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Interactive comment

Interactive comment on "Multifunction waveform generator for EM receiver testing" *by* Kai Chen et al.

Kai Chen et al.

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Dear Professor Chen, Thank you for your comment and for your valuable remarks on the manuscript! We have revised this manuscript according to your advice. All changes have been made using red-colored font.

1) Comment from the Reviewer: This manuscript lacks essential references considering the testing of EM receiver. There are papers and patents in English and Chinese considering this problems. This problems is attacked by many Chinese authors. I just list a few of works by myself here. Author's response: Thank you for pointing this out. He et al. and Chen et al. have proposed some methods for MT instrument performance evaluation. We have added the references to these two studies

in the main text and in the references section. Author's changes in the manuscript: The following studies have been added as references. Chen, R.J., Yao, H.C., and Liu, S.L.: Automatic testing system of pseudo-random multi-frequency instrument receiver. Ref. No: CN200910044457, Year: 03/2010. He, Z.X., Chen, R.J., Liu, X.J., L., and He, L.F.: Magnetotelluric instrument performance evaluation method. Ref. No: CN200910237810, Year: 05/2011.

2) Comment from the Reviewer: The authors should summary the works by other peoples in the subject studied by the authors. Author's response: We agree that this manuscript lacks essential references related to the testing of EM receivers. Author's changes in the manuscript: The following sentence has been added in the second paragraph of the introduction. For the realization of a multi-frequency EM receiver, (Chen et al., 2009) developed an automatic testing system based on pseudo-random signals. For MT receiver performance evaluation, (He et al., 2011) conducted a series process method with high efficiency. Which as detailed in the patents applied on several aspects of instrument testing."

3) Comment from the Reviewer: In line 10 - line 11, the time synchronization of waveform generator is not needed for the testing of EM receiver (AMT, MT, CSAMT, SIP, etc.). The time sync is only needed for transmitter, receiver, and calibration. We measure E/H or voltage/current at the same time. This process doesn't need precise sync of input signal. Commercial waveform generator is OK for the testing of EM receiver. Author's response: I apologize for not clarifying this in the original manuscript. For the MT/AMT mode, this process does not need the precise synchronization of the input signal. Nevertheless, I should have explained that the time synchronization of the waveform generator is important in the CSAMT and SIP modes. The waveform generator is a quasi-transmitter for indoor testing. The receiver measures the E/H or voltage/current signal that the GPS time information uses as the time reference. If there is no time reference, the schedule list of the waveform generator cannot function at all. Moreover, the commercial waveform generator is insufficient with regard to time synchronization.

Line 11 – Line 13 present the drawback of the current commercial waveform generator for EM receiver testing. Author's changes in the manuscript: Line 10 has been added in the manuscript as follows. "In controlled source audio magnetotelluric (CSAMT) and spectrum induced polarization (SIP) mode testing, the waveform generator should use the GPS time as a reference for repeating schedule."

4) Comment from the Reviewers: In line 41, simple introduction of EMR6 is needed. Author's response: A simple introduction of EMR6 has been added. Author's changes in the manuscript: The first sentence of the second paragraph in the introduction was changed to "EMR6 is a new multifunctional EM receiver for deep metal mineral exploration EM survey, which was developed by China University of Geosciences (Beijing) (CUGB) and which supports the audio magnetotelluric (AMT), MT, CSAMT, SIP, and TDIP methods on the surface and in tunnels."

5) Comment from the Reviewer: In line 151, specification of RTC is needed. Author's response: The specification of the RTC was added. Author's changes in the manuscript: The following sentences were added to the first paragraph of Section 3.1. "DS3231 from Maxim Integrated is a low-cost, extremely accurate RTC with an integrated temperature compensated crystal oscillator (TCXO) and crystal. It has the advantages of high integration level, low power, and ease of use."

6) Comment from the Reviewer: Section 3.1, exact types of MCU and CPLD are needed. Author's response: The exact types of the MCU and CPLD have been added. Author's changes in the manuscript: The following sentences were added to the first paragraph of Section 3.1. "The low power 8-bit micro-controller MSP430G2553 from Texas Instruments was used as the MCU and 5M80ZE64 from Altera was used as the CPLD."

7) Comment from the Reviewer: Line 171, what's the meaning of COMS? Author's response: It is a typo; it should be "CMOS." We have corrected the typo. Author's changes in the manuscript: "COMS" was changed to "CMOS."

8) Comment from the Reviewer: Line 173, AMY may be AMT. Author's response: It is a typo; it should be "AMT." We have corrected the typo. Author's changes in the manuscript: "AMY" was changed to "AMT."

9) Comment from the Reviewer: Line 181-185, it's not clear about the process of testing using GPS time. Author's response: For locking the GPS time to the local RTC, the MCU obtains the time information from the GPS module and writes the time information to the RTC. In the CSAMT, SIP, and TDIP modes, the MCU must know the current time before it can switch the repeating schedule. We have added the following explanation of the GPS time at the end of Section 3.1. Author's changes in manuscript: At the end of Section 3.1, we have added, "For locking the GPS time to the local RTC, the MCU obtains the time information from the GPS module and writes it to the RTC. In the CSAMT, SIP, and TDIP modes, the MCU must know the current time before it can switch the repeating schedule."

10) Comment from the Reviewer: Line 201-203, it seems no stop time in frequency switching. MCU needs time to control CPLD and CPLD needs time to sync and response. What's the communication method between CPLD and MCU? Author's response: I apologize for not clearly presenting this part in the original manuscript. While switching to a different divider, there is a one-second pause before the start of the next divider. The communication method between the CPLD and MCU is a serial-peripheral interface. Author's changes in the manuscript: "There is a one-second pause between each switch divider for the CPLD to synchronize with the MCU. The CPLD is controlled by an MCU with a serial-peripheral interface." These sentences were added to the first paragraph of section 3.2.

11) Comment from the Reviewer: THD is a vital factor determining the performance of EM receiver. Just like seismic instrument, THD testing is vital important. The authors don't consider this problem in the testing of EM receiver. Author's response: The THD is very important in the performance of the EM receiver. Actually, in the indoor test, we used a low distortion signal generator (DS360) from Stanford Research Systems as a

pure signal source. The realization of this function is challenging. It is not contained in our current work, and may be realized in a future development. Author's changes in the manuscript: At the end of the discussion section, we have added, "Total harmonic distortion (THD) is another important factor determining the performance of the EM receiver. We have used a low distortion signal generator (DS360) from Stanford Research Systems as a pure signal source. This function is not contained in the current work, and it may be realized in a future development."

We look forward to hearing from you regarding our submission. We would be glad to respond to any further questions and comments that you might have.

Sincerely, Kai Chen China University of Geosciences Beijing 100083 ck@cugb.edu.cn

Please also note the supplement to this comment:
https://www.geosci-instrum-method-data-syst-discuss.net/gi-2017-43/gi-2017-43-AC2-supplement.pdf

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Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., https://doi.org/10.5194/gi-2017-43, 2017.