H1 Measurement of electroporation pulses with oscilloscope, and voltage and current probes

Matej Reberšek
University of Ljubljana, Faculty of Electrical Engineering

Duration of the experiment: 60 min
Max. number of participants: 10
Location: Laboratory of Biocybernetics
Level: Basic

PREREQUISITES

Participants should be familiar with Electroporation hardware safety (S2). No specific knowledge is required for this laboratory exercise.

The aim of this laboratory practice is to learn how to use standard measurement equipment to measure or monitor the delivery of electroporation pulses. During the laboratory practice we will also learn what are the electrical parameters of electroporation pulses, what should we report in our studies concerning the measurement and what are some possible complications during the pulse delivery or measurement.

THEORETICAL BACKGROUND

Electroporation is initiated by the delivery of electrical pulses to biological cells. Electrical pulses may vary in pulse parameters such as pulse shape, amplitude, duration and polarity [1-3]. We may deliver different number of pulses, use combination of different pulses or vary pulse repetition rates. We also may deliver pulses in bursts or in different directions relative to the cell. The process of the electroporation is strongly dependent on the pulse parameters of the delivered electrical pulses. In order to control the process of the electroporation and to exactly specify the experimental method, and thus enable the reproduction of experiments under the same conditions, we should exactly determine and describe these electrical parameters [4]. When reporting electroporation methods we should: 1) describe exactly how the electric pulses were measured; 2) provide time-domain waveforms of the electric pulse at the electrodes; and 3) calculate or otherwise determine to what electric field the cells were exposed to [5].

EXPERIMENT

Oscilloscope, and voltage and current probes will be used to monitor the delivery of the clasical, high-frequency and nanosecond electroporation pulses to the load [6-7]. Different commercial and prototype voltage and current probes and electroporators will be available during the exercise.

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EXPECTED RESULTS

We will become familiar with the three main oscilloscope controls—vertical, horizontal, and trigger—and learn how to adjust them for accurate pulse acquisition. We will practice using the oscilloscope's measurement tools to automatically determine pulse parameters, apply sequencing to capture multiple pulses at low repetition rates, and configure the acquisition mode to record bursts of pulses. Participants will monitor the delivery of both microsecond and nanosecond pulses to a load and learn to recognize issues such as disconnections or impedance mismatches. Finally, they will observe how the choice of measurement point and wiring quality can influence both the recorded waveform and the actual delivery of the pulse.

NOTES & RESULTS