Current sources modules for non-invasive modulation of electrophysiology

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Takeaways

Here we introduce **current source modules** optimally designed for **low-noise transcranial** electrical stimulation or **high-power, high-bandwidth** electrical stimulation with **precise temporal control** and **synchronization** enabling combined **transcranial and neuromuscular stimulation**.

Background

Investigations of **direct effects of electrical stimulation** on electrophysiological activity requires **low noise stimulation** enabling **synchronous EEG** [1] or ***in vitro* cell activity** [2] recordings.

Application scenarios of electrical stimulation **target area located deeper in the brain** [3] and include **peripheral nerve** and **muscle stimulation** [4], which require **higher intensities.**

High **temporal precision** is required for both, **temporal interference** stimulation and **paired transcranial and neuromuscular stimulation**.

Stimulation effects on electrophysiological activity need to be assessed in **real-time**

Innovation

Current source modules designed for

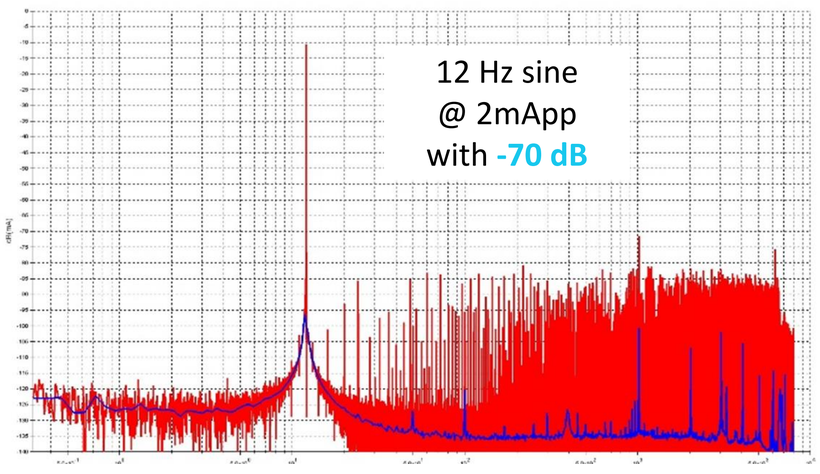
- transcranial stimulation based on **low-noise operational amplifiers**
- peripheral stimulation based on **high-power, high-bandwidth transistor** gain stages

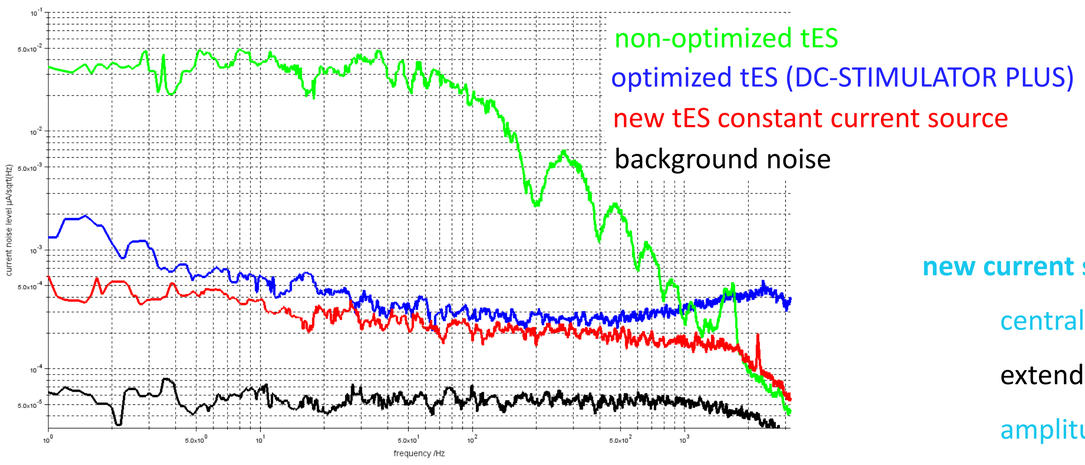
modular design with

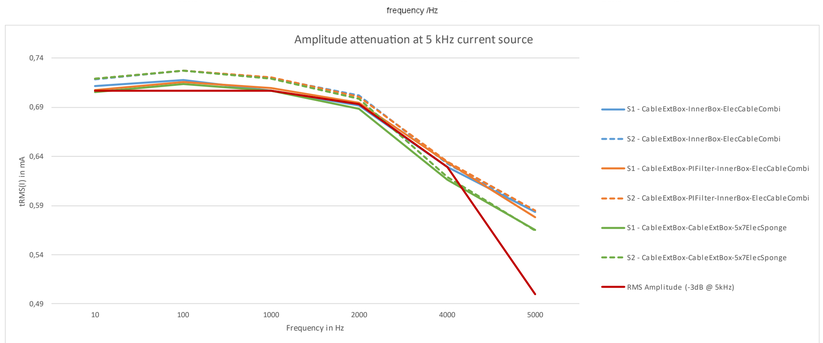
- flexible control via pulse width modulated (**PWM**) signal,
- galvanic insulation via digital isolators,
- temporal synchronization via **real-time** bus

Results

Low-noise current source







Bandwidth

3 db edge frequency: **5 kHz**

100 kHz

full scale rise time: **1 µs**

Dynamic range

+/- 4 mA arbitrary waveform

up to 1 ms duration: **+/- 40 mA**

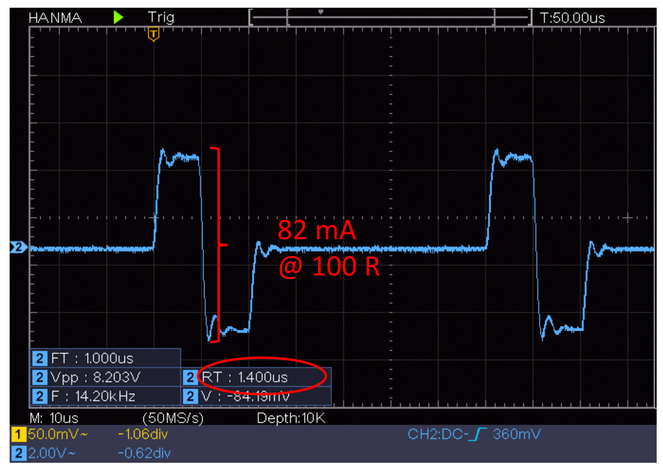
low frequency waves: **+/- 15 mA**

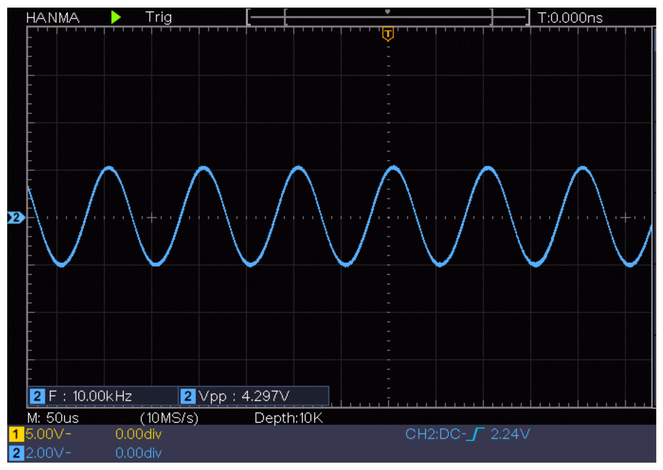
Key performance

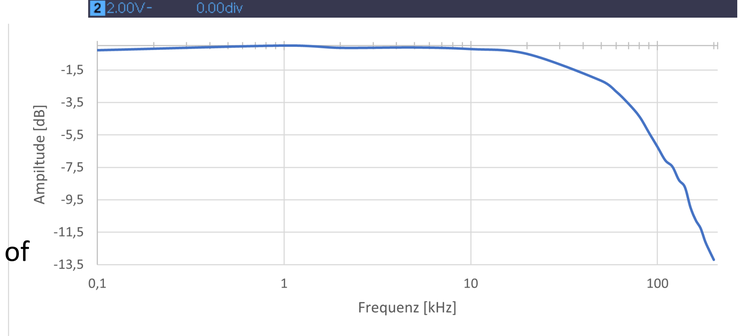
Low 1/f noise for EEG combination

fast high intensity for periphery

Wideband universal isolated power current source







Conclusion

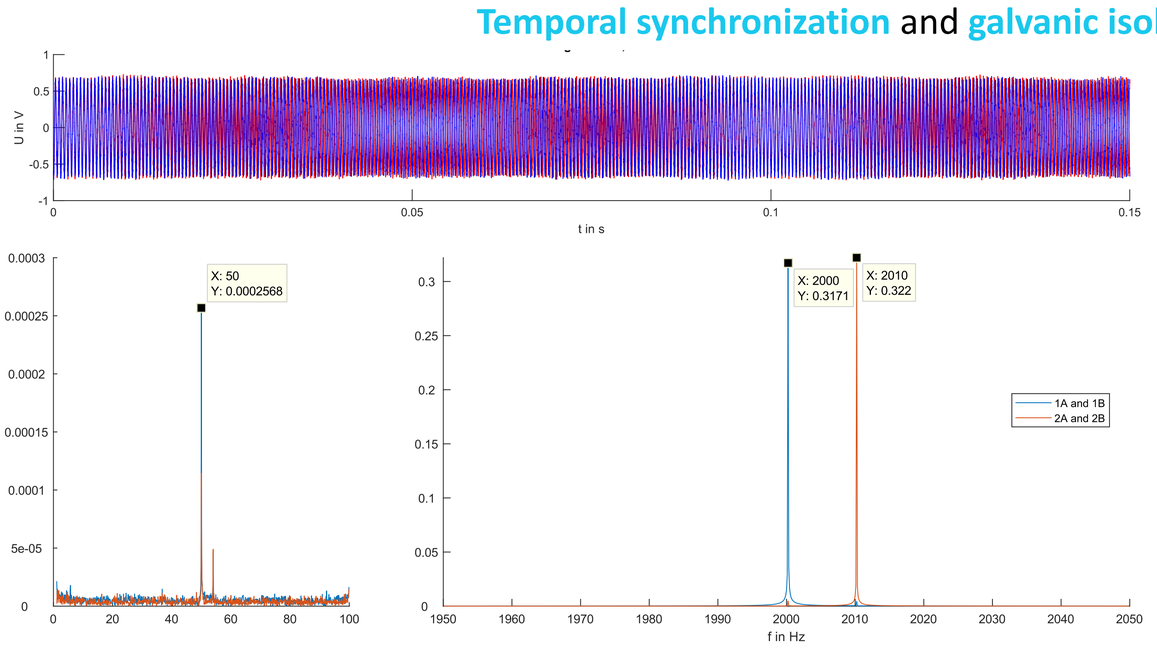
new current source modules enable:

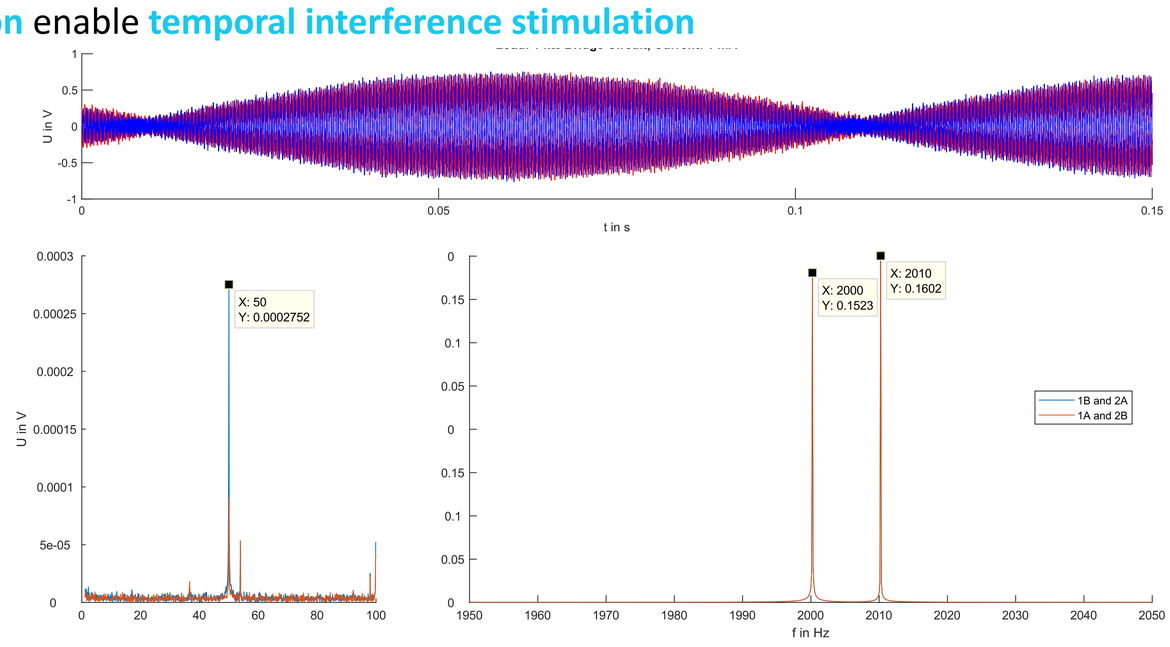
- central and peripheral electrophysiological modulation with extended parameter sets including
- amplitude modulation via PWM control
- to address further targets

temporal synchronization allows:

- pairing of transcranial or peripheral stimulation for investigations of corticospinal interactions and realization of temporal interference stimulation

Temporal synchronization and galvanic isolation enable temporal interference stimulation





References

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