TÉCNICO LISBOA

LIP

Development for the BoneOscopy and FLASHGuard Projects

David Amarante

Supervisors: Gonçalo Ribeiro, Gonçalo Roriz

LIP Intership, 4 September 2026; Lisbon, Portugal

Introduction

Signal Modeling

- Model Validation
- Model Approximation for the SiPM Used
- Laboratory Data

Amplifier Design

- Amplifier Structure
- Amplifier Properties
- Results

Model Validation

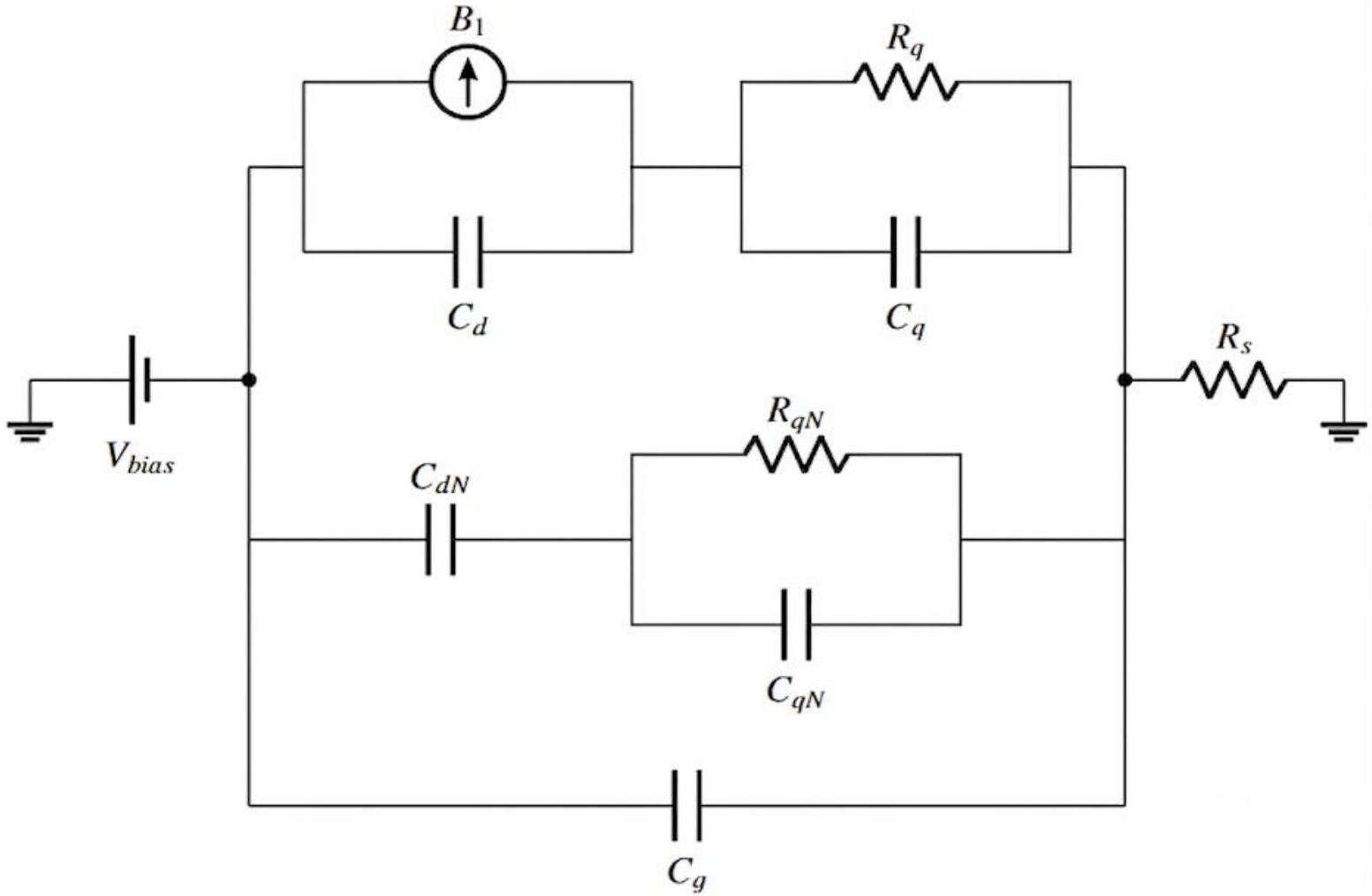


Fig. 1. SiPM SPICE Model

- Equivalent SPICE model of a single active SiPM cell
- Signal source used to reproduce the cell current pulse

Model Validation

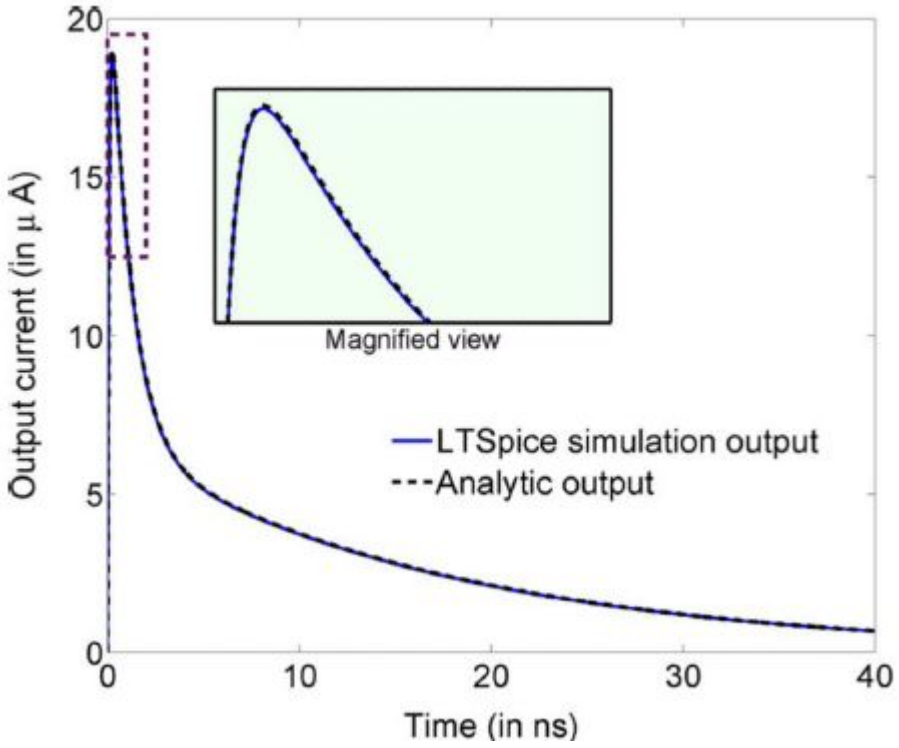


Fig. 2. Reference Graph

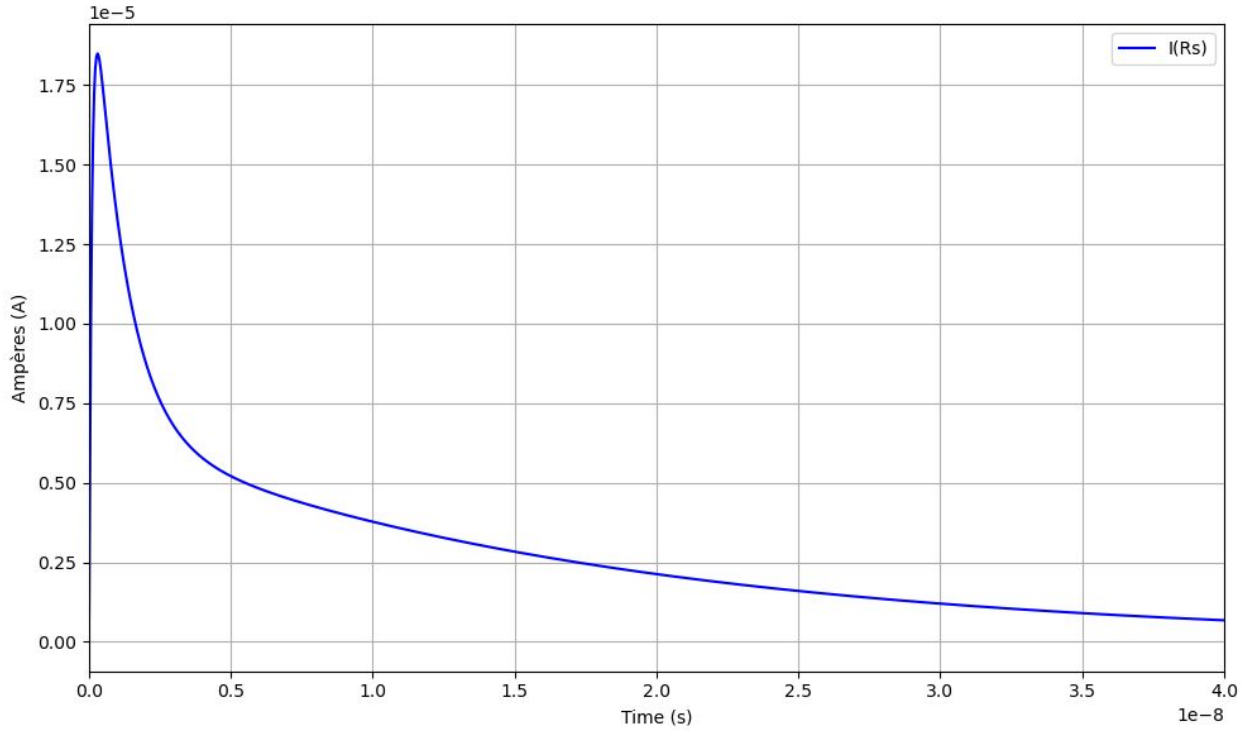
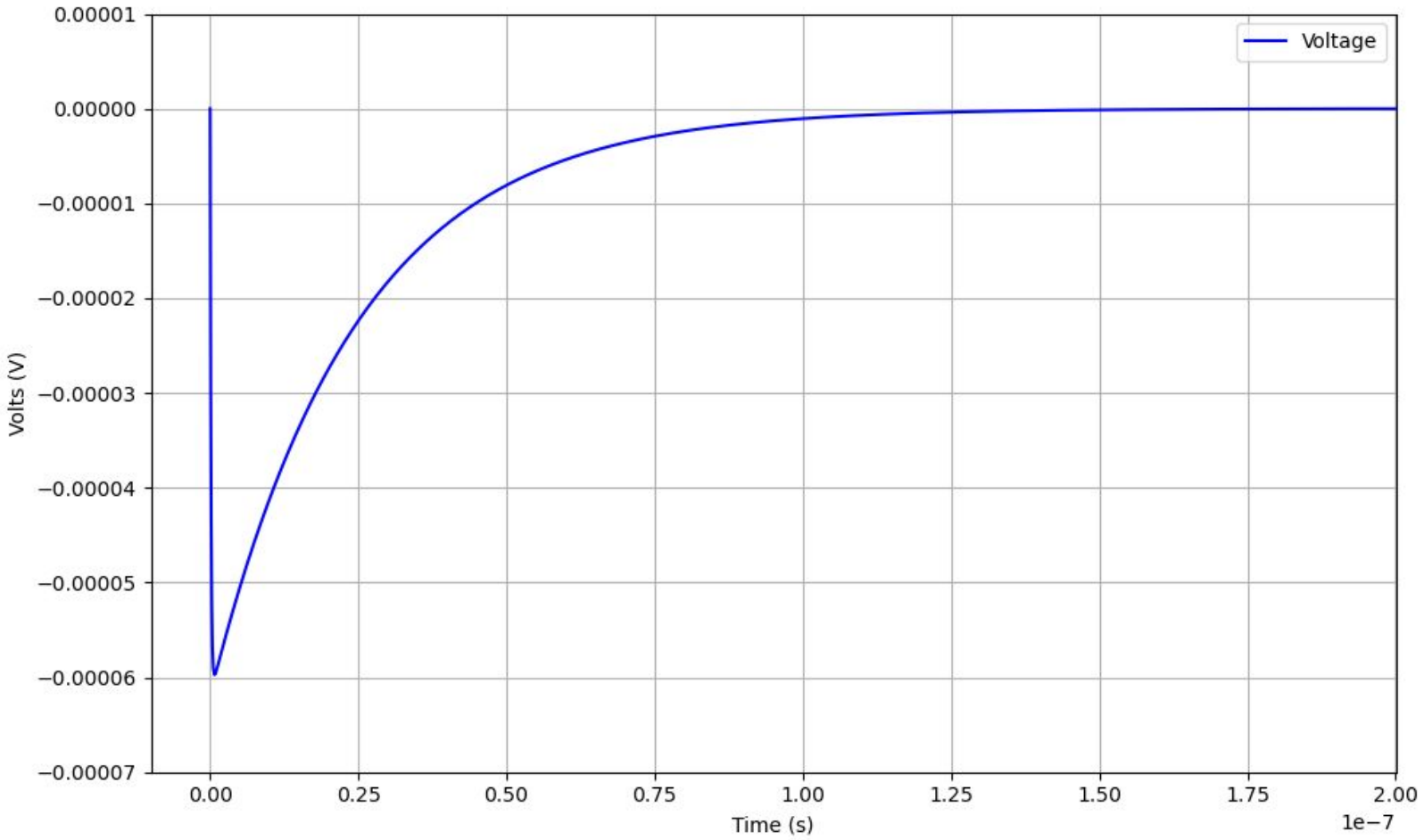


Fig. 3. SPICE Simulation Results

Model Approximation for the SiPM Used



- The parameters were approximated based on the SiPM datasheet.
- The pulse has a frequency range of approximately 100–200 MHz, due to the pulse's rise time.

Fig. 4. Approximate SiPM Graph

Laboratory Data

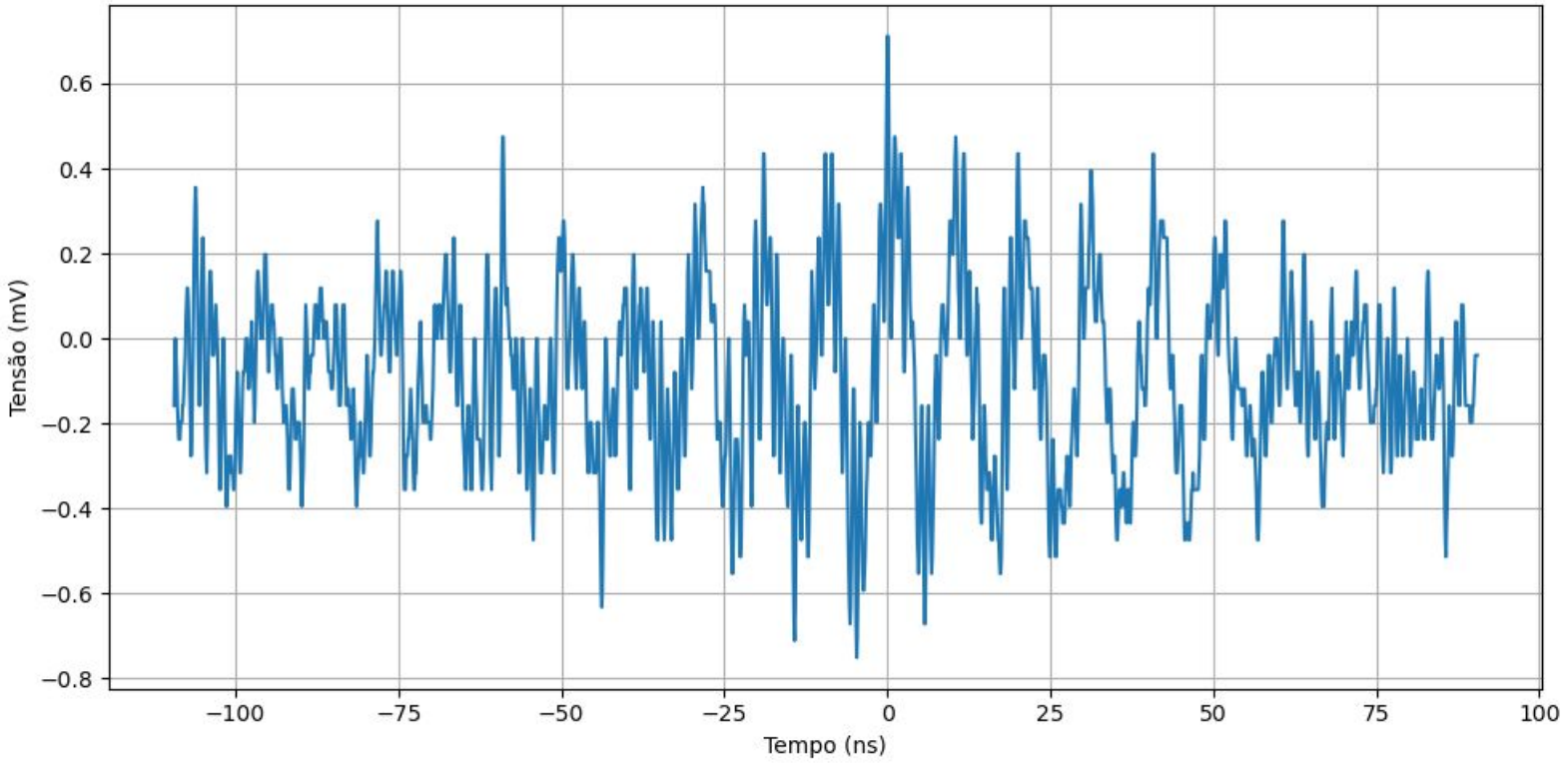


Fig. 6. Oscilloscope Data

- The signal was too weak to be detected by the oscilloscope; only noise was observed.
- The SiPM requires signal amplification.

Amplifier Structure

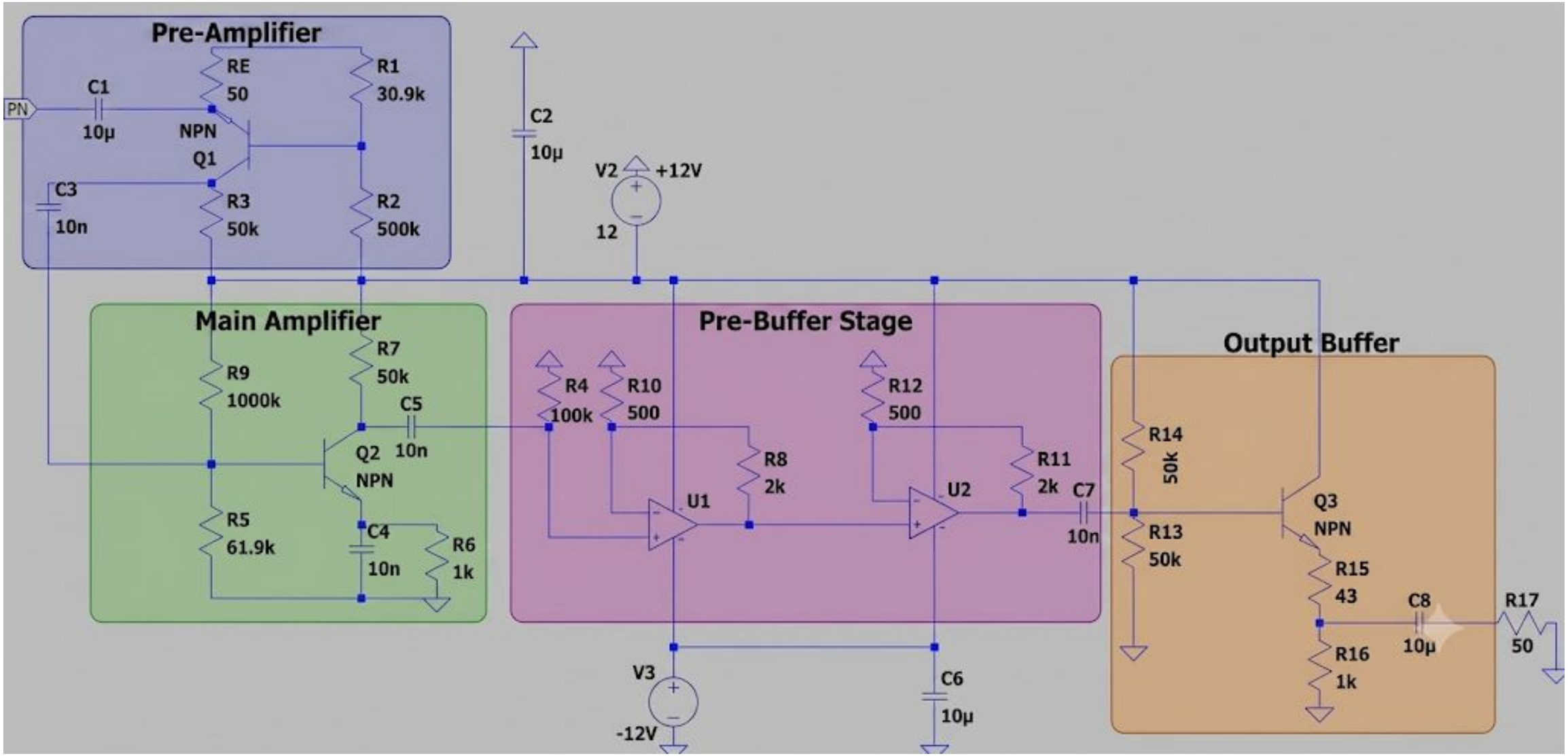


Fig. 7. Amplification Circuit

Amplifier Properties

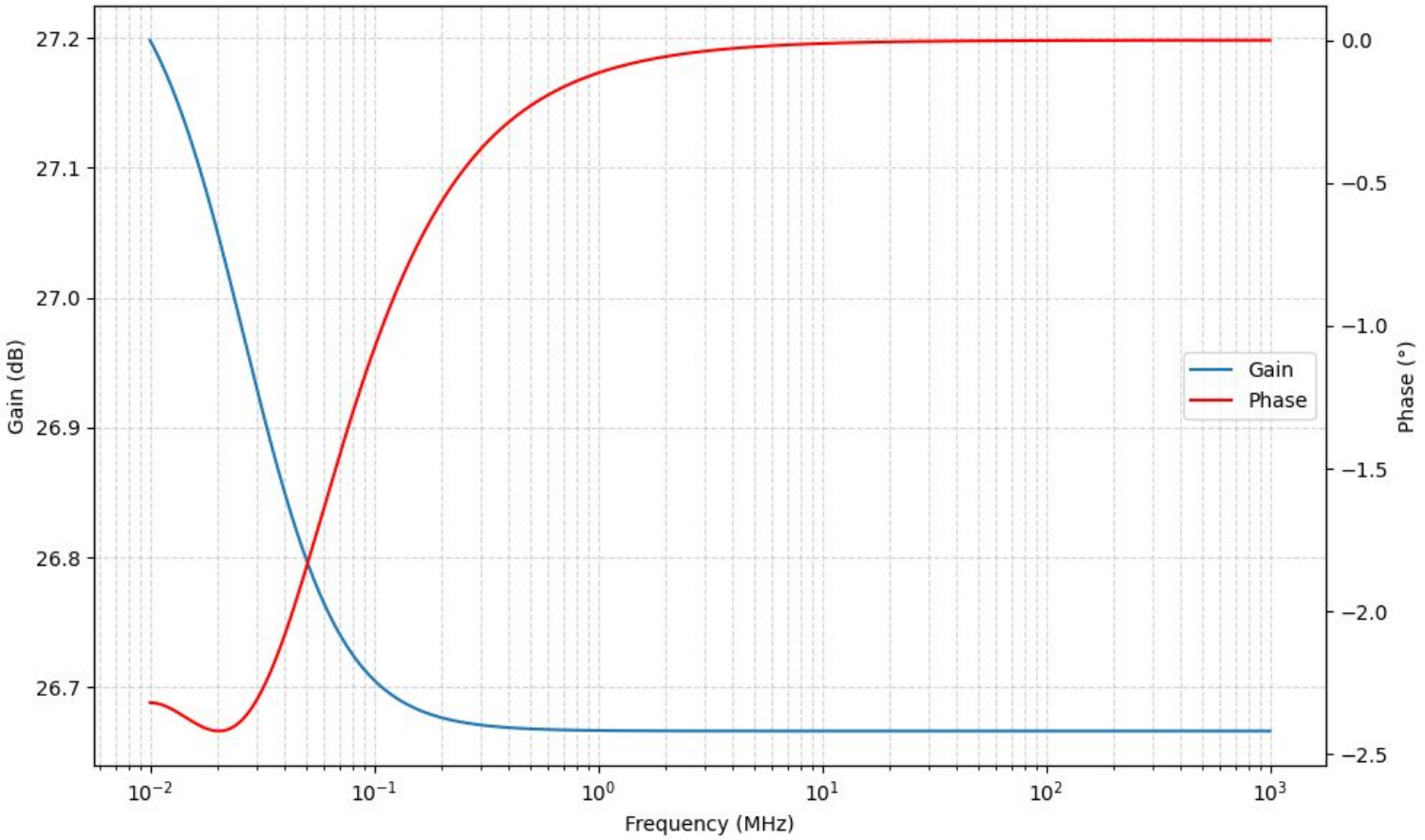


Fig. 8. Preamplifier Gain

- The common-base transistor configuration provides a low input impedance.
- And It only provides voltage gain, approximately 22×.

Amplifier Properties

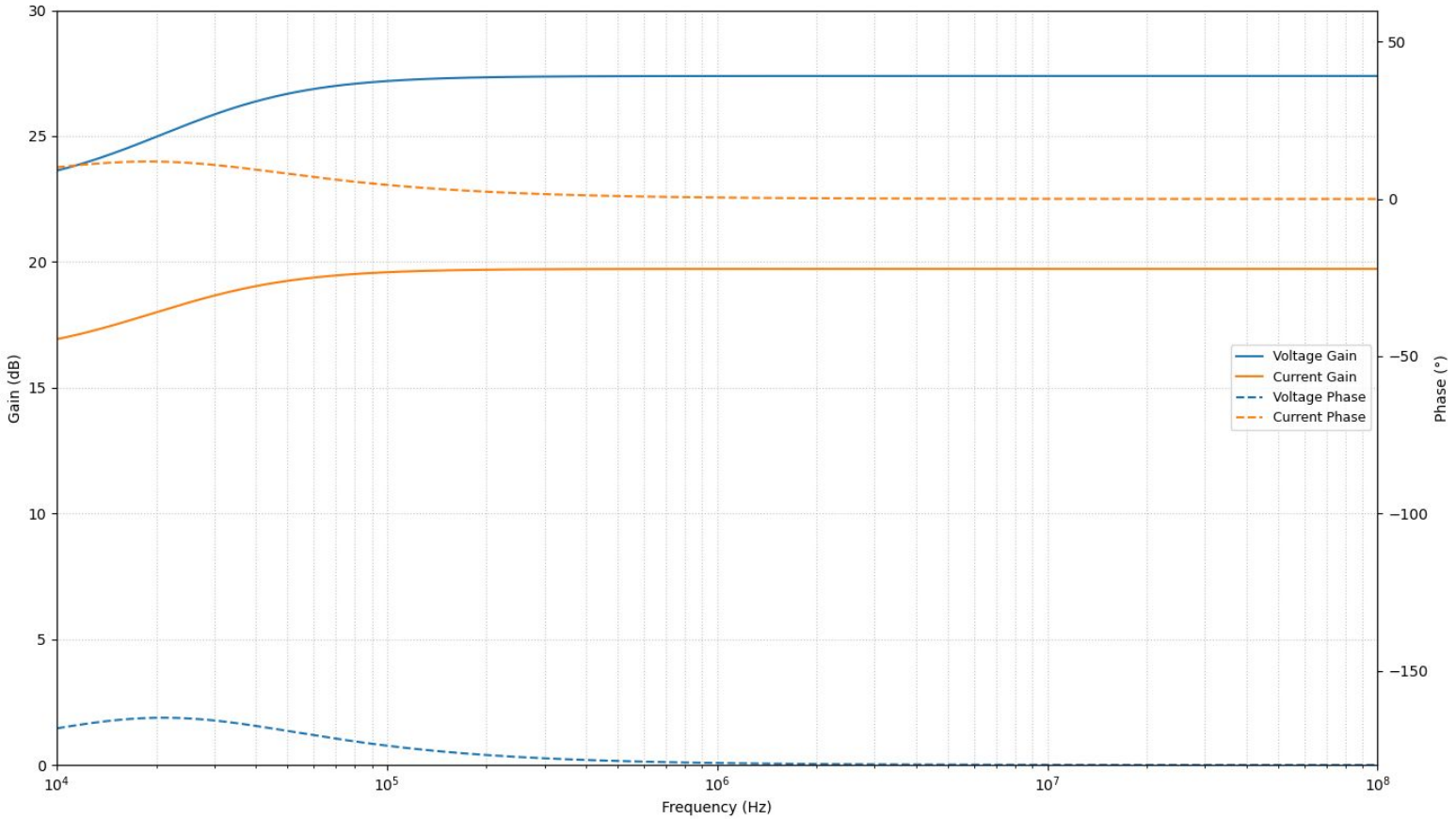


Fig. 9. Gains of the Second Amplification Stage

- A phase inversion of the signal voltage is observed, which is advantageous since the detector's original output is negative.
- A voltage gain of 22× and a current gain of 9× are observed.

Amplifier Properties

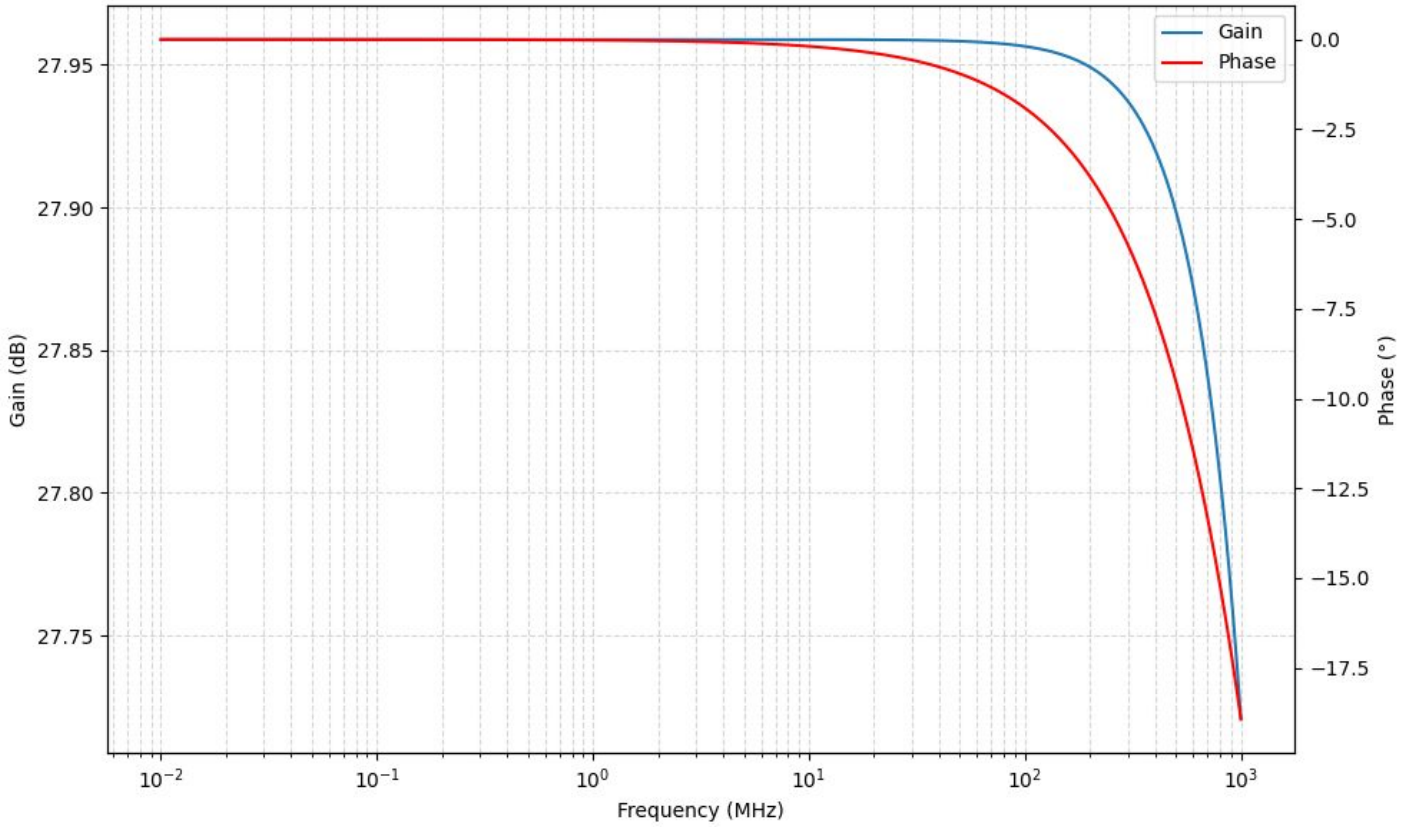


Fig. 10. Gain of the Third Amplification Stage

- The op-amp operating frequency was 30 GHz; however, a phase delay can be observed as the frequency increases.
- A voltage gain of approximately 22× is achieved.
- The purpose of this stage is to provide additional amplification before the buffer stage, where a voltage drop will occur.

Amplifier Properties

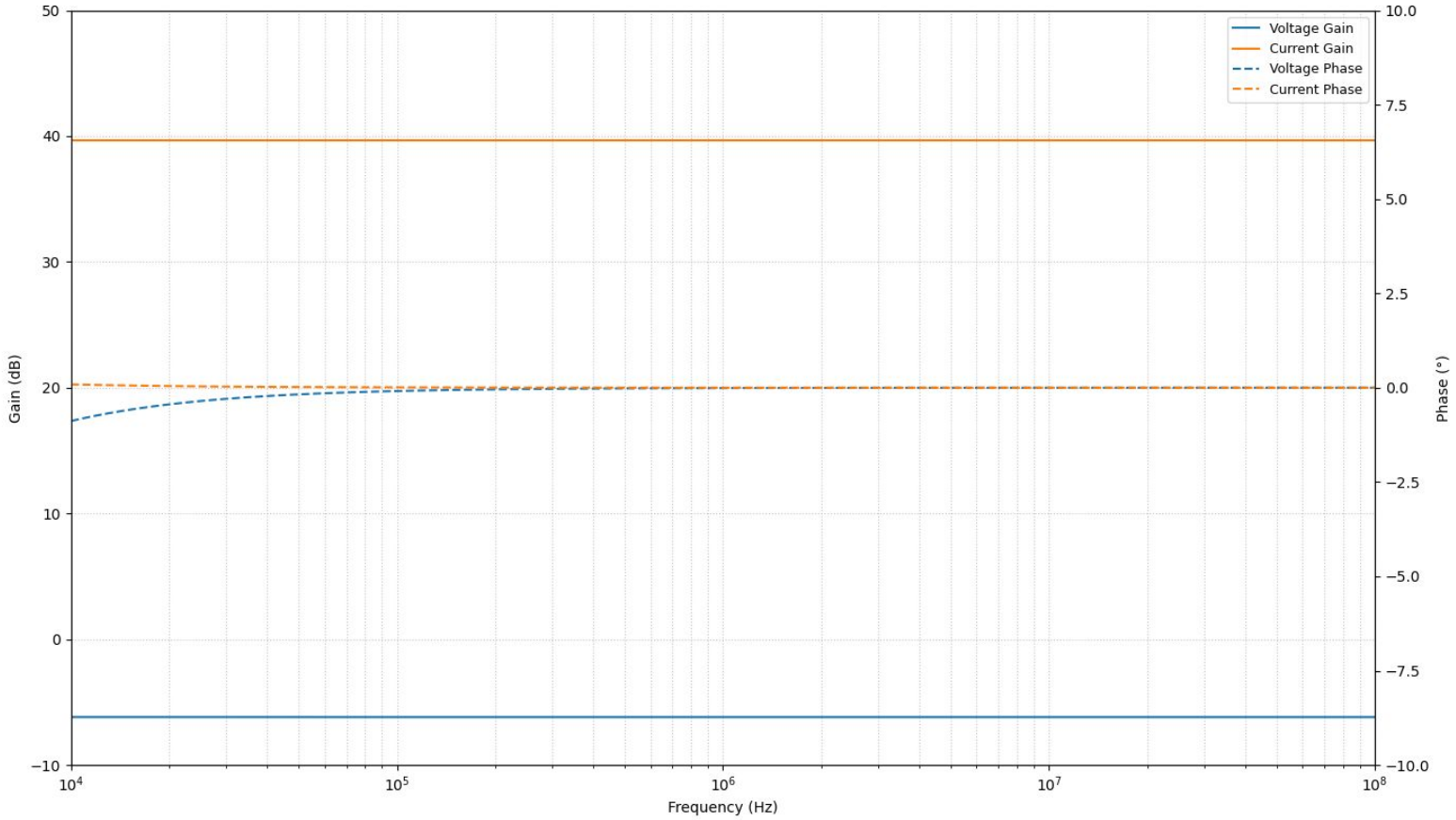


Fig. 11. Buffer Gain

- A current gain of approximately 90× is achieved.
- A voltage drop of approximately −6 dB (½×) is observed due to the buffer.
- The buffer provides an output impedance of approximately 50 Ω.

Results

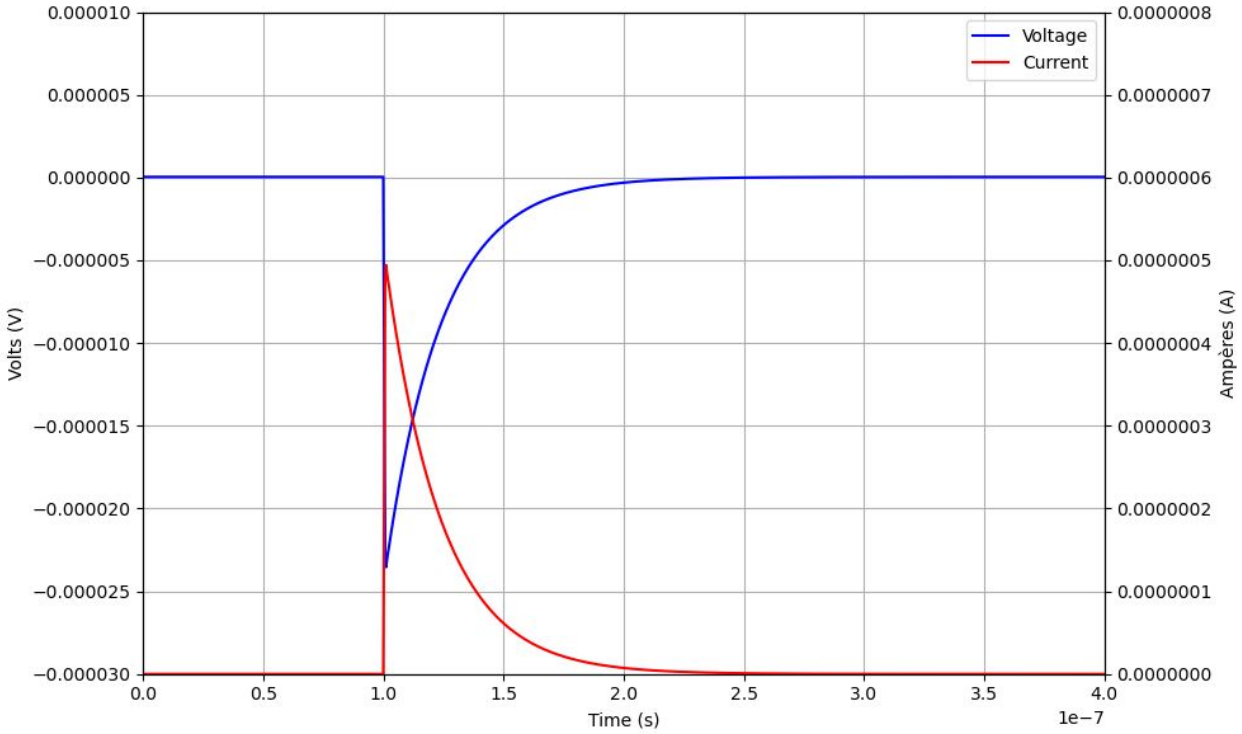


Fig. 12. Input Signal

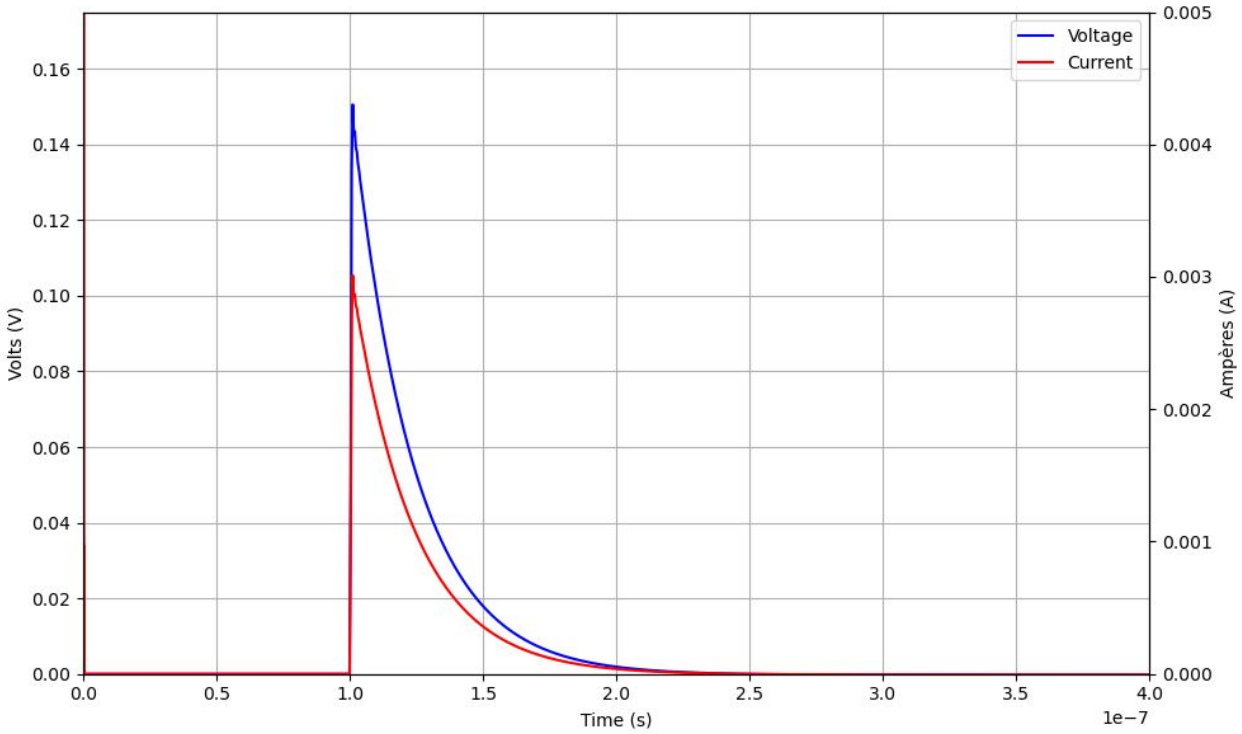


Fig. 13. Output Signal

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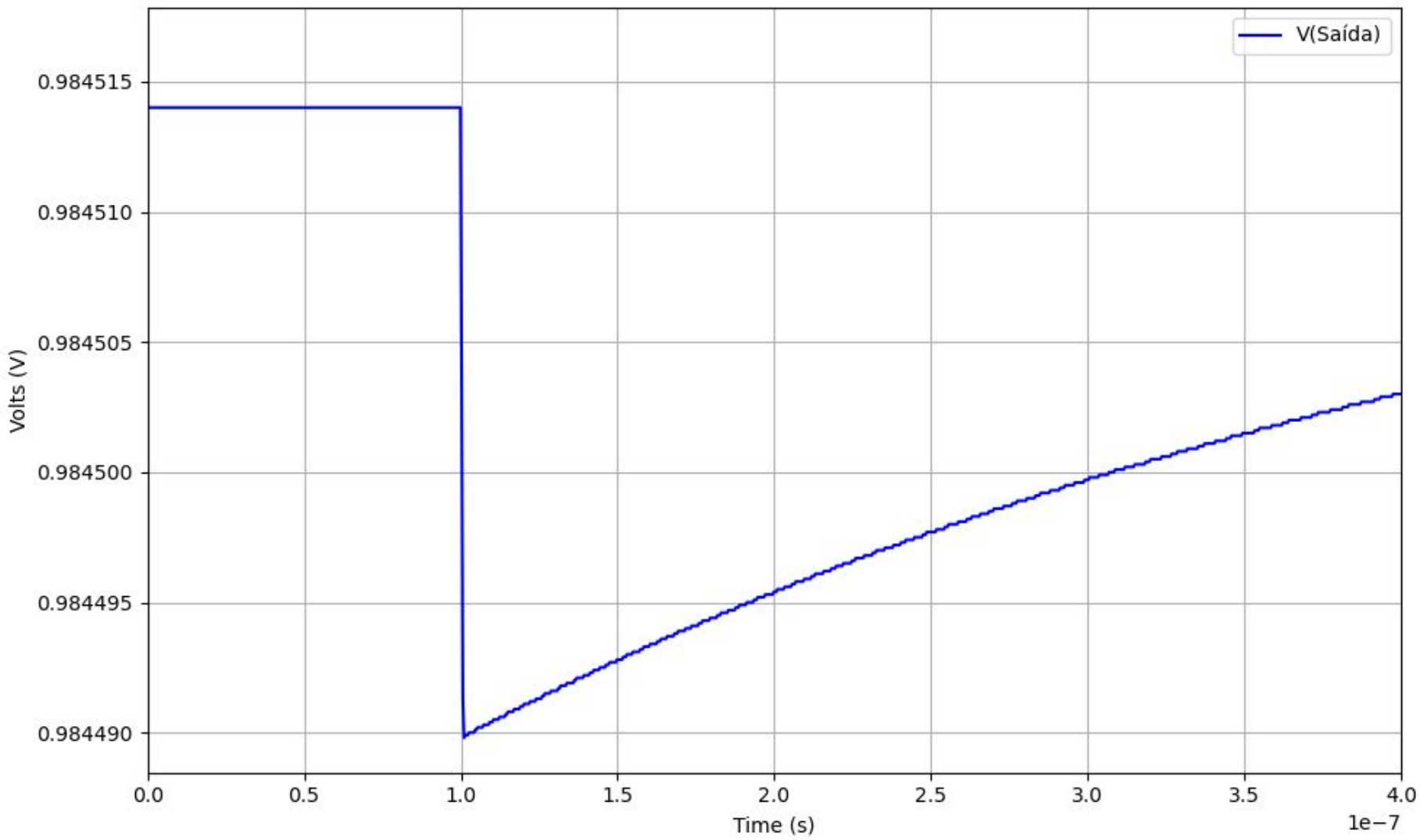

Fig. 14 High Impedance