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Performance evaluation of a data logger LS-7000-AC and preamplifier fabrication -for observation with ACROSS and Seismic arrays-

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Temporal variations in the propagation properties of seismic waves around the Nojima fault have been continuously monitored using ACROSS vibrators and seismometer arrays since February 2003[eg; Misu et al, poster session in this meeting]. Purpose of this study is detecting a change of scattering strength near a well in which water injection test will be done. Added to this, estimating temporal change in travel time of P, S and later phases are important one.

In this experiment, we adopted a data logger LS-7000, which is produced by Hakusan Industries. The firmware was updated to one provided for ACROSS use. We evaluated performance of the logger preparing for this experiment. Based on the result, we produced a preamplifier for it to meet required amplitude resolution. In this presentation we report the result and introduce the amplifier.

LS-7000 is the logger equipped with six analog input terminals with 24 bits Delta/Sigma type AD converters. We evaluated internal noise of it short-circuiting the input terminals. With 20V peak-to-peak input range, the noise level was about 10^-4 V/Hz^0.5 with 100 Hz sampling rate. This level corresponds to 1/17bits that is in agreement with the spec book. However, in the frequency domain, there was a sharp amplitude peak in between 20 and 30 Hz reaching 10^-2 V. This frequency band corresponds to ACROSS signal and it diminishes signal to noise ratio. With 2V peak-to-peak input range, the noise level was about 10^-5 V/Hz^0.5 and no peak was found. On the experiment site in Awaji Island, back ground noise is about 10 micro kine/Hz^0.5. The velocity sensor used in the experiment is L-28LB produced by Mark Products Corporation and its sensitivity is about 0.3 V/kine. The back ground noise as sensor output will be equivalent to the internal noise level of LS7000 with 2 V peak-to-peak input range. In fact, some preamplifier is required to improve the Signal to Noise ratio in this experiment.

Next, we evaluated the temperature characteristics of the logger with reference signal generated with a function generator, which is precisely synchronized with 1Mpps pulse from GPS clock. The logger was put in an incubator whose temperature was controlled between -5 and 40 degrees centigrade. As a result, the temperature coefficient of gain was 0.18 ppm/deg and accuracy of sampling timing didn't shift with temperature variation. The values are not considerable level in our experiment.

The uncertainty of estimated temporal travel time variation depends only on signal-to-noise ratio as far as the source motion and sampling are precisely synchronized with each other. Since the ACROSS firmware makes time calibration with GPS clock once a second, the accuracy of sampling time is better than 10^-7 s. The source motion is controlled in accuracy of 10^-7 s, too. So all we can do for better estimation of travel time up to 10^-7 s is suppressing the noise level as possible. We made a 6Ch instrumental amplifier with alternative gain of 0dB, 20dB and 40dB for exclusive use with LS7000. Battery terminal in D-sub connector connected to LS7000 feed DC line voltage to it. Internal DC-DC converter, which translates positive 12V to positive and negative 12V, is DCP02 and the amplifier IC is INA118, both of which are provided by Burr-Brown Co.

Using this amplifier with gain of 40 dB, the internal noise level of the logger 10^-5 V/Hz^0.5 suppressed sufficiently below the background noise at the site, which amplified up to 10^-3 V/Hz^0.5. The internal noise level of the amplifier is 3x10^-5 V/Hz^0.5 as output with 40dB. It is also sufficiently below the background noise. As a result, signal to noise ratio improved. On relatively quiet sites, this amplifier is available for general observation of earthquakes and seismic explorations.