

VLF Alpha Navigation System.

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Background:

This is a brief reference to explain the periodic signals sometimes visible on the ASV spectrogram from the Whistler Receiver.

Spectrogram:

Below in Figure 1 is a screen capture of a typical spectrogram. This particular image was captured at 9:55 PM on 20 Dec 2017. The red horizontal lines in the spectrogram are frequency calibration scales and each mark a 1 KHz interval from 0 Hz to 12 KHz at the top of the scale. Arrows have been placed to indicate the faint traces of a periodic signal between 11 and 12 KHz.

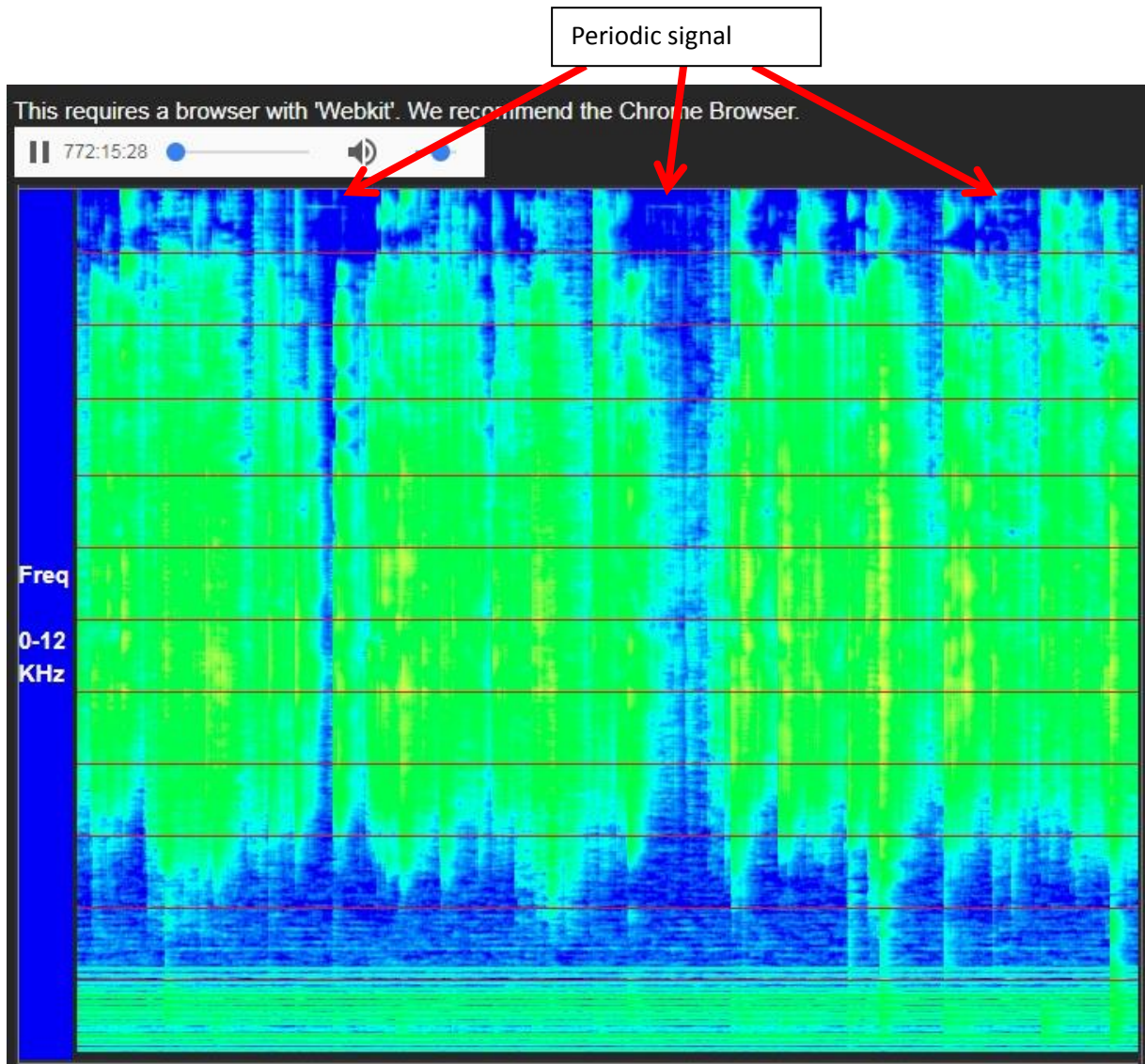


Figure 1. Spectrogram 20-12-17

Frequency Analysis:

If the audio waveform of the same signal is viewed using a spectrum display with amplitude on one axis and frequency on the other, a display shown in Figure 2 is obtained. This screen capture was achieved from the software package "Cool Edit 2000". Here a red arrow is indicating the small vertical rise in the spectrum at the frequency of 11.9 KHz. This signal correlates to the trace seen in the spectrogram. As the signal file is played back in real time the small peak seen below at 11.9 KHz appears and drops away periodically in the same manner as seen in the spectrogram. Note also the small peak in the spectrum at 15.6 KHz. More will be commented on this signal later.

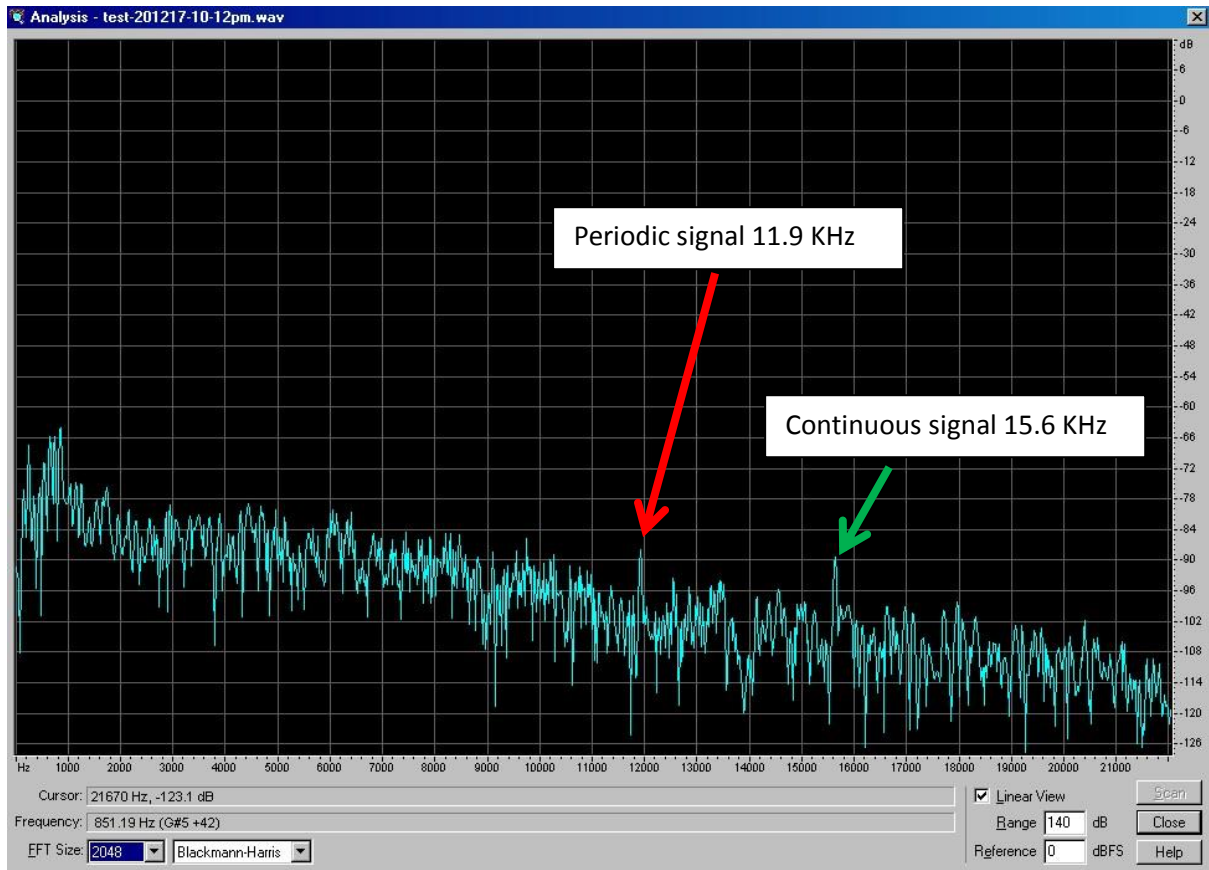


Figure 2 Frequency Analysis Spectrum Display 11.9 KHz Signal

Other Signals:

Shown in Figure 3 is a similar spectrum display of the same audio file. Indicated by the red arrow is another signal which also appears and disappears periodically at 12.65 KHz. This signal is not visible on the Whistler receiver spectrogram since it is outside the range provided on the frequency scale. Note also the same continuous signal appearing again at 15.6 KHz. Finally, shown in Figure 4 is a spectrum display which reveals yet another periodic signal this time at 14.9 KHz. These signals as well as being periodic are not always seen in a consistent manner simply due to the large bursts across the spectrum from lightning static which swamp over the small signals. The spectrum display traces have been captured during periods of relative quiet between static bursts.

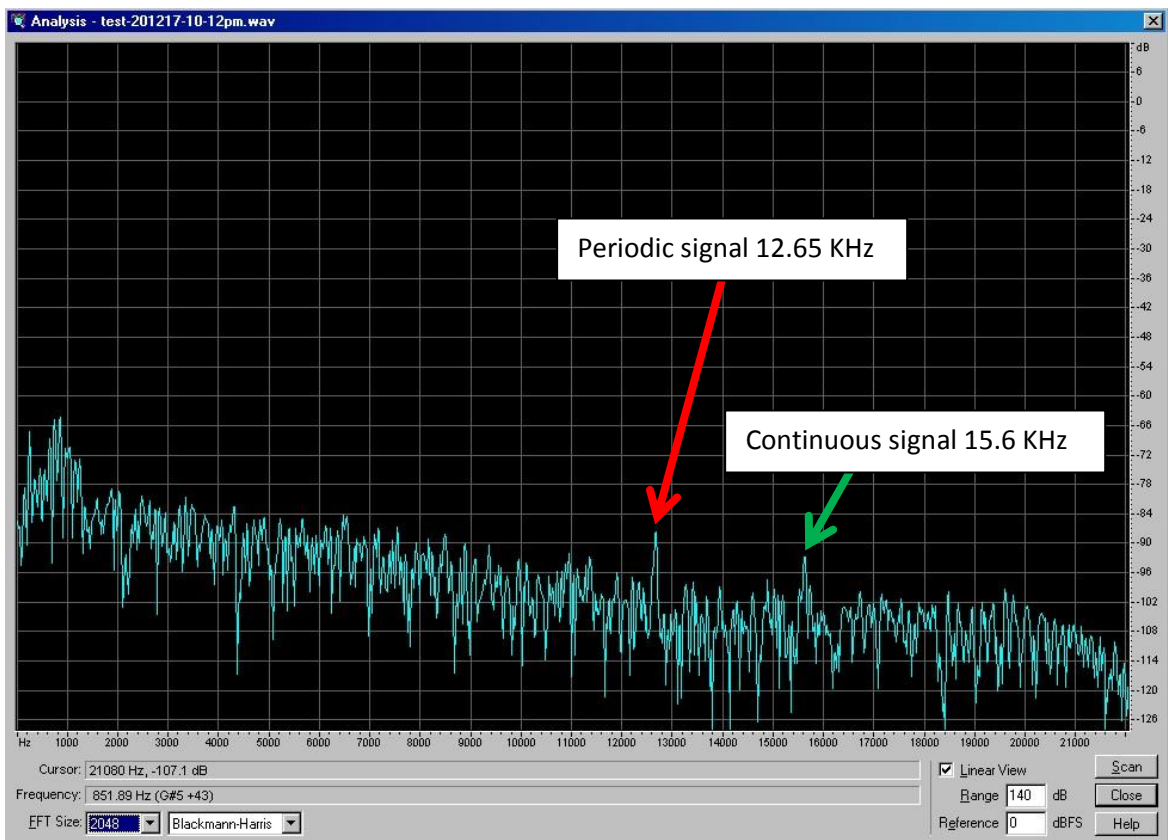


Figure 3 Frequency Analysis Spectrum Display, 12.65 KHz Signal

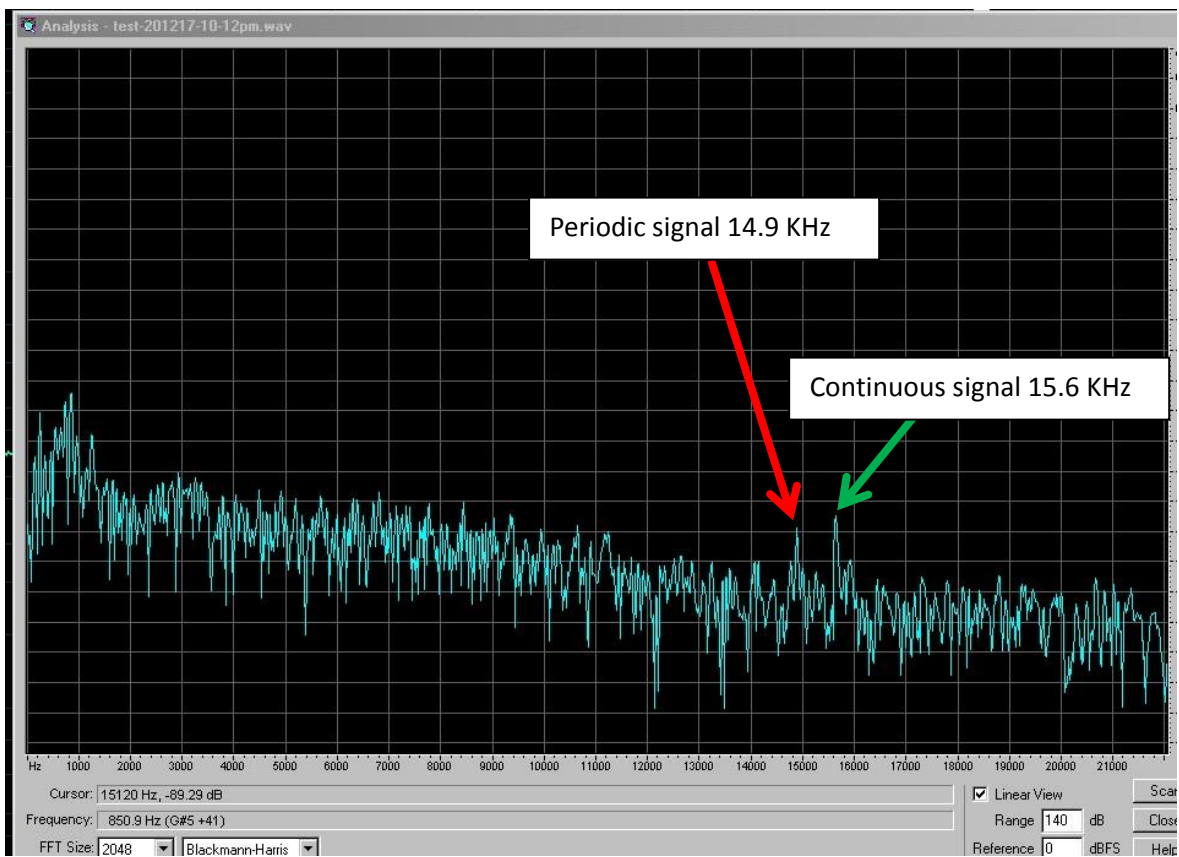


Figure 4 Frequency Analysis Spectrum Display, 14.9 KHz Signal

VLF Alpha Navigation System:

Details of this system are kept secret by the Russians for security and military reasons, so this summary has been obtained from internet sources which may or may not be correct or up-to-date. The VLF radio navigation system called "Alpha" is a system located in Russia and provides a wide range navigation service particularly suitable around the Arctic Circle. The official Russian name is RSDN-20 and stands for "Normal Long-Range Navigation System". There are several transmitting locations, Krasnodar, Novosibirsk, Khabarovsk, Revda and Seyda (Turkmenistan). The master station is in Novosibirsk. An international frequency listing also indicates the transmit power is of the order of 500 KW from each station. Not all stations appear to be transmitting, the frequencies of F4 and F5 close to 12 KHz for instance have never been observed by the author. However, it does require at least 3 to be in operation to permit navigation.

Table 1 is a summary of the transmitting frequencies and the transmitting locations referenced against the transmitting sequence, 1 to 6. The sequence consists of six pulse periods each of 600 milliseconds over a period of 3.6 seconds. The phase of each pulse does not start at the same value but repeats in an overall period of 7 pulses with a total duration of 25.2 seconds. The pulses are 400 milliseconds long with a space of 200 millisecond. The transmitted signals are pure unmodulated carrier. The very low frequency is capable of penetrating deep below sea level and is therefore a viable method for submarine navigation. A location is obtained by calibrating against phase differences between the different transmitting stations.

The ASV Whistler receiver built-in low pass filter has a cut-off of 12 KHz and is about 15 dB down in response at 15 KHz. Therefore these weak VLF signals as well as being received on the other side of the planet are also attenuated by the Whistler receiver. It is however remarkable these VLF signals propagate so efficiently around the world and in fact can be received at any time day or night.

Segment nr. station Frequency kHz	1	2	3	4	5	6
F3p 14.881091 kHz				Novosibirsk, Revda, Seyda		
F3 14.880952 kHz	Krasnodar	Khabarovsk	Novosibirsk		Seyda	Revda
F2 12.648809 kHz	Revda	Novosibirsk	Khabarovsk	Krasnodar		Seyda
F4 12.090773 kHz		Revda				
F5 12.044270 kHz			Seyda			
F1 11.904761 kHz	Novosibirsk	Seyda	Krasnodar	Khabarovsk	Revda	

Table 1. Alpha Transmitting Locations and Frequencies.

15.6 KHz Signal:

At my home in Bayswater I have observed many VLF signals from time to time. Some appear for only short periods then are not seen again for many months. In the suburbs one is also highly subjected to local radio interference from all manner of domestic appliances from washing machines, TV receivers and battery chargers that can completely ruin any attempt at receiving VLF radio signals. I have routinely heard the Alpha signal on 14.9 KHz beeping away and although I have difficulty hearing the lower signals on 12.65 KHz and 11.9 KHz I can see them on a waterfall spectrum display. I have never observed a continuous signal at 15.6 KHz. The Whistler receiver appears to be receiving a unique signal. I have several lists of international VLF signals. The listing for 15.6 KHz designates the transmitter with the identity code of EWB which is located in Odessa in the Ukraine. This transmitter uses a narrowband frequency shift modulation and is typically an encrypted signal sending military messages to submarines.