)

Here you will see a list of dates -- links to a particular day's solar data. The dates are in UTC time (Coordinated Universal Time, similar to GMT where the boundary lies at Greenwich, England). You probably won't live in that time zone, so you need to be able to convert to your

local time. There is a chart in the appendices or you can use an online tool at <http://www.timezoneconverter.com/cgi-bin/tzc.tzc>.

Find the day you want to investigate and click on the link. You will find a page that looks similar to the chart below:

:Product: 20050831events.txt

:Created: 2005 Sep 01 2102 UT

:Date: 2005 08 31

Prepared by the U.S. Dept. of Commerce, NOAA, Space Environment Center.

Please send comments and suggestions to SEC.Webmaster@noaa.gov

#

Missing data: ///

Updated every 30 minutes.

Edited Events for 2005 Aug 31

#

#Event	Begin	Max	End	Obs	Q	Type	Loc/Frq	Particulars	Reg#
7520 +	0018	0023	0033	G12	5	XRA	1-8A	B1.6 1.3E-04	0806
7520	0024	0024	0024	G12	5	XFL	S18E35	5.0E+01 8.4E+01	0806
7530 +	0052	0110	0123	G12	5	XRA	1-8A	B5.0 5.9E-04	0806
7530	0055	0111	0122	G12	5	XFL	S18E34	8.5E+02 2.1E+03	0806
7540	0155	0156	0156	PAL	G	RBR	410	480	
7550 +	0952	1002	1008	G12	5	XRA	1-8A	B3.2 2.2E-04	0806
7550	0958	1003	1007	G12	5	XFL	S17E32	6.5E+02 1.6E+03	0806
7560 +	1026	1151	1251	G12	5	XRA	1-8A	C2.0 1.2E-02	0803
7560	1028	1028	1031	SVI	U	RBR	606	320	0803
7560	1028	1028	1028	SVI	G	RBR	2695	21	0803
7560	1030	1218	1250	G12	5	XFL	N13W13	4.8E+03 1.1E+04	0803
7560 +	1042	1042	1042	SVI	G	RBR	245	75	0803
7560 +	1042	1042	1042	SVI	G	RBR	410	80	0803

If you would like detailed information on the contents of these reports, see:

<http://www.sec.noaa.gov/ftpdir/indices/events/README>.

The top three lines tell you a file name (which you can ignore), the date this particular table was created (which you can also ignore), and the date of the data (:Date:). Check that the “:Date:” is the one you want to be looking at.

The event reports include 10 columns:

Event: This column is a way that SEC uses to catalog solar events in their own system, so we

can ignore it for now.

Begin: This is the time in UT that the event started. For instance, in California any time before about 1200- 1400 is in the night time (depending on what season it is since the Sun rises at different times) so when you are looking for your events start further down in the 1300's.

Max: This is when the event has hit its peak X-ray flux. This is useful when dealing with a flare whose beginning has been lost in interference or sunrise/sunset.

End: This is when the event officially ends.

Obs: This column stands for observer, and tells you which of the GOES satellites is reporting the event. We are most interested in the G12 and G10 satellites, which report solar flares. Different satellites report different types of events, most of which we can't detect.

Q: This is for radio bursts, sweep frequencies, storms and optical flares. It's a way of categorizing the quality of the data they received. Since SID can pick up some radio bursts and optical flares it may be worth your while to read more about the Q column in the **README** file listed above.

Type: This column is very important -- it tells you what type of event has occurred. Remember SID can only pick up things that disturb our ionosphere but there a lot of other things going on out in space! Solar flares are listed as **XRA** for X-ray event. These are the events that you will pick up on your SID. We have detected a few radio bursts and optical flares with SID but these have been rare occurrences.

Loc/Frq: This stands for Location or frequency. Ignore this for now.

Particulars: This column tells how big a flare GOES detected. To understand it, you need to know how solar flares are calculated:

B class flares: These are the smallest flares and occur often. SID is not sensitive enough to detect them.

C class flares: Some of the C class flares can get pretty big. SID is able to detect flares Class C2.0 or above, although there have been incidents where we have picked up C1.0 flares.

M class flares: Are larger yet and occur less frequently. These should be very apparent on your SID graphs.

X class flares: These are huge and easy to detect. If aimed at the Earth, they can cause major disruptions in cell phone communication, radio, and power grids. In October of 2003 an X25 flare was recorded, the largest flare recorded in history! X class flares are usually too much for SID to handle and they will peak off the charts, causing a plateau effect.

Reg #: This column tells you which active region (sunspot number) of the Sun produced the event.

If the GOES catalog indicates a flare at the time your graph shows a spike, you have most likely detected a flare!

Sometimes SID monitors pick up flares that do not appear in the GOES catalog. Then you have found an “undocumented” flare! It doesn’t appear on the charts because the charts are reduced from data by humans, who sometimes make mistakes. We are looking into the possibility of having flares detected by students be incorporated into the general GOES catalogs.

Remember that the GOES satellites are detecting solar flares as they are emitted from the Sun. Your SID monitor is detecting changes to the Earth’s ionosphere caused by those same flares. So while your monitor and the satellites are tracking different effects, they are based on the same phenomena.

Active Region numbers: Viewing the regions of the Sun on-line

Active regions are places on the visible surface of the Sun containing strong magnetic fields in complex configurations. They are often associated with a particular sunspot and in constant change and flux. These active regions are usually the source of the solar flares you have detected.



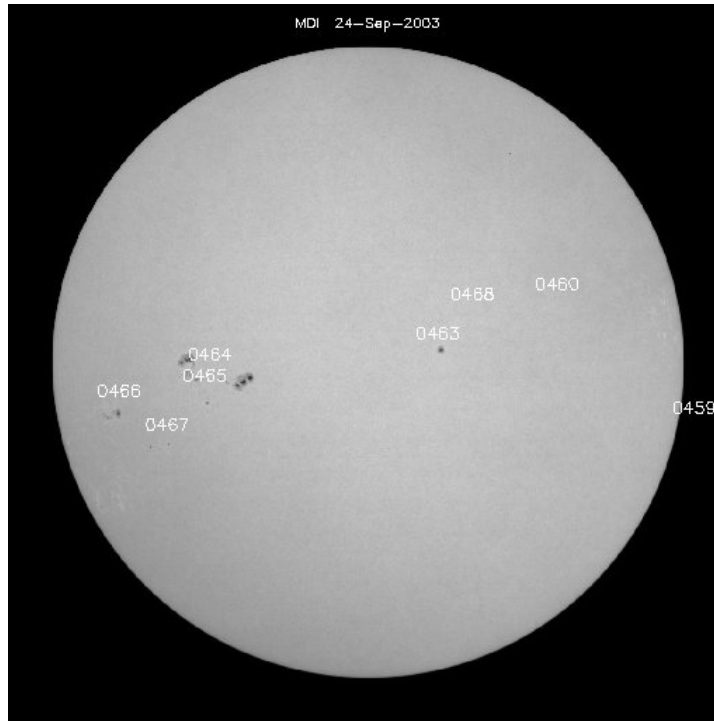
Active regions are given consecutive numbers as they appear on the disk. If you have detected a flare and want to know where on the Sun it came from, look at REG# in the GOES catalog listing. To see the region numbers identified, go to:

<http://sohowww.nascom.nasa.gov/> and hit “Sunspots” in the upper right corner

The current day’s solar active regions will always be shown there. If you need to check for previous days’ images, hit the “List of all available daily images” on that same page.

The images of active regions come from the great Solar and Heliospheric Observatory (SOHO),

a spacecraft circling the Sun and on which our Stanford team has an instrument, MDI. Here is a sample image of the Sun listing the “active regions” from which solar flares or other events might have emanated. Note that each new sunspot or active region will receive a new name, so these images change frequently:



Predicting Flares

Now you have identified a solar flare in your data, found it in the GOES database, and tracked it down to the active region/sunspot group that produced the flare. You can also watch the progress of active regions on the Sun and try your hand at predicting which groups might generate what size of flares, then use your monitor to track your predictions.

The SOHO spacecraft, sitting 1 million miles from the Earth, takes images of the Sun every day, 24 hours a day. For the most recent images of the Sun, check out:

<http://sohowww.nascom.nasa.gov/> and hit “The Sun Now” button

Since the Sun rotates on its axis in about 27 days (at its equator), over a period of time you will see the sunspots and active regions move and rotate on or off the visible disk.

In fact, you can even virtually “see through” the Sun to track an active region before it gets to the front side! To understand how this works, look at:

http://www.nasa.gov/vision/universe/solarsystem/soho_xray.html

You can look at the farside/backside images of the Sun every day at

<http://spaceweather.com>

If you'd like more information, and would like to track movements of the Sun's active regions from its backside, try:

http://soi.stanford.edu/data/full_farside/

Getting Help

If you are having trouble getting your monitor to work or data to appear, contact your Research Mentor. If that fails, you may contact:

SID@sun.stanford.edu

Now, go for it!

Now that you have the tools to investigate your data it should be fun! It will become easier and faster with practice. You may find events that GOES data has not posted or maybe you found an event other than a solar flare. You may be able to make predictions about potential flares and track your accuracy. You are part of a network of people watching the sky and looking for solar flares. We will all have questions and answers. If you have found something new or strange let us know. Share your findings with other people in this program. Happy hunting!

Chapter 5 Centralized Data and Communicating with other Users

Accessing Data at Stanford

The Stanford Solar Center has set up a centralized database to collect and make available SID data from many sites. You can retrieve data either by viewing graphs or asking for data files. See:

<http://sid.stanford.edu/database-browser/>

Sending Data to Stanford

If you wish, you can ftp (file transfer protocol) your data files to Stanford for inclusion in the database. Your distribution disk should have included a file called “**sidsend.bat**”. If you have used the default file location, you should find this file at:

C:\SOLARSID\Bin\SIDsend.bat

This is a script that you can run periodically or regularly to copy your files to the Stanford “**sid-ftp.stanford.edu**” machine. The chapter on installations gives more details.

If you do not have an internet connection, we would still like to receive your data files. Can you regularly copy them onto a CD or other medium? If so, send your files to:

Stanford Solar Center -- SID Project
Stanford University
HEPL-4085
491 South Service Road
Stanford, CA 94305-4085

Blog and Communications

There is a blog where SID users can communicate with each other. Currently, it is:

<http://sidmonitors.blogspot.com/>

This site may change as we need increased functionality. If you cannot find the blog site, contact SID@sun.stanford.edu.

Chapter 6 Resources

There is more information about the space weather monitors at:

<http://solar-center.stanford.edu/SID>

Most of the resources listed here require access to the internet. If you do not have access and have particular questions, we will try to help as best we can. Often we are able to copy internet resources onto a CD and send it. To get in touch with us, use:

SID@sun.stanford.edu *[if you have email]*

Or

Stanford Solar Center -- SID Project
Stanford University
HEPL-4085
455 Via Palou
Stanford, CA 94305-4085
650-725-2333 (FAX)



Photo by David Fritts

Information About Space Weather

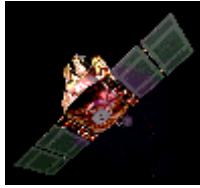
For most of human history, the only detectable manifestation of "space weather" was the beautiful auroras. Now, our civilization is often perturbed by invisible but powerful blasts from the Sun that have the potential to seriously affect us on Earth. We call this "space weather" – conditions caused by violent transfers of matter and energy from the Sun. The sources can include radiation storms, solar flares, and ejections from the Sun as well as disturbances in the Earth's magnetic field caused by the Sun. You are already familiar with solar activity's effects on the Earth's ionosphere. Besides those, solar storms not only trigger beautiful auroras, but also damage or kill satellites, disrupt power grids and electrical systems, interfere with cell phones and other communications, and disturb animal movements. They can even threaten astronauts and high-flying airplanes with their radiation!

To learn more about space weather on the web:



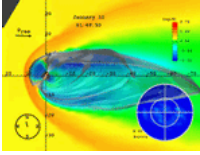
SpaceWeather.com -- <http://spaceweather.com>

Daily science news, images, and information about the Sun-Earth environment. Find out about recent solar flares, spots on the Sun, current solar wind speed, potential auroras, and spots currently on the back side of the Sun!



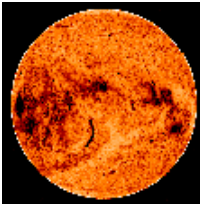
Space Weather Research Explorer –
<http://www.exploratorium.edu/spaceweather>

Produced by the Exploratorium in San Francisco, CA, USA, this website explains space weather concepts and provides links to live data. Hear interviews with scientists who study space weather.



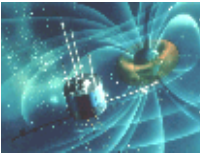
Space Weather Today <http://www.windows.ucar.edu/spaceweather/>

For students and educators. A treasury of resources on what is happening today in space and on space weather itself. These pages are part of the world-famous Windows to the Universe project.



Space Weather Center -- <http://www.spaceweathercenter.org/>

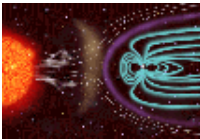
A site designed especially for younger kids. You can learn more about space weather, and even play games like Magneto Mini Golf!



Dr. Sten Odenwald's Space Weather Site

<http://www.solarstorms.org/>

Tells you about space weather's impact on technology and what we can do about it.



Space Weather Now -- <http://www.sec.noaa.gov/SWN/>

Primary site to provide information about current space weather conditions. Developed by NOAA/National Weather Service of the USA.



To get started on the topic of space weather, see the Stanford Solar Center -- **<http://solar-center.stanford.edu/solar-weather/>**



Space Weather for Pigeon Racers and Fanciers

<http://solar-center.stanford.edu/solar-weather/pigeons.html>

Space weather conditions interfere with racing pigeons' ability to navigate.

Books on Space Weather:

1. **The 23rd Cycle: Learning to Live with a Stormy Star** by Sten Odenwald, Columbia University Press, 2000.
Also available on the web at <http://www.solarstorms.org/S23rdCycle.html>
2. **The Role of the Sun in Climate Change** by Douglas V. Hoyt and Kenneth H. Schatten. Oxford University Press, USA, 1997. ISBN: 019509414X
Mostly of interest to students in climate studies, this book focuses on solar variations as a driver for climate change.
3. **Sentinels of the Sun: Forecasting Space Weather** by Barbara B. Poppe, Kristen P. Jorden. Johnson Books, 2006. ISBN: 1555663796

Takes a look at space weather and the Space Environment Center, an American federal agency devoted to the study of the Sun. The numerous players in the story have brought this science to the forefront of space physics and solar forecasting because they understand that Earth systems will be increasingly affected by the Sun.

4. **Storms from the Sun: The Emerging Science of Space Weather** By Michael Carlowicz and Ramon Lopez. National Academies Press, 2002. ISBN 0309076420. *Written for a general audience, this book provides colorfully written descriptions of major solar storm disruptions of communications satellites, power grids, and all the technological devices dependent on them. Also contains some discussion of the basic science behind space storms.*

5. **Storms in Space** by John W. Freeman Cambridge University Press, 2001. ISBN: 0521660386

A very readable account of space weather storms and their effects. Provides a new understanding and appreciation of how seemingly insignificant disturbances on the Sun can have major effects here on Earth.

About the Sun



<http://solar-center.stanford.edu/solar-weather/>

A general introduction to the Sun, its science, culture, music, art, and even folklore. Includes classroom activities and information for educators.



If you would like to observe the Sun yourself:

<http://solar-center.stanford.edu/observe/>



<http://www.windows.ucar.edu/tour/link=/sun/sun.html>

Windows to the Universe website on the Sun.



<http://sunearthday.nasa.gov/>

This NASA website brings together the rich expertise of scientists, educators, and museums to develop innovative products and programs that share the exciting discoveries and knowledge from NASA Sun-Earth Connection missions and research programs with the public.

Books and articles about the Sun:

1. "The Sun – Living with a Stormy Star", *National Geographic* July 2004, pp. 2-33.
2. "SOHO Reveals the Secrets of the Sun," by Kenneth R. Lang; *Scientific American*, March 1997, pp. 40-47.

3. **The Complete Idiot's Guide to the Sun** by [Jay M. Pasachoff](#). Alpha Books, 2003. ISBN: 1592570747
General book about the origin and history of the Sun, including information on the Sun's physical properties; how solar flares, sunspots, and winds on its surface affect Earth's atmosphere and environment; solar and lunar eclipses, transits, and occultations, and early astronomers' discoveries about the Sun.
4. **Journey from the Center of the Sun**, by Jack B. Zierker. Princeton University Press, 2002. ISBN 0-691-05781-8
5. **Nearest Star – The Surprising Science of Our Sun**, by Leon Golub & Jay M. Pasachoff. Harvard University Press, 2001. ISBN 0-674-00467-1
6. **Sun, Earth and Sky** by Kenneth R. Lang, Springer 1997. ISBN 3-540-62808-8
A visually dramatic and lavishly illustrated book that introduces the Sun, its physics, and its impact on life on Earth.
7. **Sunquakes – Probing the Interior of the Sun**, by J. B. Zirker Johns Hopkins University Press, 2003. ISBN 0-8018-7419-X

Chapter 7 Uninstalling and Returning Your Monitor

If you have not explicitly purchased your SID monitor system, then understand that it remains the property of Stanford University. You may use the monitor for as long as it is running and incorporated into your educational programs. Once it is no longer functioning or you are no longer using it for educational purposes, we ask that you return the monitor to Stanford, at your own expense.

Monitors and supplies should be returned to:

Stanford Solar Center
Deborah Scherrer
Stanford University
HEPL-4085
491 South Service Road
Stanford, CA 94305-4085

If you have questions, send email to:

SID@sun.stanford.edu

Two programs are available on your CD for uninstalling your monitor system:

unins000.exe and **unins000.dat**

In newer systems, you can also uninstall from the Windows Start Menu:

Start > Programs > SOLARSID > _Uninstall_ > Are_you_sure > Uninstall SID Software Components

Appendices

A. VLF Station List¹

<i>Country</i>	<i>Location</i>	<i>Name</i>	<i>Frequency</i>	<i>Power (kHz)</i>	<i>Latitude / Longitude</i>
USA	Cutler, ME	NAA	24.0	1000	44.65 N -67.3 W
	Jim Creek, WA	NLK	24.8	250	48.20 N -121.92 W
	Lualualei, HI	NPM	21.4	566	20.4 N -158.2 W
	LaMoure, ND	NML	25.2	500	46.35 N -98.33 W
	Aquada, Puerto Rico	NAU	40.75	100	18.40 N -67.18 W
Antarctica:	South Pole	VLF	20.0		-09 / 0
Australia	Harold E. Holt (North West Cape)	NWC	19.8	1000	-21.8 114.2 E
China²:	Changde	3SA (alternates 3SB)	20.6		25.03 111.67
	Datong	3SB (alternates 3SA)	10.6		35.60 103.33
France:	Rosnay	HWU	20.9	400	40.7N 1.25E
	St. Assie	FTA ³	16.8		
	LeBlanc (NATO)	HWV	21.75		40.7 N, 1.25 E
Germany:	Rhauderfehn	DHO	23.4	500	53° 10' N 07° 33'E
Iceland:	Keflavik (US Navy)	NRK	37.5	100	65N -18E
	Keflavic	TFK	37.5		
India:	Katabomman	VTX3	18.2		8.47 77.40
Italy:	Tavolara	ICV	20.27	43	40.88N 9.68E
	Sicily	NSC	45.9		38N 13.5E
Japan:	Ebino	JJI	22.2		32.04 130.81
Norway⁴:	Kolsas	JXN	16.4	45	59.51N 10.52E
Russia⁵:	Arkhangelsk	UGE	19.7	150 input	64N24 41E32
	Batumi	UVA	14.6	100 input	
	Kaliningrad	UGKZ	30.3	100 input	
	Matotchkinchar	UFQE	18.1	100 input	
	Vladivostok	UIK	15.0	100 input	
Turkey	Bafa	TBB	26.7		37.43 27.55
United Kingdom	Anthorn	GBZ	19.6	500	52:71N -3:07W
	Anthorn (NATO)	GQD	22.1	500	52:4N -1.2W
	London	GYA	21.37	120	51 N 2 E

There is no transmitter below 18.3 kHz usable for SID monitoring in Europe.

Transmitting times for Russian transmitters other than 66.7 are short

More information can be found at [//www-user.uni-bremen.de/~ews2/RDF_project.html](http://www-user.uni-bremen.de/~ews2/RDF_project.html)

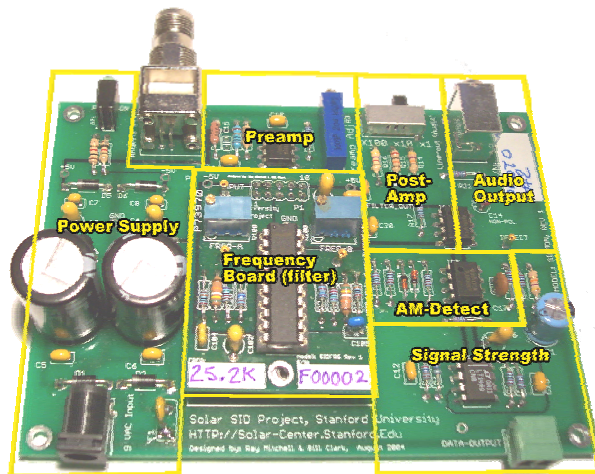
¹ Info courtesy of Bill Hopkins, Technical Representative for Pacific-Sierra Research Corp. with updates from Chris Chapman, Morris Cohen, Peter Schnoor, and Deborah Scherrer

² There is evidence of two powerful new transmitters being operated by China, only on for selected periods. These are at 21.1 kHz coming from the west of China, and 24.1 kHz from the east coast of China.

³ Out of service for a number of years

⁴ Off? Short transmitting time?

⁵ Most of the Russian transmitters are either pooled (like the alpha transmitters around 11-13 kHz) or tend to alternate several frequencies between several sites.



B. SIDMON Theory of Operation

The SID space weather monitor (SIDMON) is an AM receiver that is tuned to one VLF station. The inputs are for power and antenna and outputs are one audio and one signal strength. Inside the box the signal is detected/filtered, amplified, rectified, and integrated to measure signal strength. (For engineering students wanting to understand or extend the capabilities of the SIDMON, a detailed technical manual is available.)

The internals of the SIDMON are divided into the following sections and the signals follow the following path:

Power Supply: This section takes the 10 VAC from the wall transformer and converts it into the + 5 volt and – 5 volt DC supplies for the rest of the circuit board. These are monitored from the front panel as the Green (+5 volt supply) and Yellow (-5 volt Supply) LED's.

Preamp: The first amplification stage from the antenna. The signal output is controlled by the potentiometer (blue rectangular control) that is labeled RF Adj. on the front panel.

Frequency Board (Filter): The daughter card that plugs directly onto the motherboard to select the SIDMON's frequency to be monitored. This unit has two pre-tuned adjustments that are preset and not to be changed. If you need to monitor a different frequency, contact us for the appropriate frequency board or an additional SIDMON.

Post-Amp: Amplifies the output from the Frequency Board in the post-amp stage before going to the final amplification stages. The post amp has a 3-position slide switch, marked x1, x5, and x10, that relates relatively to the actual multipliers in this amplification stage. Typical usage should be at x1.

AM-Detect: Removes the negative portion of the AM envelope through active rectification.

Audio Output: A buffered output to feed into a pair of powered speakers or line-input device. It is **not** capable of powering headphones or un-powered speakers. The audio output is useful only while setting up and calibrating the SID monitor. NOTE: we have noticed that leaving the speakers in the system can load down the monitor's signal strength readings.

Signal Strength: Averages out the peaks from the AM-detection stage. The signal is scaled to swing between the two power-supply voltages, thus giving the SIDMON an overall 10 volt range

VLF Propagation:

There are two components to RF signals: The ground wave and the sky wave. The ground wave is primarily an E-field (electrical) and travels along the ground. This signal does not contain any SID information because it does not bounce off the ionosphere. So these waves are of no interest to us. The other component is called the sky wave. As its name implies, it is the signal that comes from the sky -- the result of one or more bounces off the ionosphere. Sky waves are detected using a wire-loop antenna (which you will build). The magnetic component from the RF signal is converted via induction into a small electrical signal then amplified by the SIDMON.

C. Common Sources of Interference

The most common sources of noise (interference) are located in close proximity to the antenna. Here is a list of the most common sources that can be eliminated:

- Computer Monitor: When not using your computer monitor it is best to turn it off for data collection
- Television Set: The antenna should be shielded or kept at least 10-15 feet away from a television that is on.
- Florescent Lights: The noise from these is usually small but can be a problem with some antenna
- Motors and Pumps: Not always a problem but they have the potential to cause noise
- Light Dimming Switch: New models are not usually a problem but some older switches have the capability of being noise sources.
- Microwave ovens
- Outdoor sulfur lights

To make sure your antenna is shielded from these noise sources, be sure to place the antenna as far from these culprits as possible. A minimum distance of 10 feet is recommended. Computer monitors may need to be placed near the antenna but they should be turned off when data collection is taking place.

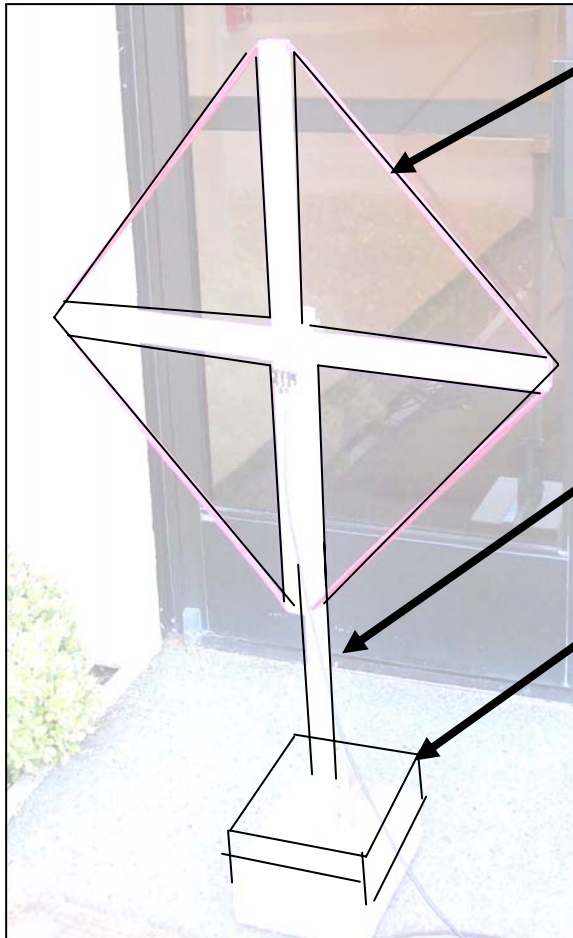
Another major source of noise is lightning. The best way to tell if you are picking up lightning strikes is to switch the Post Amp Switch on your monitor to x5 or x10. Then plug in speakers and listen to the signal. If you are hearing a lot of “snaps” “crackles” and “pops” lightning is most likely causing the interference in your data. Lightning strikes can be picked up by the VLF antenna from quite a great distance.

D. AWG Conversion Chart

AWG Gauge	Diameter Inches	Diameter mm	Ohms per 100ft	Ohms per KM
10	.1019	2.58826	.9989	3.276392
11	.0907	2.30378	1.26	4.1328
12	.0808	2.05232	1.588	5.20864
13	.072	1.8288	2.003	6.56984
14	.0641	1.62814	2.525	8.282
15	.0571	1.45034	3.184	10.44352
16	.0508	1.29032	4.016	13.17248
17	.0453	1.15062	5.064	16.60992
18	.0403	1.02362	6.385	20.9428
19	.0359	.91186	8.051	26.40728
20	.032	.8128	10.15	33.292
21	.0285	.7239	12.8	41.984
22	.0254	.64516	16.14	52.9392
23	.0226	.57404	20.36	66.7808
24	.0201	.51054	25.67	84.1976
25	.0179	.45466	32.37	106.1736
26	.0159	.40386	40.81	133.8568
27	.0142	.36068	51.47	168.8216
28	.0126	.32004	64.9	212.872
29	.0113	.28702	81.83	268.4024
30	.01	.254	103.2	338.496
31	.0089	.22606	130.1	426.728
32	.008	.2032	164.1	583.248

E. Construction Hints for a Small Antenna and a Base

We describe how to build a small antenna made out of wood and metal. Again, you are free to adapt your design as you wish. There are three main parts to this SID antenna: the antenna, mast and base.



Antenna:

50 turns of #26-#28⁶ wire. Magnet wire will work, but be more fragile. The X (or cross) frame is notched in the ends to hold the wire and is joined in the center where it can be attached to the mast. A terminal block is used to connect the wires to the coax cable.

Mast:

This raises the antenna portion above the base; it does not have to be very high. It simply needs to firmly hold up your antenna.

In fact, you might find a way to combine your base and mast, or put “feet” on your antenna.

Base:

The basic idea is to build a sturdy base that has some weight so your antenna won’t blow over. (Since antennas rarely can be placed in the classroom because of electrical interference they frequently get relegated to the roof or some out of the way location.)

Constructing the Base

The purpose of the base is to give stability to the antenna to prevent it from falling over. You could just as easily put a wood pole or 2”x2” in a bucket and fill it with rocks or concrete. The one built in this document is made from wood.

Start with a 12” x 12”x 4” (header) scrap piece purchased at a local building supply store. It could just as well have been several 2x4s with pieces of plywood stacked on top and bottom. It should be painted to resist the elements. For an extra touch, screw four rubber feet underneath the corners to prevent scratching surfaces.



⁶ These are USA standard sizes. In Europe, the equivalent is something with a diameter of about 3-4 millimeters.

To attach the two 6-inch “L” brackets you need to get the spacing correct. Be sure that the mast will be centered on the base. Place the “L” bracket on the edge of the base and make sure to allow for the ¼” nut and metal plate as seen in this photograph:



One suggestion is that you thread the two U-bolts in place with a nut on one side and a wing nut on the other side.

When attaching the L brackets, use the upper and lower holes in the “L” bracket (not middle) so that the mast (when inserted) will line up and be held by the two U-bolts. At this point in the construction you can test to make sure the mast will fit in place.

Use a carpenter’s square to make sure the “L” brackets are straight by measuring from the edge of the board. Mark the holes with a pencil. Pre-drill the pilot holes. Then use a total of 6 wood screws (3 per side) to fasten the “L” bracket to the base.

If you wish, line up the mast and put a 2-inch hole about 1 inch deep in the base to accommodate the mast.



Constructing the Mast



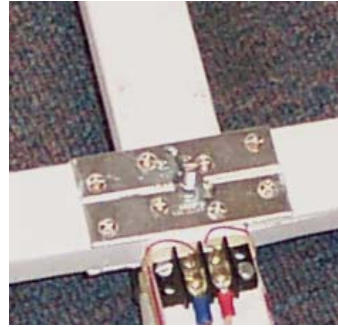
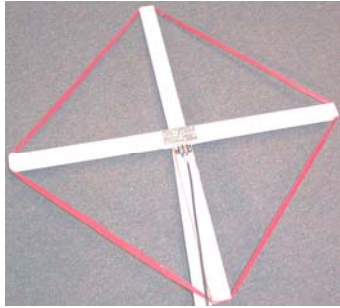
The mast is a wooden 1 ½” to 2” round stock and should be long enough to hold the antenna up. This is not critical: 3 or 4 feet is sufficient, longer is okay too. The mast does not have to be tall like a television antenna because the VLF signal is ground (and ocean) penetrating. PVC pipe, or even driftwood, could be used for the structure of the antenna.

To attach the antenna, a bracket is bolted to the top of the mast. A 3” to 4” 1/4x20 threaded bolt is double “nuttet” to hold the bolt in place and provide the spacing away from the mast (this is for mechanical rather than electrical reasons). A wing nut is used to attach the antenna to this assembly. Additional washers and/or star / lock washers may be advisable to use as well to keep the frame from spinning in the wind.



Constructing the Antenna Frame

Your frame simply needs to hold up the wire. For this design, the idea is to make the cross equal lengths in each direction. This antenna is a cross shape cut from 1”x2” boards; one continuous length of 30” and two 14 ¼” boards. These should be sanded and painted to resist weather.



Attach the boards in the center. The shorter boards are held together by four mending plates: two per side held by four screws per plate. It is good practice to pre-drill pilot holes to prevent wood from splitting. After the plates are installed, drill a $\frac{1}{4}$ " hole through the center as a means to connect the antenna to the mast. (Hint: to find the center use a straight edge and draw diagonal lines from the corners of the mending plates. 'X' marks the center position.)

Attach a two position terminal block below the mending plates as shown in the photograph.



To hold the wire on the antenna, the four ends of the cross are notched and shaped using a round wood rasp to form a "U" shape notch about $\frac{1}{2}$ " deep. The entry and exit edges are beveled to relieve any sharp corners and prevent the wire from breaking when being wound.

Take care on this step – the wood can break if you are not careful!

(Note: although our photos show the wire on the antenna, yours will not be wound yet.)

F. Configuration File Keywords

<i>Line</i>	<i>Keyword</i>	<i>Required/ Optional</i>	<i>Example Value</i>	<i>Comments</i>
SITE				
	Site	R	WSO	
	Longitude	R	-122.17	
	Latitude	R	37.41	
	Comments	O	This is a comment	
DEVICE				
	Device	R	DI-194RS	
	Port	R	Example1: COM* Example2: COM2	* = find on any port numbered 1 thru 20. Any number = literal port number, use this if you have more than one DATAQ connected.
CHANNEL				
	Channel	R	1	For the DATAQ: 1 thru 4 valid.
	DataType	R	SOLAR-SID	
	StationID	R	NLK	
	Frequency	R	24.8 KHz	
	MonitorID	R	S-0001-FB-0001	
	SampleRate	R	5 Seconds	
	Range	O	-5 to +5 volts	This is the max/min voltage range.
	DateInstalled	O	01-JAN-06 01:00:00 UTC	
	Contact	O	JohnQPublic@Whatever.com	
	Problems	O	Has lots of noise on it	
	Comments	O	This is a comment	
	Observer	O	RM	

G. Solar Flare Classifications

<http://spaceweather.com/glossary/flareclasses.html>

Ranking of a solar flare is based on its x-ray output. Flares are classified according to the order of magnitude of the peak burst intensity (I) measured at the Earth in the 0.1 to 0.8 nm wavelength band as follows:

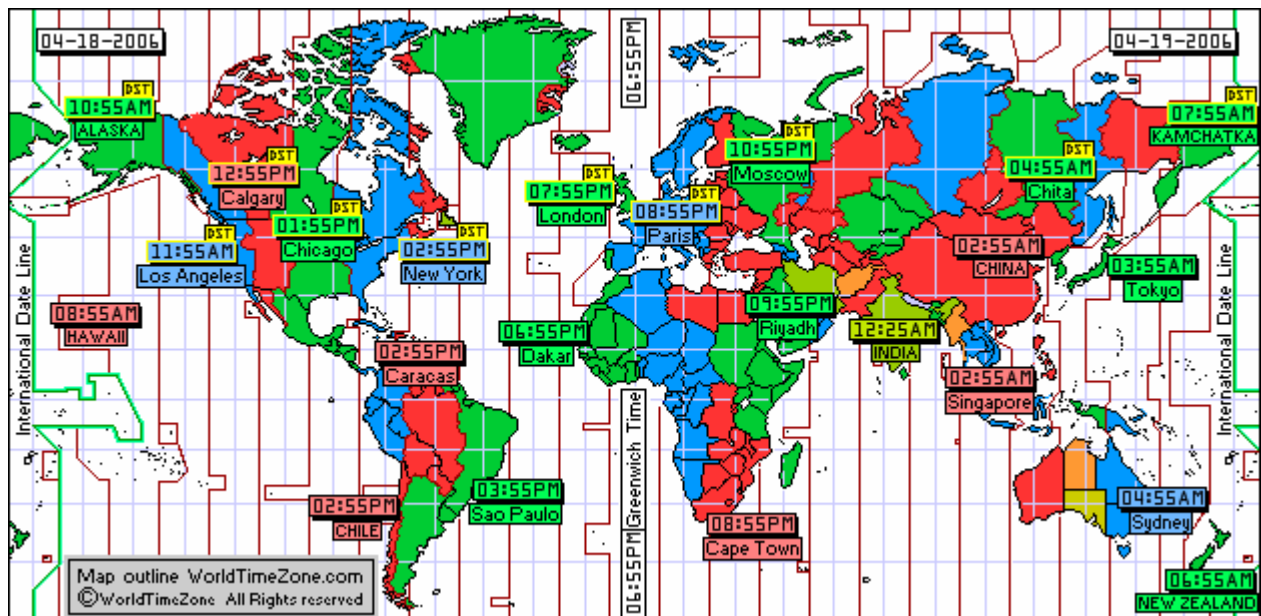
Measured as the Peak, 1-8 Angstrom (0.1-0.8 nm band)	
Solar Flare Class	Intensity: Watts / square meter
B	$I < 10^{-6}$
C	$10^{-6} \leq I < 10^{-5}$
M	$10^{-5} \leq I < 10^{-4}$
X	$I \geq 10^{-4}$

Note: the GOES satellite cannot read past 10^{-2} watts/meter² -- that translates to an X-20 flare.

Each category has nine subdivisions ranging from 1-9, e.g. C1 to C9, M1 to M9, X1 to X9. A multiplier is used to indicate the level within each class. For example: M6 = 6×10^{-5} watts/square meter.

H. World Time Zones

To compare our data, we need to understand the Earth's various timezones. Greenwich, England has been the home of Greenwich Mean Time (GMT) since 1884. (GMT is sometimes called Greenwich Meridian Time because it is measured from the Greenwich Meridian Line at the Royal Observatory in Greenwich.) GMT sets current time or official time around the globe. Most time changes are measured in hours and minutes from GMT. All our SID data is given in GMT so that we can easily compare data. You will need to determine your time zone to compute how much different your local time is from GMT.



Map from <http://www.worldtimezone.com/>.

To find your timezone and its offset from GMT, go to:

<http://www.greenwichmeantime.com/gmt-converter2.htm>

I. SID Monitor Quick Reference Sheet

My station name	
My monitor ID	
Transmitter I monitor	
My Timezone & its offset from GMT	
My latitude & longitude	
Blog Site	http://sidmonitors.blogspot.com/
Help email	SID@sun.stanford.edu
SID Data Site	http://sid.stanford.edu/database-browser/
SID ftp site	sid-ftp.stanford.edu
SID Web Site	http://sid.stanford.edu
Solar flare charts – current (GOES)	http://www.sec.noaa.gov/rt_plots/xray_5m.html
Solar flare charts– previous (GOES)	http://www.lmsal.com/SXT/plot_goes.html?goes=Access+GOES+DATA
Solar flares – catalog (GOES)	http://www.sec.noaa.gov/ftpmenu/indices/events.html
Solar images -- current (SOHO)	http://sohowww.nascom.nasa.gov Hit “Sun Now” button
Solar images – backside / farside	http://spaceweather.com http://soi.stanford.edu/data/full_farside/
Space Weather Current info	http://spaceweather.com http://www.sec.noaa.gov/SWN
Sunspot website (SOHO)	http://sohowww.nascom.nasa.gov Hit “Sunspots” button
Time zone information	http://www.greenwichmeantime.com/gmt-converter2.htm