

CLASS: platform for stimulation and recording via wearable multiplexed electrodes

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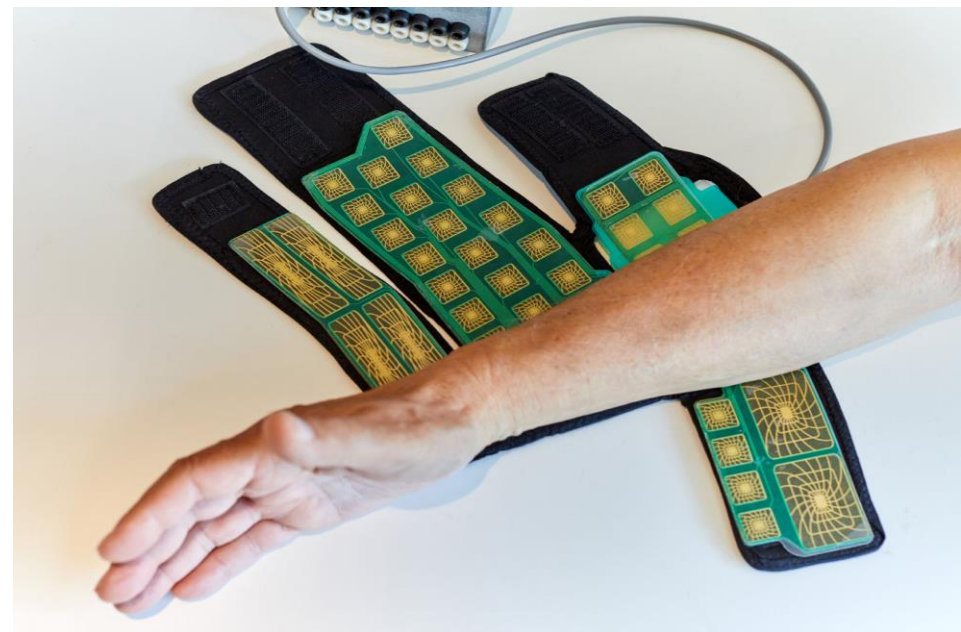
Wearplex Special Session, 13th Vienna FES Workshop, September 23-25, 2019

CLASS PLATFORM

TECNALIA has developed CLASS (**C**losed-**L**oop **A**cquisition and **S**timulation **S**ystem)

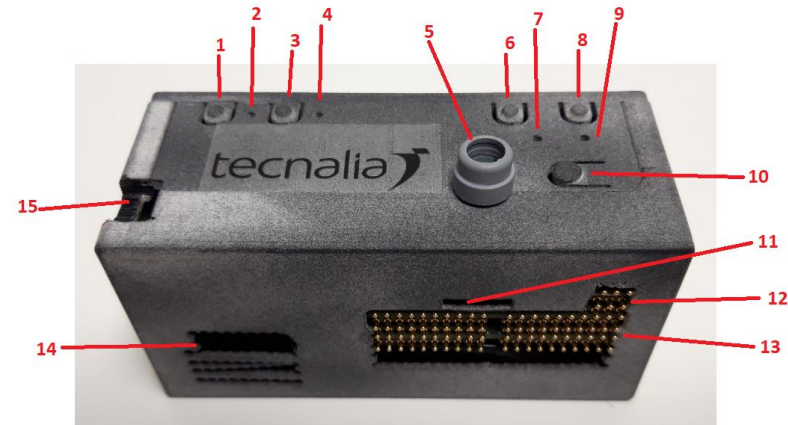
A FES and neuromodulation platform for research purposes.

The platform allows a wide range of stimulation types, physiological signal recordings and the synchronization between them to provide closed-loop stimulation.



CONCEPT

- **Compact and portable** system consisting of stimulation, acquisition, signal processing and control modules
- Microprocessor with DSP to pre-process and/or process data in **real-time** and
- 3rd party board for **programmable applications** in Python or C for researchers.
- **SD card to store information** such as configuration parameters and all acquired timestamped information along with other data as i.e. errors or warnings.
- A **Bluetooth module** is used to communicate the device with external systems such as PC, mobile or tablet. Used to **exchange data in both directions**, i.e. configuration messages to the device and data stream to the external system.
- Pressure loaded Pogopins connect directly to printed or textile electrodes or a connector box



CLASS: ELECTRICAL STIMULATION

Stackable stimulation modules able to provide FES, TENS and electro-tactile feedback with controlled currents from 0.1 to 100mA (with voltages from 50 to 200V).

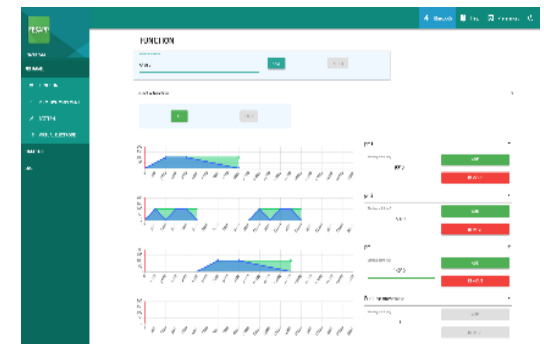
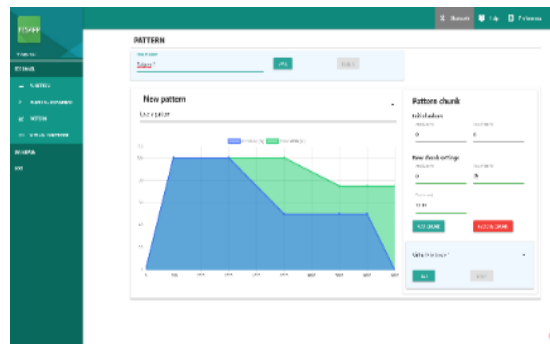
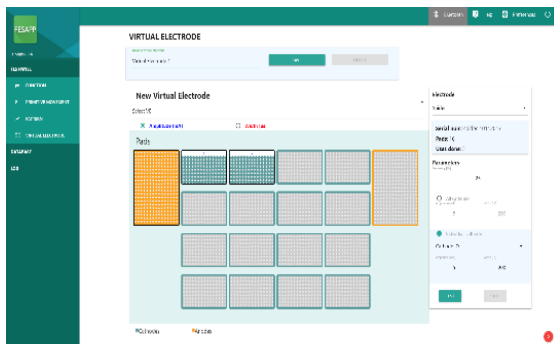
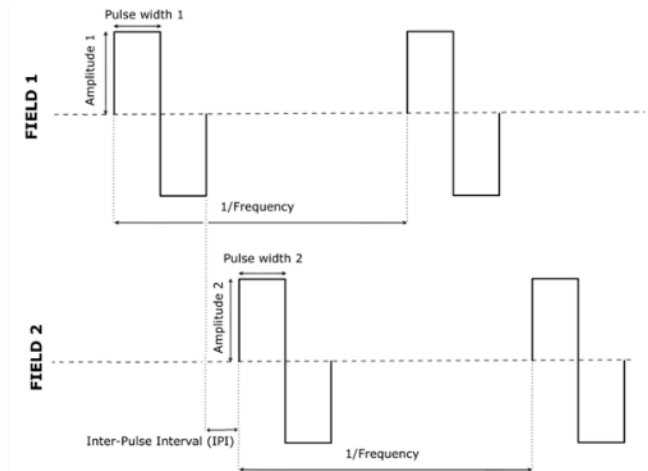
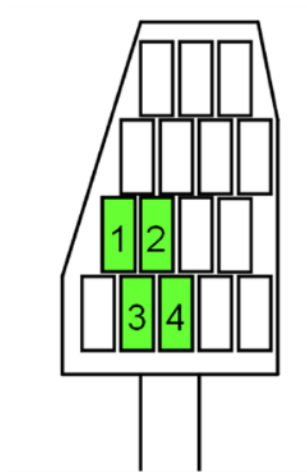
Each module will allow having **16 stimulation channels** with configurable anodes and cathodes that can provide monophasic, biphasic symmetrical and biphasic compensated pulses.

Stimulation parameters as amplitude, frequency, pulse width, etc. can be configured in **up to 48 stimulation channels**.



FEATURES ELECTRICAL STIMULATION

- Virtual electrode concept
- Pattern concept
- Movement Primitive concept
- Synchronous and asynchronous stimulation
- External Control: 2 input and 2 output **triggers** for stimulation and acquisition.



SPECIFICATION ELECTRICAL STIMULATION

Technical specs:

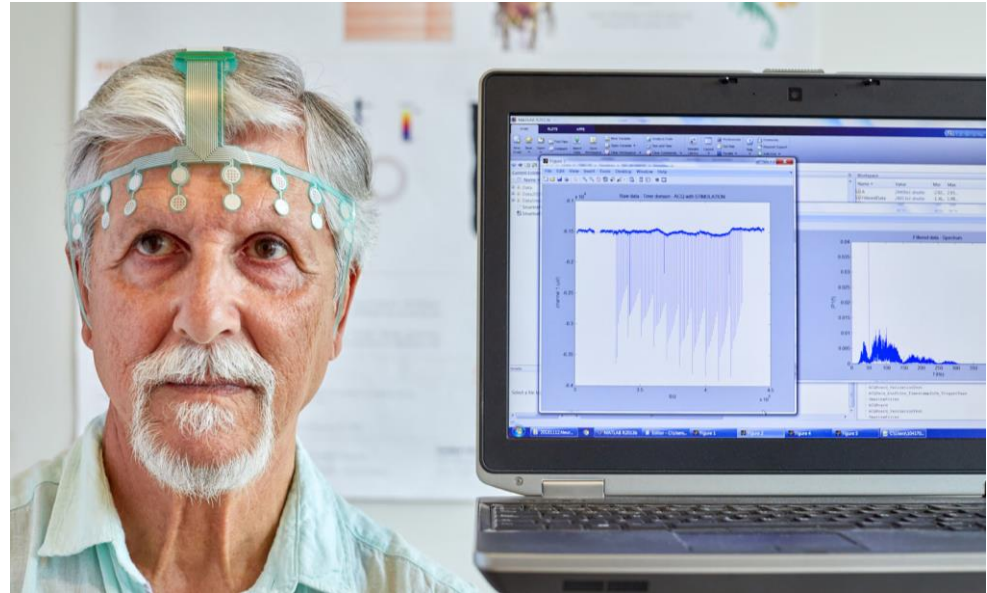
Stimulation module		
Parameter description	Value	Unit
Step-up DC/DC converter output voltage (current source power supply)	200 (Down to 50V) (Controllable output)	V
Step-up DC/DC converter output power	1.5	W
Stimulation pulse amplitude	1 - 100	mA
Stimulation pulse amplitude changing step	100	μA
Stimulation pulse width	30 – 4000	μs
Stimulation pulse width changing step	10	μs
Rise time	<6	μs
Fall time	<6	μs
Stimulation frequency	0.1 – 500	Hz
Stimulation frequency changing step	0.1	Hz
Interpulse interval	0.25 - 1	ms
Pulse shape	<ul style="list-style-type: none"> • Monophasic • Biphasic symmetrical • Biphasic balanced-asymmetrical 	
Number of cathode/anode channels	48	Ch
Stimulation / multiplexing mode	<ul style="list-style-type: none"> • Asynchronous • Synchronous • Cathode/anode multiplexing 	
Electrode connector type	Pogopin	

CLASS: SIGNAL ACQUISITION

Stackable (up to 4 modules) **signal acquisition modules** to acquire physiological signals. 2uV peak-to-peak noise. Each module will allow having 16 monopolar or bipolar acquisition channels. The modules can have independent or common reference.

Allows **contact impedance measurement** and electrode disconnection detection.

Includes a **9 DoF IMU** that can be used to monitor user's movements and/or trigger the stimulation or acquisition.



SIGNAL ACQUISITION

Technical specs:

Acquisition module (electrophysiological signals & IMU)		
Parameter description	Value	Unit
Number of acquisition channels	32	Ch
Acquisition channel type	Monopolar/Differential	
ADC resolution	23 + sign	bit
Signal amplification	24	dB
CMRR	> 110	dB
Shield driver	YES	
Active DRL circuit	YES	
Possible sampling rates for each channel	250, 500, 1K, 2K, 4K, 8K	SPS
Electrode impedance measurement	YES	
Electrode lead-off detection	YES	
Electrode connector type	Pogopin / Pin strip / Clip	
Internal digital IMU	9	DoF
Sampling rate (acc & gyro)	>500	Hz
Sampling rate (magn)	>50	Hz

OTHER SPECIFICATIONS

Other technical specs:

Input/output module		
Parameter description	Value	Unit
Number of trigger input channels	2 (1 stim + 1 acq) (5kV isolated)	Ch
Trigger input voltage level (digital signal)	0 - 3.3 (5V tolerant)	V
Number of trigger output channels	2 (1 stim + 1 acq) (5kV isolated)	Ch
Trigger output voltage level (digital signal)	0 - 3.3	V
Trigger output pulse width	0.1 - 1	ms
Internal synchronization between stimulation and acquisition	YES	
Communication & storage module		
Parameter description	Value	Unit
USB port for battery charge, data transfer and acquisition & stimulation configuration	1 (5kV isolated)	
Pogopin for battery charge, data transfer and acquisition & stimulation configuration	1 (5kV isolated)	
Bluetooth 4.0 for data transfer and acquisition configuration	1	
Removable on board storage for acquisition	μSD card	
μSD card capacity	>64	Gb
General		
Parameter description	Value	Unit
Buttons	5	
ON/OFF button	1	
Current increase/decrease buttons	2	
STIM start/stop button	1	
ACQ start/stop button	1	
Buzzer (for error)	1	
LEDs	5	
Yellow (for STIM)	1	
Orange (for ACQ)	1	
Red (for error & battery)	1	
Blue (for Bluetooth)	1	
Green (for ON/OFF)	1	
Power supply	Li-Poly battery	
Battery capacity	2000	mAh
Integrated charger powered from USB	USB connector	
Design of a dock/cradle for charging & data transfer	YES	
Design of a dock/cradle for commercial electrodes	YES	

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THANK YOU

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