Performance Evaluation of Immense Technologies' EEG Sensor

Immense Technologies

***Abstract*—This paper presents the performance evaluation of a proprietary EEG sensor technology developed by Immense Technologies. Electroencephalography (EEG) has long stood as a pivotal tool in both medical and research domains. With the rapid advancements in neurology and related fields, the need for precise and reliable EEG measurements has never been more imperative. Our study focuses on the gain measurements of a buffer-configured amplifier integrated into the sensor, which is a fundamental aspect of achieving accurate EEG readings. The amplifier, designed with optimized biasing and advanced shielding circuits, promises enhanced EEG signal detection. Our results emphasize the significance of the sensor's stability across a wide frequency spectrum, showcasing its potential for diverse applications requiring accurate EEG measurements.**

***Index Terms*—EEG, Sensor, Amplifier, Gain, Shielding, Biasing.**

I. INTRODUCTION

Electroencephalography (EEG) sensors have long been instrumental in the realm of neuroscience, offering insights into the complex electrical activities of the human brain. Over the decades, as our understanding of the brain has deepened, the tools to study it have also undergone significant evolution. Despite the advancements, achieving precise and noise-free EEG readings remains a challenge, especially with the presence of external electromagnetic interferences. Immense Technologies, recognizing these challenges, has ventured into developing a proprietary EEG sensor technology. This sensor, with its buffer-configured amplifier, promises enhanced performance and reliability, setting a potential benchmark in EEG measurements.

II. METHOD

The rigorous testing methodology employed for evaluating the amplifier's gain was paramount to ensuring the reliability of our findings. Our measurements spanned the full frequency spectrum, ranging from $0.2\,Hz$ to $99\,Hz$. Each test was conducted using excitation signals with varying amplitudes: $100\,\mu V$, $1\,mV$, and $10\,mV$. This excitation signal was shaped as a sine wave, generated by a custom function generator built on the TI DAC1282 platform[1]. The generated signal was directed in two pathways. The first pathway led the signal to a specific load of $68\,MEGOhm$ applied to the sensor, closely mimicking real-world applications. Concurrently, the second pathway channeled the signal directly to the ADS1299, a high-performance EEG acquisition analog front-end System on Chip (SoC) from Texas Instruments[2]. Given the susceptibility of EEG measurements to external interferences, a shield was installed on the sensor during the tests. The sensor's output, after processing the load, was then captured and fed back to the same ADS1299 SoC. This setup allowed for a direct comparison between the original excitation signal and the sensor's output.

An adaptive measurement window length was utilized, set to record for a duration of $5 \times (1/frequency + 1)$ seconds. This decision was made to strike a balance between capturing adequate data and ensuring timely readings. During the analysis phase, the Fast Fourier Transform (FFT) was employed, serving as a powerful tool in frequency domain analysis. The triggered frequency was then meticulously compared with the trigger signal. It's essential to note that variations in the amplitude of the trigger signal across tests ($100\,\mu V$, $1\,mV$, and $10\,mV$) were strategically chosen to simulate different real-world scenarios, reinforcing the robustness of our methodology.

III. RESULTS

The acquired results from the rigorous testing are both insightful and promising. The buffer-configured amplifier's near-ideal performance across the frequency spectrum is a testament to its design and optimization. While the ideal gain of 1 (V/V) was consistently observed across the majority of the frequency spectrum, slight degradations at higher frequencies were noted. Such degradations, though minimal, are expected due to inherent circuit constraints and external factors. The overarching significance of these results lies not just in the numbers but in the sensor's potential to revolutionize EEG measurements, especially in challenging conditions.

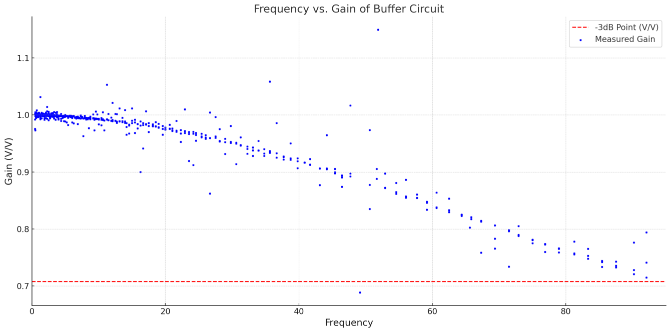

Fig. 1. Frequency vs. Gain of EEG Sensor's Amplifier

IV. TEMPERATURE CONTROL

A vital aspect of our research involved evaluating the amplifier's gain under controlled temperature conditions. The measurements were primarily conducted at an ambient temperature of 31°C. However, for comprehensive analysis, multiple measurements were also taken at an elevated temperature of 80°C. As can be seen in the figure below, there's a noticeable trend in the behavior of the amplifier's gain as the temperature rises. The observed data indicates a marginal drop in gain at high temperatures. This drop can be attributed to the increased leakage current of the biasing circuitry at elevated temperatures. The implication of this behavior underscores the importance of temperature control and its role in ensuring consistent EEG readings across diverse operational environments.

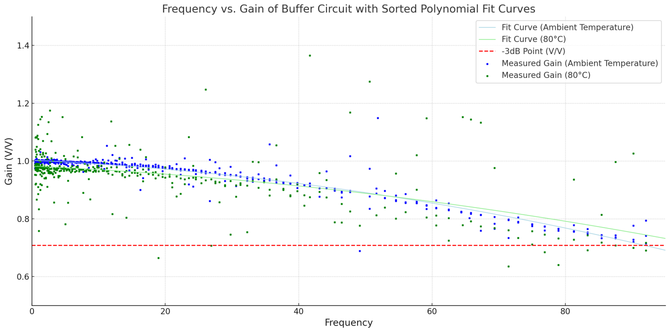

Fig. 2. Temperature vs. Gain of EEG Sensor's Amplifier

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