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Geoscientific Instrumentation Methods and Data Systems Discussions

Interactive comment on "A remote-control datalogger for large-scale resistivity surveys and robust processing of its signals using a software Lock-In approach" *by* Frank Oppermann and Thomas Günther

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Response to Anonymous Referee (gi-2017-37-RC2)

Dear Referee, Thank you for reviewing our manuscript and raising issues that help to improve the manuscript.

1. The introduction of the paper is well referenced and topics addressed clearly described. As a comment : Complementary references may be find in the research domain civil engineering in the field of application of large scale structures monitoring.

Paragraphs dealing with the datalogger are clear.

Response: Thank you very much. We did not look into the field of civil engineering as it is outside of the Geosciences scope that the journal is focused on. No change.

2. Anyway, in its actual form it is difficult to evaluate what is the contribution part of authors on such system versus functionalities already proposed with these dataloggers by “Controlord” company.

Response: Maybe we did not point this out clearly. As a major point, we added adjustable preamplifiers that allow changing the gain remotely during the experiment. Whereas the signals of most standard data loggers (e.g. temperature, water level, pressure etc.) remain largely constant in magnitude, the ERT signals cover a wide range of magnitudes as a function of different geometries (source-receiver distance) and thus voltage. Therefore, it is vital for good ERT data to optimize the input gain. Furthermore, the PPS synchronization was a feature not included in the Gigalog S. We added in the logger layout to make this clear: It is vital for good ERT data to optimize the input gain, as ERT signals cover a wide range of magnitudes due to different geometries (source-receiver distance). and The GPS timing can be transferred by an NMEA-Format string, which results in synchronization of one second accuracy, or by the PPS (Pulse-per-second) signal that is doing a synchronization within 1 ms.

3. Furthermore, it seems that the provider of such system has stop its activity at the end of 2016, so it should be of interest for the community to suggest alternative solutions.

Response: The company is still alive and selling the logger. In October 2017 we got a new firmware update (Version 1710) from Controlord. At any rate, one can take any basic logger to create such a data logger if it meets the required specifications. Giving potential names of manufactures would be arbitrary and therefore we would not like to give advantage to any of them.

4. Finally, synchronization of measurements seems addressed just by periodic ad-

justment of datalogger clock thank to GPS PPS. What is the time synchronization drift observed between datalogger and which accuracy is required for ERT measurements?

Response: The synchronization accuracy of the PPS signal is at around 1ms. The drift of the internal clock is below 20 ppm, typically 5 ppm. We observed a time difference between the dataloggers in the lower ms range. For ERT with periods above 1 s, the absolute timing is not important as the working point is determined by the processing software at any rate. Moreover, the mask technique makes the determination robust against time stretching.

5. About the 3 post-processing approaches comparative study (FFT, Stacking and Lock-in), methodology and results obtained are clearly described and discussed.

Response: Thank you.

6. In figure 9 RMS signal evolution analysis could be more commented versus DC and VPP for few parts that present some particular gap with global evolution of VPP and DC.

Response: You are right. We now discuss Figure 9 and the course of the individual curves in more detail. New text: The main criteria to obtain the real phase is the maximum of the DC function within a specific DC search area (THdc threshold of DC function, usually 25%). At an ideal square wave signal the DC-value of the convoluted signal is the desired amplitude. As this can lead to wrong results for signal contributions like overshoots, we additionally look if there is also a minimum of the Vpp function within a Vpp search area (THvpp threshold of Vpp function, usually 20%). The LabView function for the Vpp amplitude is calculating the positive and negative peak values from a histogram statistics that can cause the minimum of the Vpp function to be wide. To find the real phase within a wide Vpp minimum the minimum of the RMS function below the RMS search area (THrms threshold of RMS function, usually 10%) is used because the RMS value is very sensitive. This procedure is shown in the flow diagram in Figure 10 (a) and shown on the example in Figure 10 (b): The minimum of the quadratic sum

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Discussion paper

eval(i) of the 3 normalized criteria functions determines the phase, whereas we find the amplitude in the DC function DC(i).

7. Did authors have addressed effect of time lag between synthetic data in their analysis? If yes is it integrated in the noise model used or will it be addressed in future works?

Response: As explained above (4.), for the long-period ERT signals time lags are not an issue. The synthetic data have a length of 10min, which corresponds to the length of real ERT signals. Particularly the mask signal neglects the signal changes and is therefore robust.

8. For the field experiments, how many measurements repetition were made?

Response: We just did two “repetitions“ by injecting two different current strengths that can be used to check repeatability. Furthermore, the use of reciprocal (forward and reverse) arrays allows for a more rigorous and well-established data check. One could of course also split the signal that contains about 100 periods into several segments and analyze them individually, thus deriving an additional standard deviation. We added some text: As another quality check we injected two different current strengths. The proportion of the recorded dipole voltages should be identical to the proportion of the injected currents. The small current does not saturate dataloggers in the vicinity of the current source, and high current provides enough amplitude for the biggest source-receiver distances.

9. The conclusion is clear and perspective about CSEM should be moderate by the difficulty of time synchronization between dataloggers when high frequency analysis is required.

Response: We are confident that the data loggers can be used for CSEM experiments. Actually we just finished a successful CSEM experiment with different sources and receivers. Although data analysis is still in progress, the absolute timing can be found by correlation methods. Also a systematic time dilatation can be compensated by appropriate time series analysis methods.

10. Remark: Page 9, line 289and 290 authors use “grey” comment in the text but figure 15 is in color.

Response: We specifically refer to the lower row of subfigures, where we used light grey and dark grey to indicate values above and below the color bar limit, respectively. Note that we provided a new version of Figure 15 in the response to reviewer 1 (AC1), which is as well in the new manuscript.

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