

Technical Document

SRI32S Preamplifier Noise level (High Gain Unit)

1. Introduction

The SRI32S datalogger supports a very high performance digitizer. The analog front-end of the digitizer is a very critical unit which implements the digitizer matching between several seismic sensors. The performance of the analog front end (or preamplifier) must be equal or better to the digitizer performance to maintain the overall excellent signal quality.

2. Scope of work

The preamplifier supports a variable gain stage. The default input range for the SRI32S preamplifier is 40Vpp, 20Vpp and 10Vpp for matching with the common commercial seismometers as well as with GEObit's seismometers. For the case that a passive sensor consisted of geophones is going to be connected with the unit, GEObit provides an ultra low noise preamplifier, with noise level less than 50nV at gain X64 which equals to 0.625Vpp. At this document we describe the experiment of the preamplifier noise measurement. we post the measurements and we calculate the noise level.

3. Preamplifier Description-Gain

The high input gain preamplifier is basically a modification of the standard SRI32S differential preamplifier. Changes have been made only at the gain stage of the unit. The input range has been changed thus providing very high amplification at the input signal. Standard supported gain sets for the High Gain Preamplifier unit provide amplification X16, X32, X64. These gain sets have been calculated assuming that the 40Vpp input is referred to gain X1. High gain sets are ideal for any passive seismic sensor connection. The digitizer can perfectly match with any 4.5Hz or 2Hz geophone sensor.

Gain Set	Vpp input range	Vpp differentially	Vpp at each input rail
X16	2.5	+/- 1.25V	+/- 625mV
X32	1.25	+/- 625mV	+/- 312mV
X64	0.625	+/- 312mV	+/- 156mV

Table 1: Available Gain sets

4. Noise Measurement Experiment

In this document we analyze the performance of the high gain preamplifier. Each channel is set to a different gain, only for the purposes of this test, so we are able to analyze the performance for each case. In particular, the ch1 is set to gain X16, ch2 is set to gain X32 and the ch3 is set to gain X64. A DC voltage coming from a battery is connected to the input of the preamplifier. The instrument was left to record the input battery voltage for some hours and then the data were analyzed for noise level calculation.

5. Noise Analysis

This noise analysis is based in signal standard deviation method which equals with the RMS noise. From there, number of noisy bits (ENOB) can be calculated [1]. A matlab algorithm has been implemented which process the signal, calculates the standard deviation and then the ENOB of each channel. The basic part of the code is:

```
%----- input data file

[ch1,ch2,ch3,Sampsec]=corerd(stationname,ii);

%----- histogram, ENOB ch1
figure
hist1 (ch1, 100)
dev1 = std(ch1);
enob_ch1=log2(dev1)

%----- histogram, ENOB ch2
figure
hist2 (ch2, 100)
dev2 = std(ch2);
enob_ch2=log2(dev2)

%----- histogram, ENOB ch3
figure
hist3 (ch3, 100)
dev3 = std(ch3);
enob_ch3=log2(dev3)
```

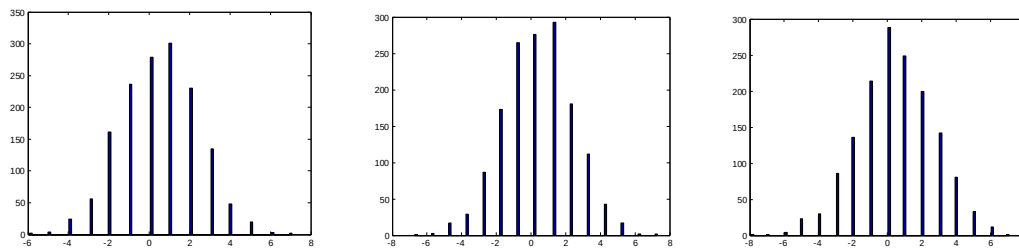


Figure 1: Noise histogram at gain X16, X32, X64 respectively

The results are

CHANNEL	GAIN	ENOB	NOISY BITS
1	X16	23.0523	0.9477
2	X32	22.9912	1.0088
3	X64	22.8378	1.1622

Table 2: Effective resolution related with gain

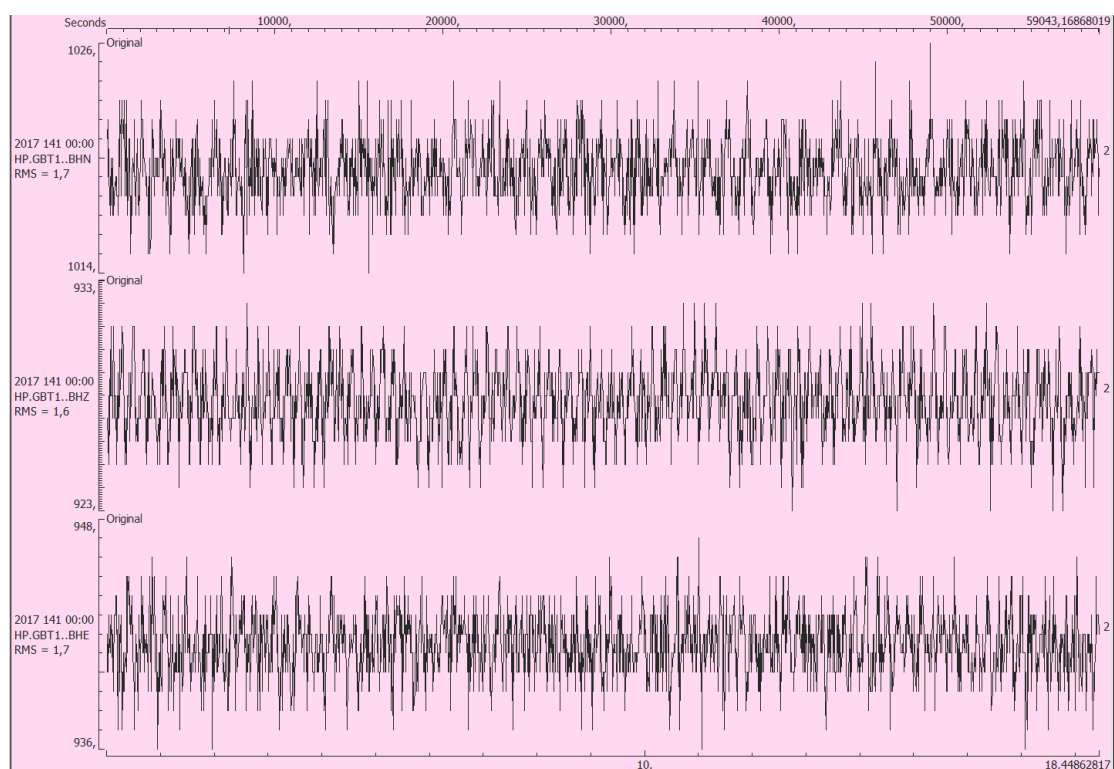
For estimating the noise level of the preamplifier, we need to know the bit weight at each gain set, and then multiply with the noisy bits for the calculation of the level of the input noise.

GAIN	NOISY BITS	BIT WEIGHT (nV/cnt)	NOISE LEVEL (nV differential)
X16	0.9477	149.01	141.21
X32	1.0088	74.50	75.15
X64	1.1622	37.25	43.29

Table 3: Noise level related with gain

6. Signal Plots

The signal plots were perfect in all cases of gain set.



7. Conclusion

It is proved that the SRI32S preamplifier is a high performance front-end unit, providing low noise levels, less than 50nV, therefore it becomes ideal for any passive sensor monitoring. The datalogger can be used at cases where weak seismic signals have to be acquired like those are coming from deep borehole sensors installations.

8. References

[1]- ADCs: Does ENOB tell the whole story? Bonnie Baker - EDN Network, April 17, 2008