NeuroNexus

Intracortical Microsimulation (ICMS) and Recording

Microsimulation and Recording with Microelectrodes

Many users are interested in stimulating through one microelectrode array while recording from another microelectrode array. While possible, users should be aware that an artifact will appear on the recording electrodes during any stimulation. An ideal solution to the artifact problem remains an active topic of research.

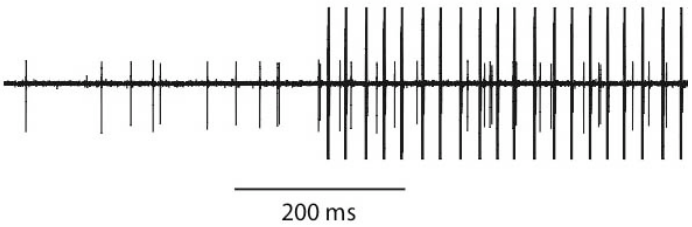
What is the Artifact?

The artifact can be thought of as a broadband electromagnetic signal caused by a change in voltage over time (dV/dt). The rapid (infinite slope) change in voltage that occurs when an electrical pulse is delivered results in a transient electromagnetic artifact signal propagating through the implanted animal (see figure below and to the right). The artifact only occurs during voltage *changes*; for example a D.C. offset on an electrode will not cause a stimulus artifact.

A microstimulation artifact appears on all recording traces of a NeuroNexus Array during 10 ms of current stimulation from a nearby intracellular glass electrode. Notice recovery time of artifact is ~3 ms, and that artifact only appears upon stimulation onset and offset (Data courtesy of Mickey London).

How Can the Artifact be Mitigated?

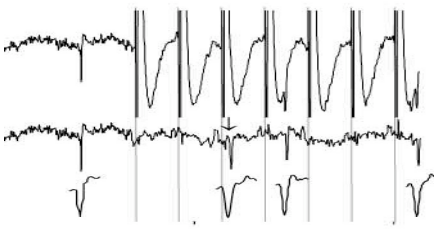
As the back voltage needed to generate current in the brain is a function of the resistance (or impedance) of the stimulating electrode via Ohm's Law (V=IR), the lower the voltage delivered, the lower the stimulus artifact. Thus, impedance lowering methods should be applied before microelectrodes are implanted (see accompanying tech note: Intracortical Microsimulation (ICMS) with Microelectrodes).



Above trace shows a unit recorded from the neocortex without (left side) and with (right side) microstimulation of arm musculature. Notice that the artifact temporarily swamps the recordings even though the stimulation is distant from the brain (Data courtesy of Chet Moritz)

How Can the Artifact be Mitigated? Pt II

If your stimulus artifact voltage is low enough that you have not swamped your amplifiers, you can recover your spiking activity via realtime template subtraction. When you begin your microstimulation, store a 5 ms waveform of the stimulus artifact in your software program. Then, in real time (possible using Tucker Davis Technologies hardware and software), subtract a running average of your stimulus artifact waveform sample from your recording signal whenever you deliver a microstimulation pulse to your stimulating electrode (see data below, courtesy of Robert Turner: top trace shows raw signal, bottom trace shows artifact subtracted signal).



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