How SuperSID works.

A loop antenna to pick up VLF signals reflected from the ionosphere

A PreAmp to raise very small signals to a level can be captured by a PC sound card.

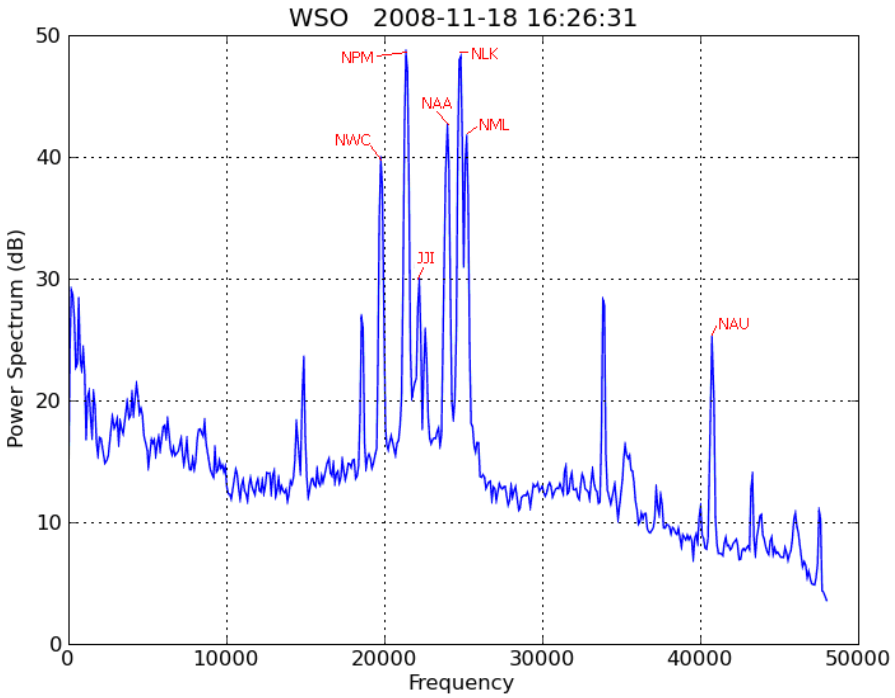
A sound card to convert signal from analog to digital.

A PC to process data and estimate signal strengths though a day. Sudden Ionosphere Disturbance indicates Solar Flare on the SUN.

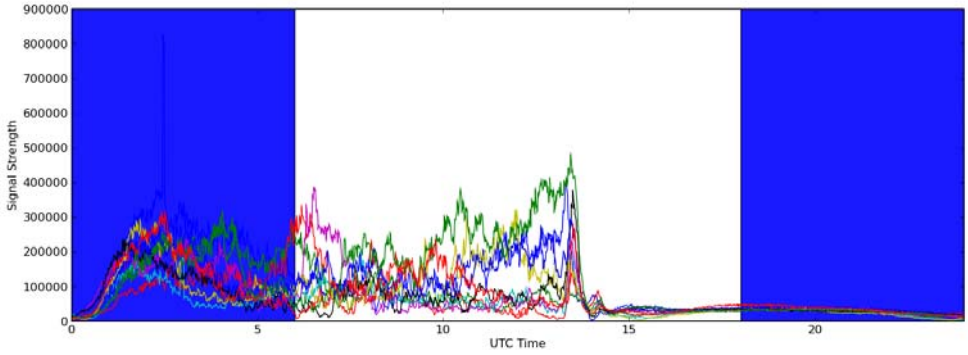
First, we need a loop antenna to pick up radio signals reflected from the ionosphere.
This signal typically is very small, only ~0.1 mili-volts. A PreAmp is needed to amplify the signal about a thousand times, to the level that can be captured with a PC sound card. The sound card‘s task is to convert the signal from analog to digital. Then, a program running on PC, processes the data, estimates the signal‘s power spectrum and track the signal strengths though the day.
Since the reflected radio signals are strongly influenced by the Sun’s radiation, plotting the signal strengths over time could tell us when there is a Solar Flare on the Sun.

Here is a sample plot showing how a VLF spectrum might look like. The signal strengths of the radio stations appear as vertical spikes standing in the noise floor. While the noise floor raises and drops very wildly from one second to the next, these spikes stand solemnly. These spikes slowly rise at night and lower to a stable level during the day.

We are only interested in monitoring the peaks' values, or signal strength variations through the day.



Here is a sample plot of one VLF station's signal strength variation over several days.
As of now, earlier days of the Sun's new cycle, the Sun is very quiet. The day-time pattern would look very flat (from 15 to 24 UTC)



During a Solar Flare, the intense blast of X-ray radiation ionizes the atmosphere further, brings the radio reflection to a lower layer. That effectively increases the signal strengths, lifts them out of typically day-time pattern…In another words, seeing the signal strengths lifted out of out typical day-time pattern, telling us the presence of a Solar Flare on the Sun. And, that is the sole purpose of SuperSID!

Sound Card Installation:

We highly recommend using a HD sound card for studying SID.
An inexpensive sound card like the Sound Blaster‘s Audigy SE ($29) can sample audio signal at 96 KHz, giving us the full VLF spectrum.

Many VLF stations in Europe and Asia are transmitting at frequencies lower than 22KHz. These stations can be monitored with earlier sound cards (AC97 standard). These sound cards are widely available on PC and laptops. Unfortunately, VLF stations in North America are transmitting at higher frequencies. We need to add a HD sound card.

If you choose to install a HD sound card, please also install the driver software came with the CD (and skip other bundled applications, we don’t need)

Note:
Since, there maybe more than one sound card installed on your PC. There may be multiple audio input channels like CD ROM, microphone, line-in which can be enabled and muted independently…
Please double check to make sure, we enabled, Line-in of the newly installed Audigy sound card and it is not being muted.

On Windows, we can check that at
Start | Control Panel | Sound, Speech and Audio Devices | Sound and Audio Devices | Audio (TAB) | Under => Sound Recording | Volume (and Options menu | Properties)

PreAmp Installation:

We are in process of designing a new PreAmp circuit, which brings the signal from the antenna directly to the sound card. We hope to improve the signal quality and simplify some wiring.

At the mean time, we can use the PreAmp circuit built-in the current SID.

We can do that using an audio cable (in following picture) to tap to the Frequency Board connector inside the SID.

Please open up the SID box, remove the Frequency Board and plug in the header connector. Please match Pin 1 (marked with red paint) with the label on the board. And, plug the audio plug into the Line-in (blue) of the sound card.

SuperSID Software Installation

Please copy supersid_v1_00 directory from the CD to your C: drive

Under supersid_v1_00 directory we have four directories:

1. /Program: contains all the binaries
2. /Data: store plot images, data written by SuperSID daily at 24:00 UTC
3. /Document: helps, installation, trouble shooting tips.
4. /Config: with “supersid.cfg” which contains all the configurations.

SuperSID Configuration:

All the configurations are in “/Config/supersid.cfg”

Note:

We can run the “supersid.exe” first to get acquainted with the program before having to change any configurations.
We can click on the screen to inspect the frequencies, signal strength of the peak.
We can generate testing tone to see it appears on spectrum.
We can plot sample data files…

Here is a sample of supersid.cfg with interleave comments.

```
[PARAMETERS]

site_name = WSO
longtitude = -122.17
latitude = 37.41
utc_offset = -08:00

time_zone = Pacific Standard Time
monitor_id = SuperSID-001

#  Audio sampling rate is an important characteristic of a PC sound card.
#  The sampling rate determines the highest frequency component of the signal
#  VLF Spectrum range is from 3KHz to 30KHz
#  Typical PC Sound Card (AC97 standard)  can display stations (signal) up to 22 KHz
#  HD Sound Card can display the full VLF Spectrum.

# audio_sampling_rate = 96000  (if available)
audio_sampling_rate = 48000

log_interval = 5

# Two log_format choices: “sid_format” and “supersid_format” (multiple data columns)
# log_format = supersid_format
log_format = sid_format


# Two log_types: “raw” or “filtered”
```

```
# log_type = raw
log_type = filtered
plot_offset = 1 (available later, which displays the daily plot with local time)
number_of_stations = 3  (Choose a few frequencies to monitor, which ever seem to stay
high above the noise level, though out the day)


[STATION_1]
call_sign = NAA
color = r
#frequency = 24000  (available with 96KHz sampling rate)
frequency = 5000

[STATION_2]
call_sign = NLK
color = b
#frequency = 24800  (available with 96KHz sampling rate)
frequency = 10000

[STATION_3]
call_sign = NWC
color = g
#frequency = 19800
frequency = 20000
```

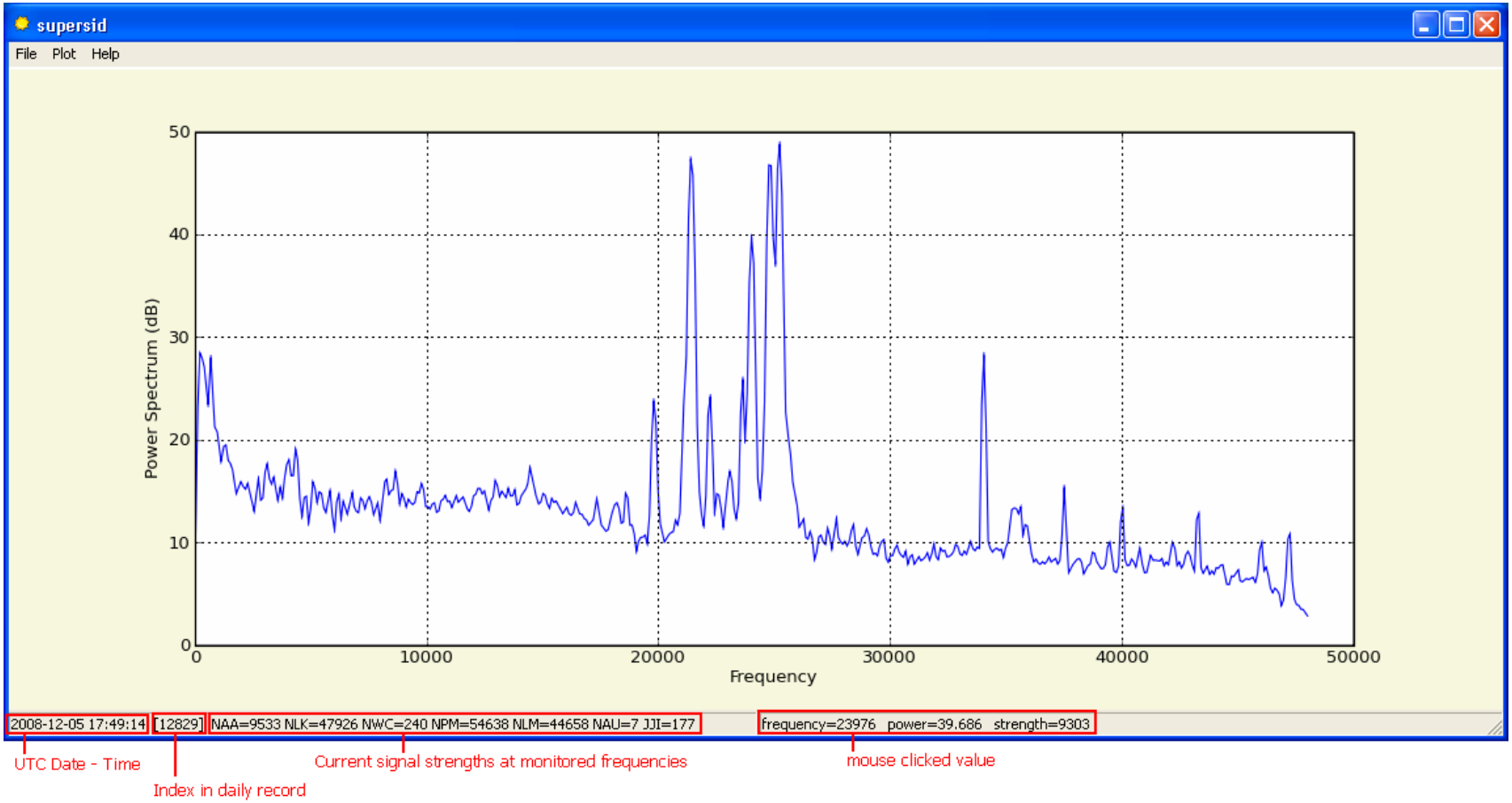
“supersid.cfg” has one main section (PARAMETERS) which defined the global parameters and multiple optional sections (STATION_#) defining parameters for each stations.

Audio sampling rate is the most important parameter. It determines the highest frequency component of the signal can be preserved (Niquist’s Theorem).
Earlier PC sound card (AC97 standard) is widely available on desktops and laptops.
These sound card supports music CD player quality, can sample audio signal at 48 KHz.
Newer sound cards support High Definition Audio (HD). They can sample audio signal at 96 KHz or higher.

Since the VLF Spectrum range is defined from 3KHz to 30 KHz.
We recommend using HD sound cards to study Sudden Ionosphere Disturbance.

Note: Common stations that SID monitored in the North America like NAA (24KHz), NLK (24.8KHz), NML (25.2KHz) are not available on AC97 sound card. From California, we can pick up NPM (21.4KHz) or NWC (19.8KHz). These stations could be selected instead.

We will see errors, if selecting to monitor frequencies higher than the sound card supports.


supersid
File Plot Help
Power Spectrum (dB)
Frequency
0
10
20
30
40
50
0
10000
20000
30000
40000
50000
2008-12-05 17:49:14
[12829]
NAA=9533 NLK=47926 NWC=240 NPM=54638 NLM=44658 NAU=7 JJI=177
frequency=23976 power=39.686 strength=9303
UTC Date - Time
Index in daily record
Current signal strengths at monitored frequencies
mouse clicked value

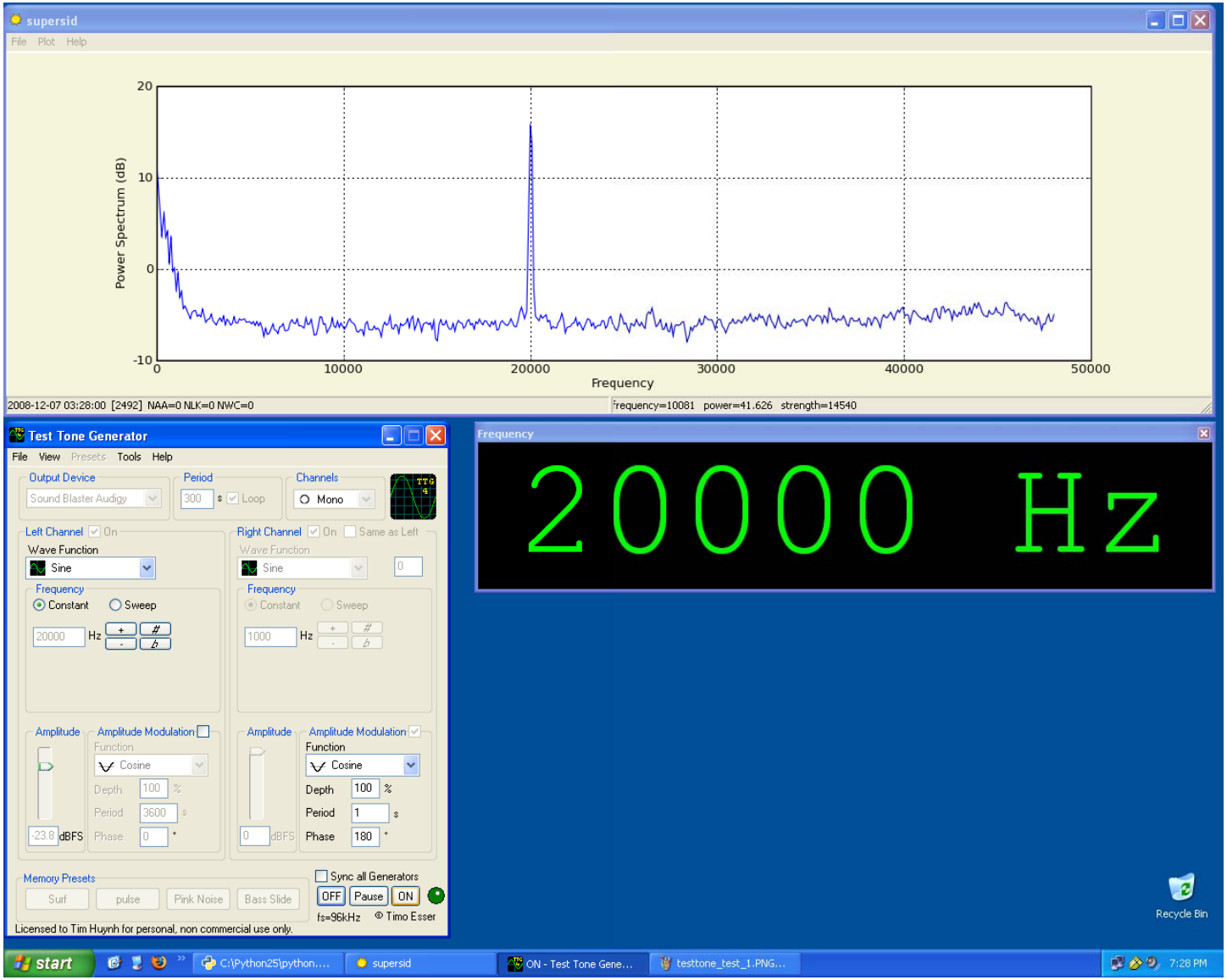
Running SuperSID:

Double click on “supersid.exe” under /Programs directory, we will see this main window. By default, every 5 seconds, supersid wakes up, collects 1 second of data, calculates the power spectrum density (using Welch’s method) and displays the spectrum on its main window. We can also click on the graph to inspect the frequencies at these peaks. This is very handy, when we first setup an antenna, not knowing what VLF station available in the area. We can rotate the antenna around to see which VLF stations seem to be consistently high above the noise level throughout the day. These are good candidates to monitor. If we can not find any peak seem to be consistently raised above the random noise level, we probably need to relocate the antenna to a better location further away from power lines, building electrical interferences….

Typically, the monitored signal strengths are kept in memory and written to text files at the end of the day (at 24 UTC, in /Data folder). If needed, we can always trigger it to dump the current data in the memory into a file called “current_raw_buffer.csv” by clicking on “Save buffers” under File menu.
By default, the signal strengths of different stations are written into separate files (“sid_format”), but they can be combined into a single file with multiple columns (super_sid_format”). The signal strengths can be saved as is (“raw”) or automatically “filtered” to remove interferences (look nicer). These choices can be set in /Config/supersid.cfg.

We can plot data file using “supersid_plot.exe” by dropping data file onto its short cut or by clicking on Plot on the menu bar. If we like to compare the data from different files, we can click on Plot again without closing the previous graph window. On the graph window, there are handy tools for Zoom/Pan, Scale/Drag, Go Back, Crop and Save image…

And, finally, here is a shareware (Test Tone Generator) that we found pretty useful to check the operation of the sound card, SuperSID before collecting real data (for whom without a function generator)
http://www.esseraudio.com/ttg.htm


supersid
File Plot Help
Power Spectrum (dB)
Frequency
2008-12-07 03:28:00 [2492] NAA=0 NLK=0 NWC=0
frequency=10081 power=41.626 strength=14540
Test Tone Generator
File View Presets Tools Help
Output Device
Sound Blaster Audigy
Period
Channels
Mono
Left Channel
Right Channel
Same as Left
Wave Function
Sine
Frequency
Constant
Sweep
20000 Hz
1000 Hz
Amplitude
Amplitude Modulation
Function
Cosine
Depth
Period
Phase
Memory Presets
Surf
pulse
Pink Noise
Bass Slide
Sync all Generators
OFF
Pause
ON
fs=96kHz
Timo Esser
Licensed to Tim Huynh for personal, non commercial use only.
Frequency
20000 Hz
Recycle Bin
start
C:\Python25\python....
supersid
ON - Test Tone Gene...
testtone_test_1.PNG...
7:28 PM