

## ***Interactive comment on “One-chip analogue circuits for a new type of plasma wave receiver onboard space missions” by Takahiro Zushi et al.***

**W. Schmidt (Referee)**

walter.schmidt@fmi.fi

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The manuscript describes the implementation of a mixed analog / digital plasma wave receiver with significant parts of the analog aspects combined into a single ASIC. The rationale behind this specific implementation and its advantage compared to other implementation approaches are outlined. As during the past decades and also in the future the observation of plasma waves in different parts of the solar system have been and will be of high importance in understanding the interaction between the solar wind and the near-environment of the various bodies inside the solar system like planets, their moons, comets and asteroids, attempts to minimize volume and power consumption for related instrumentations are very welcome. As the authors point out one of the large challenges is the wildly different signal strength in different parts of the spectrum from sub-Hertz to MHz ranges. Using a set of analog filters alone with separately ampli-

C1

fied and sampled channels for the different frequencies requires a large amount of components and especially for low frequencies large volumes and masses. The alternative is digital spectral analysis by sampling a wide band signal covering all frequencies of interest. This approach has to accommodate several contradicting requirements: The dynamic range of the analog input part and digitalization stage has to be large enough to accommodate the strongest signals while having a resolution sensitive enough to detect also the weakest signals of interest. The high frequency end of the spectrum requires fast sampling while the low frequency part requires long sampling periods leading to a large amount of raw data. As it usually is not possible to transmit this data amount to Earth, an efficient strategy for on-board pre-processing is crucial. The manuscript concentrates on the problem of the plasma wave signal's dynamic range problem. The shown implementation solves this problem by dividing the spectrum into 3 alternative bands, then uses an externally controlled amplification optimization in this band via the special properties of the developed ASIC. The smaller bandwidth allows either slower sampling for low frequencies or shorter sampling times for high frequencies thereby reducing the amount of samples and the related necessary electrical and processing power significantly. Adjustable band-limiting filters and amplification can be optimized to the specific needs of the used digital analysis and the properties of the sampled signal. While the sections 2, 4 and 5 concentrate on the application of the ASIC inside a wave spectrum receiver, the spectrum analysis part is delegated to an external FFT process to be implemented inside the instrument controller of the space instrument or the laboratory computer. In this respect the manuscript seems to be a bit misleading. Title and abstract correctly describe the general role of the analog ASIC. But already in the second part of the introduction starting at line 20 only its application inside a spectrum receiver is stated though its actual implementation as a waveform receiver is mentioned in the following sentence. The same aspect was also highlighted in the author's response to reviewer 1's first major point explaining that the analog part of the new spectrum receiver and the waveform receiver can be installed in the same ASIC. Only in the conclusion starting on line 21 a dedicated spectrum receiver is hinted

C2

at suggesting the integration of the optimized, but general-purpose analog circuitry of the current ASIC design, and ADC and the FFT-calculation capability inside the same chip optimizing its use for spectrum measurements. The selected approach of demonstrating the usefulness of the ASIC inside a spectrum receiver is certainly justified. But it would have been useful to keep the two aspects – the developed integrated controllable amplifier/filter circuitry inside a small ASIC and its optimized utilization inside an FFT-based spectrum analyzer – separate. This would only need minor adjustments to the introduction starting at line 20. Example: “This paper proposes a new type of small plasma wave receivers for future space missions. As an example the utilization of the developed miniaturized analog component inside a spectrum receiver is demonstrated. It is based on waveform receivers . . .” While the rest of the paper could remain in its last corrected version 3 as it is, also the conclusion is somewhat misleading. Again it only concentrates on the spectrum receiver aspect while in fact the proposed system is a wave form receiver for selectable bands covering each a different part of a typical plasma wave spectrum. This approach simplifies the digitalisation process and subsequent FFT calculation and optimizes the obtainable results for these bands compared to current wide-band implementations as demonstrated in the paper. But the spectrum receiver aspect is introduced via the FFT-implementation which is outside the scope of the article. This also means that using the measured samples without post-processing a full waveform receiver including phase information is created. And using e.g. wavelet transformation instead of an FFT even the phase information could be retained in the compressed data. Again just modifying the first sentence of the conclusion somewhat could be sufficient to correct this impression. A suitable version could be “This paper proposed a new type of a configurable analog front end circuit for plasma wave receivers that allows miniaturization and overcomes the disadvantages of conventional receivers. In its application as FFT-based spectrum wave receiver it measures and calculates . . .”

With these or similar minor adjustments to the latest version I propose the publication of the manuscript

C3

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C4