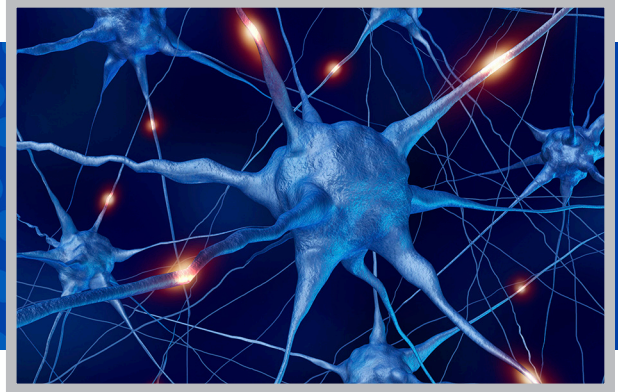# EEG/EMG SYSTEMS

Pinnacle offers **BIOPOTENTIAL RECORDING SYSTEMS** for sleep, seizure and general behavioral paradigms in freely moving mice and rats. Our EEG/EMG systems use head-mounted amplification to produce exceptionally clean waveforms, even during animal movement. We offer wireless & tethered preconfigured three-channel systems. A flexible four-channel tethered system is available which includes the capability to incorporate simultaneous accelerometer, optogenetics or sensor measurements.

WIRELESS SYSTEM FOR MICE & RATS

Pinnacle's turn-key **WIRELESS EEG/EMG SYSTEMS** can record up to three biopotentials simultaneously and present data in real time for review. This lightweight, head-mounted Bluetooth® device enables animals to move freely. It is ideal for behavioral paradigms and group housed research. The same hardware can be used for mice and rats.

COMMON USES

SLEEP STUDIES

SEIZURE RESEARCH

DEPTH ELECTRODES

CORTICAL RECORDINGS

LOCAL FIELD POTENTIAL

COGNITIVE STUDIES

8274 WIRELESS SYSTEM SPECIFICATIONS

# Channels	3		
# bits	12		
System Configuration	SL	SE3	SE3 (EI)
High Pass Filter	EEG 0.5 Hz; EMG 10 Hz	EEG 1.0 Hz	EEG 1.0 Hz
Input Range	+/- 480 uV	+/- 480 uV	+/- 960 uV
Total Gain	2600 V/V	2600 V/V	1300 V/V
Resolution	0.23 uV	0.23 uV	0.47 uV
Sample Rate & Battery Life*	256 - Battery Life 6 + days; 512 - Battery Life 4 + days; 1024 - Battery Life 2 + days		

8274 WIRELESS SYSTEM WEIGHT & SIZE

System Weight**	Mice	3.8 g
	Rats	6.8 g
Size	Mice	17.1 x 16.2 x 11.0 mm
	Rats	32.1 x 21.2 x 18.3 mm

*Bluetooth interference may affect battery lifetime. For longer studies the removable battery can be easily replaced.

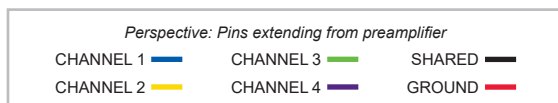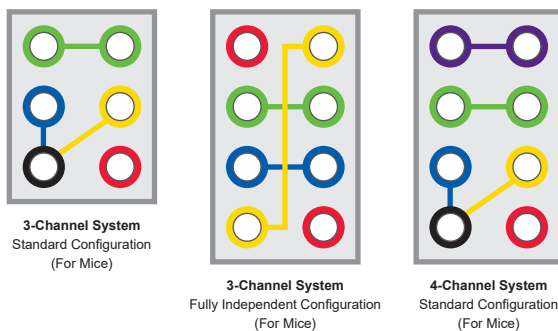**Includes electronics, battery and enclosure.

TETHERED SYSTEM

OUR TETHERED TURN-KEY SYSTEMS are engineered to deliver clean, artifact-free data. EEG and EMG waveforms are amplified and filtered at the head of the animal by the preamplifier. Signals are then passed through the low-torque swivel to the data conditioning and acquisition system for final-stage amplification and filtering. Each channel in our three- and four-channel systems features independent, adjustable gain and filter settings.

TETHERED SYSTEM FEATURES	3-CHANNEL	4-CHANNEL
Available for both mice and rats	✔	✔
Optimized for sleep and seizure experiments	✔	✔
No cable artifact	✔	✔
Adjustable gain and low-pass filters	✔	✔
Digital input/output controls	✔	✔
Analog output	✔	✔
Optogenetics support	✔	✔
Biosensor support		✔
Accelerometer support		✔
Sampling rate up to 20,000 Hz per channel		✔
Fully configurable channels		✔
Reconfigurable via preamplifier exchange		✔

HOW OUR PREAMPLIFIERS WORK

Pinnacle's preamplifiers provide differential amplification (x10 or x100) between electrodes. Our standard three and four-channel preamplifiers have two referential channels and one or two differential channels. Fully referential and fully differential versions are also available.

Example: A 2 EEG/1 EMG preamplifier configured for seizure studies in mice has a gain of x100 on all channels, 1.0 Hz high-pass filters on the EEG channels, and 10 Hz high-pass filters on the EMG channel.

3-Channel System
Standard Configuration
(For Mice)

3-Channel System
Fully Independent Configuration
(For Mice)

4-Channel System
Standard Configuration
(For Mice)

Perspective: Pins extending from preamplifier

CHANNEL 1 ▬	CHANNEL 3 ▬	SHARED ▬
CHANNEL 2 ▬	CHANNEL 4 ▬	GROUND ▬

SYSTEM FOR RATS

COMMUTATORS

A P1 Technologies commutator is mounted above the cage. The commutator's two-plug set-up allows for even rotation of the rotor.

PREAMPLIFIERS

Signals are amplified and filtered at the animal's head using our preamplifiers, which ensure the delivery of clean, artifact-free data. An 18-inch cable connects from the preamplifier to the commutator, and the wires are protected by a metal spring coil. A P1 screw connector is used to secure the preamplifier to the animal's head.

High-Pass Filters: 0.5 Hz EEG, 10 Hz EMG for sleep; 1.0 Hz EEG, 10 Hz EMG for seizure
Gain: x100 for sleep; x10 for seizure

3-Channel Configurations	Sleep	Seizure
2 EEG/1 EMG	●	●
3 EEG		●
4-Channel Configurations	**Sleep**	**Seizure**
2 EEG/1 EMG/1 BIO	●	●
2 EEG/1 EMG/1 Accelerometer	●	●
3 EEG/1 EMG	●	●
3 EEG/1 BIO		●
3 EEG/1 Accelerometer		●
4 EEG		●
4 EEG Fully Referential		●

RAT HEADMOUNTS
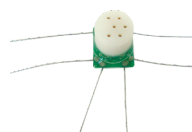
Prefabricated rat headmounts use fittings mounted on a 9 mm X 9 mm board with EEG or EMG electrode wires attached. An additional two-pin electrode is used for 4 EEG configurations.

CUSTOM CONFIGURATIONS AVAILABLE

DATA CONDITIONING AND ACQUISITION SYSTEM

A data conditioning and acquisition system (DCAS) performs secondary amplification and filtering before sending data to Pinnacle's Sirenia® Acquisition software for collection via a USB connection.

Specifications	3-Channel	4-Channel
Adjustable Sampling Rates	200 - 2,000 Hz	200 - 20,000 Hz
Software Configurable Low-Pass Filters	11 Hz - 1 kHz	21 Hz - 15 kHz
ADC Resolution	16 bits	16 bits
TTL Input/Outputs and Analog Outputs	4 TTL Input/Outputs	4 TTL Input/Outputs and 4 Analog Outputs

## SYSTEM FOR MICE

COMMUTATORS

A low-torque commutator, which is mounted above the cage, allows for unencumbered freedom of movement.

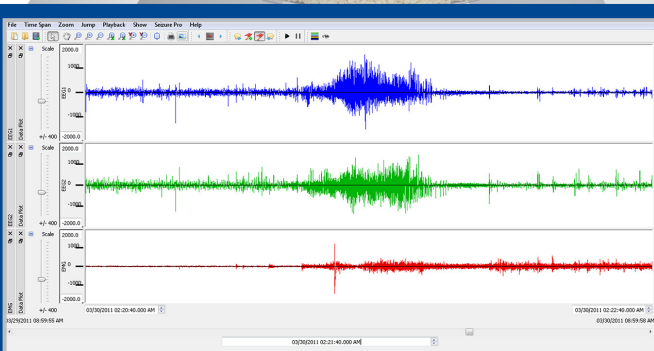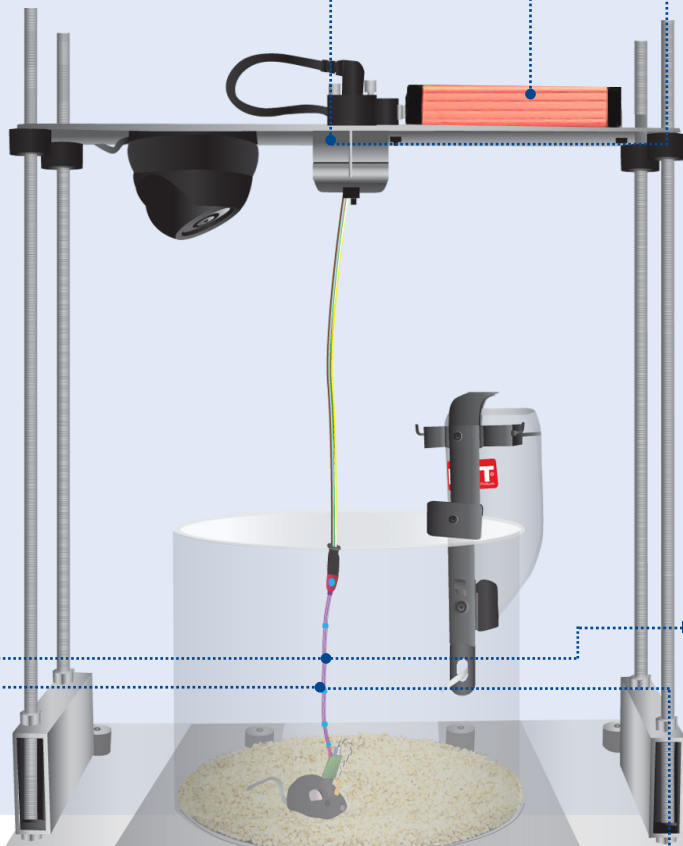**Rotational Torque:** < 2 x 10^{-4} N-m

PREAMPLIFIERS

Signals are amplified and filtered at the animal's head using our preamplifiers. This ensures the delivery of clean, artifact-free data. The cable from the commutator connects to the seven-inch cable of the preamplifier. Six insulated wires are banded together to create this lightweight cable. The mouse preamplifier connects to a headmount via a friction fit.
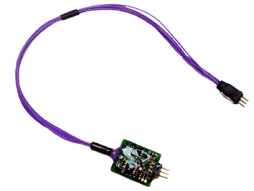
High-Pass Filters: 0.5 Hz EEG, 10 Hz EMG for sleep; 1.0 Hz EEG, 10 Hz EMG for seizure
Gain: x100 for sleep; x10 or x100 for seizure

3-Channel Configurations	Sleep	Seizure
2 EEG/1 EMG	●	●
2 EEG/1 EMG (Independent)	●	●
3 EEG		●
3 EEG (Independent)		●

4-Channel Configurations	Sleep	Seizure
1 EEG/1 EMG/2 BIO	●	●
2 EEG/1 EMG/1 BIO	●	●
2 EEG/1 EMG/2 BIO	●	●
2 EEG/1 EMG/1 Accelerometer	●	●
3 EEG/1 EMG	●	●
3 EEG/1 BIO		●
3 EEG/2 BIO		●
3 EEG/1 Accelerometer		●
4 EEG		●
4 EEG Fully Referential		●

MOUSE HEADMOUNTS

Prefabricated headmounts reduce surgery time, allow for reproducible electrode placement and provide ready-to-insert EMG leads. Six- or eight-pin headmounts support flexible electrode placement for customizable cortical or depth recordings.
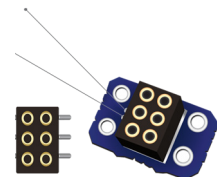
Seizure event from a C57 mouse model captured using Pinnacle's three-channel EEG/EMG system.

Data courtesy of Drs. Philip Haydon and Jerome Clasadonte, Tufts University School of Medicine, Department of Neuroscience

SUPPORTING PRODUCTS

SLEEP DEPRIVATION
Gently restrict sleep in rodents based on real-time EEG/EMG thresholds or programmed schedules without human intervention.

SYNCHRONIZED VIDEO
Integrated video recording provides a platform for synchronizing EEG and EMG changes with observable behavioral states. Video can be added to any new or existing hardware system. Captured video is displayed live on screen as it is streamed from the animal and is synchronized with other recorded data in playback mode.
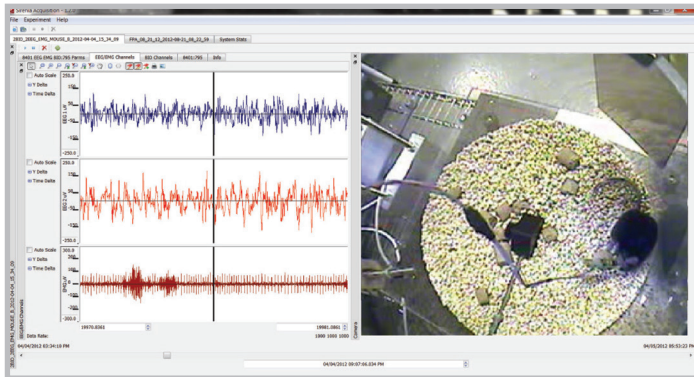
EEG and EMG data recorded simultaneously with full-color video.

SENSORS *
The addition of sensors enables the correlation of EEG/EMG activity with neurophysiological changes in freely moving mice and rats.

OPTOGENETICS *
LED fiber probes allow for localized stimulation of neurons in specific brain regions with precise timing and illumination control while simultaneously monitoring EEG/EMG.

USE WITH YOUR EXISTING AMPLIFIER *
Analog adapters allow researchers to use their existing amplification/ acquisition systems with Pinnacle's preamplifiers and headmounts.

*Tethered Systems Only

> *"The clarity of the data rivals anything I have ever seen. Quite simply, this is the best system for EEG and sleep recording on the market today."*
>
> — Dr. Fred Turek
> *CEO, NuNetix, Inc.*

ADVANCED ANALYSIS SOFTWARE

SIRENIA® SEIZURE PRO
Quickly identify, analyze and log user-defined seizure events in a given time period. Tools include spectral power, heat maps, line length, amplitude and seizure duration. Custom reports and graphs.
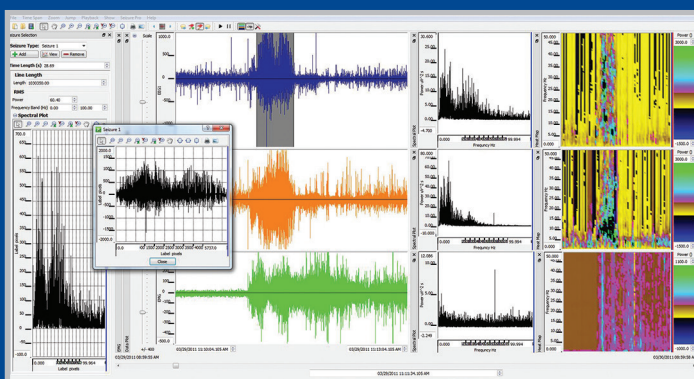
A seizure event in a C57 mouse identified and selected for automated analysis using Sirenia® Seizure Pro.

SIRENIA® FEEDBACK PRO
Create rule sets using baseline data, thresholds and power analysis to initiate stimuli in real-time for a variety of sleep, seizure, optogenetics and other studies.

SIRENIA® SLEEP PRO
Reduce scoring and analysis time with semiautomated tools such as cluster scoring, threshold scoring, hypnograms and spectral plots. Quickly compare scores, perform bout and sleep analyses and customize high-quality charts and graphs.
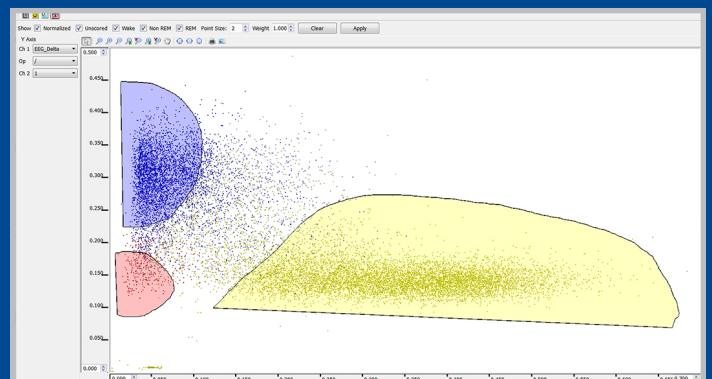
Data from a C57 mouse are quickly scored using Sirenia® Sleep Pro's semi-automated cluster scoring tool.

SIRENIA® X-Y TRACKING
Track real-time or pre-recorded locomotor behavior. Includes quadrant and user-defined zone analysis, speed plots, movement trajectories, heat maps and overlay capabilities.

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