

## Compact Nanosecond Bipolar Pulse Generator for On-chip Modulation of Biological Response

Ilan Davies\* <sup>(1)(2)</sup>, Nissar Karim<sup>(1)</sup>, Amira Eltokhy<sup>(1)</sup>, Lynn Carr<sup>(1)(3)</sup>, Christopher Hancock<sup>(1)(2)</sup>, Cristiano Palego<sup>(1)</sup>, Emre C. Durmaz<sup>(4)</sup>, Canan Baristiran Kaynak<sup>(4)</sup>, Mehmet Kaynak<sup>(4)</sup>, Arnaud Pothier<sup>(3)</sup>, Delia Arnaud-Cormos<sup>(3)</sup>, Philippe Leveque<sup>(3)</sup>

(1) Bangor University, Bangor, LL57 1UT, United Kingdom

(2) Creo Medical, Chepstow NP16 5UH, United Kingdom

(3) XLIM-UMR 7252, University of Limoges/CNRS, 87060 Limoges, France

(4) IHP, Innovations for High Performance Microelectronics, 15236 Frankfurt (Oder), Germany

### Abstract

The SUMCASTEC project aims to isolate and neutralize brain cancer stem-like cells (CSC) using electromagnetic stimulation [1]. We present a new compact nanosecond pulse electric field generator that can deliver 500 V, 10 ns bipolar pulses that was developed in the frame of the project. The generator is optimized for driving miniaturized lab-on-chip (LOC) applicators thus supporting modulation of cell response, with relatively lower input voltage, and higher field uniformity than in conventional dish-based or cuvette applicators. The preliminary experimental results demonstrate modulation of CSCs response to nanosecond pulses through field reversal are presented.

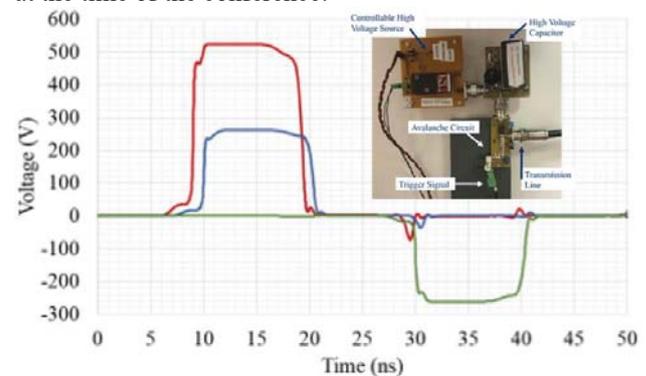
### 1 Introduction

Nanosecond bipolar pulse cancellation consists in the reduction of the effects of a unipolar electric pulse exposure by applying a second pulse of opposite polarity [2]. This modulation of biological response has been reported in a variety of cell and nerve excitation conditions therefore propelling an intensely investigated area of research in bioelectrics. Typically, the nanosecond pulses utilized in bipolar cancellation studies rely on sophisticated (e.g. laser) switching technologies, which impair compactness, portability, and cost-effectiveness.

### 2 Materials and Methods

The pulse generator developed during SUMCASTEC is essentially a very compact and low-cost solution because 1) it relies on commercially available avalanche transistor technology [3], and 2) because it was optimized for driving miniaturized LOC applicators where small electrode gaps result in low voltage threshold for cell permeabilization. Fig. 1 shows a breakdown of the circuit arrangement for the pulse generator along with its typical monopolar and bipolar output waveforms. While the bipolar waveform result in 50% reduction with respect to the monopolar pulse maximum voltage, such amplitude was sufficient for permeabilization of CSCs in the lab-on-chip applicator even for moderate delivered pulses number and repetition frequencies. Additionally, it can be noticed that the

achieved impedance matching conditions result in low secondary pulses, or ringing, which is critical for accurate analysis of response modulation. Test on bipolar cancellation of CSCs stimulus response are currently in progress with the present generator and will be discussed at the time of the conference.



**Figure 1.** (a) Circuit arrangement and (b) typical waveforms for the present nanosecond pulse generator.

### 3 Acknowledgements

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### 7 References

1. [www.sumcastec.eu](http://www.sumcastec.eu)
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3. I. Davies et al. "Push-pull configuration of high-power MOSFETs for generation of nanosecond pulses for electropermeabilization of cells". *Int. J. Micro. Wire. Tech.* 11, 7 (2019).