



*Evolocus*

Equipment for Biomedical Research  
Animal Behavior & Electrophysiology  
[www.evolocus.com](http://www.evolocus.com)

## MASTERING ELECTROPHYSIOLOGY IN FREE-MOVING ANIMALS

**Neurologger®**  
records behavior and  
electrophysiological data

For laboratory  
and field studies

- EEG
- Neurons up to 32 channels
- ECG
- Vocalization up to 100 kHz
- Activity
- Temperature
- LFPs
- Heart rate
- EMG
- EOG
- Expandable by optical or electrical brain stimulation, motorized microdrive, GPS

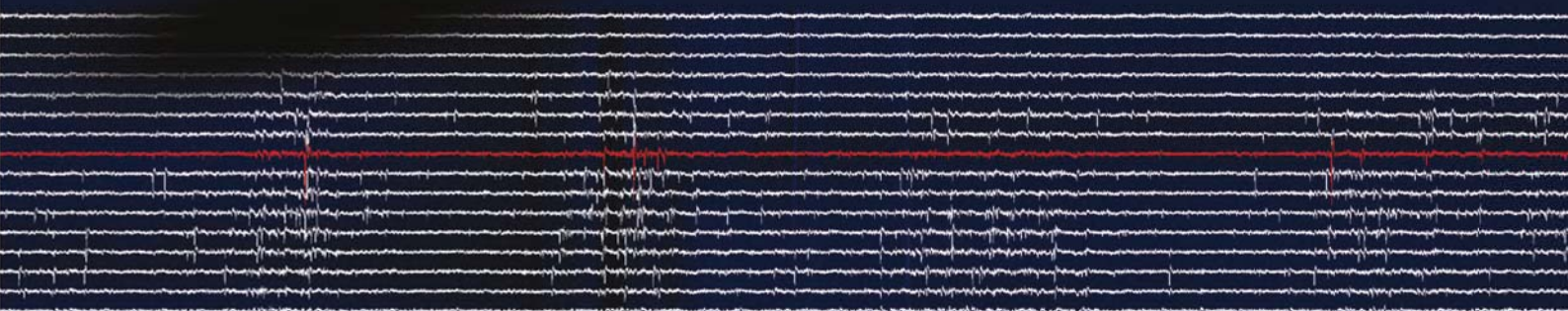


Fits to mice and larger animals



New 3rd  
generation!

Verified:  
30+  
publications!



# Neurologger®

## The first generation - for large animals



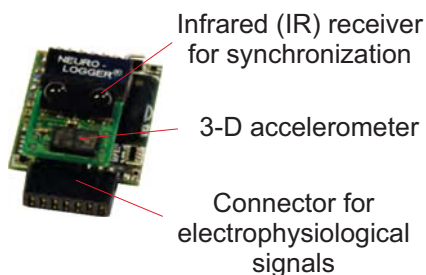
8 differential neurophysiological channels (EEG, ECG, EOG, EMG)  
three of which can be used for 3-D accelerometer  
5.31 g recorder weight + ~9 g typical battery  
Total weight about 15 g without enclosure

Micro SD up to 32 GB

Connector for electrophysiological signals

## The second generation - for mice and larger animals

### Neurologger 2A



Infrared (IR) receiver  
for synchronization

3-D accelerometer

Connector for  
electrophysiological  
signals

4 neurophysiological channels with sampling rate up to 19.2 kHz  
for EEG, ECG, EOG, EMG, LFPs and neuronal activity.  
3-D accelerometer  
Infrared (IR) synchronization with external equipment.  
The recorder weight in the most complete configuration is 1.71 g  
+ ~1 g typical battery weight makes total weight 2.71 g.  
The battery holder can add 0.63 g.

### Neurologger 2A other variants



Only  
3-D accelerometer,  
256 MB memory,  
weight 1.28 g



The lightest version:  
electrodes are soldered  
directly to the board,  
clip connector for data  
downloading, 1 GB,  
weight 0.95 g



The same as before  
but with the connector  
for the electrodes,  
weight 1.05 g



Micro board with  
3-D accelerometer  
is added, weight of  
recording combination  
1.61 g



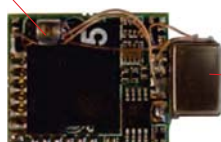
Water-proof ECG recorder for marine birds  
IR receiver is replaced by magnetic sensor.  
Putting permanent magnet in the vicinity  
of the sensor creates a label in the logger record.  
Memory 1 GB, rechargeable battery 3.7V, 240 mAh.  
The battery is sufficient for 4 days.  
Total weight of encapsulated logger 20 g.

### Neurologger 2B

#### Enhanced version with increased data rates

4 channels with sampling rate up to 33.3 kHz for sound and neuronal activity recording.  
Single-channel 200 kHz mode for ultrasound recording.

Microphone



Contact  
microphone

Version for zebra finches, marmosets

Microphone

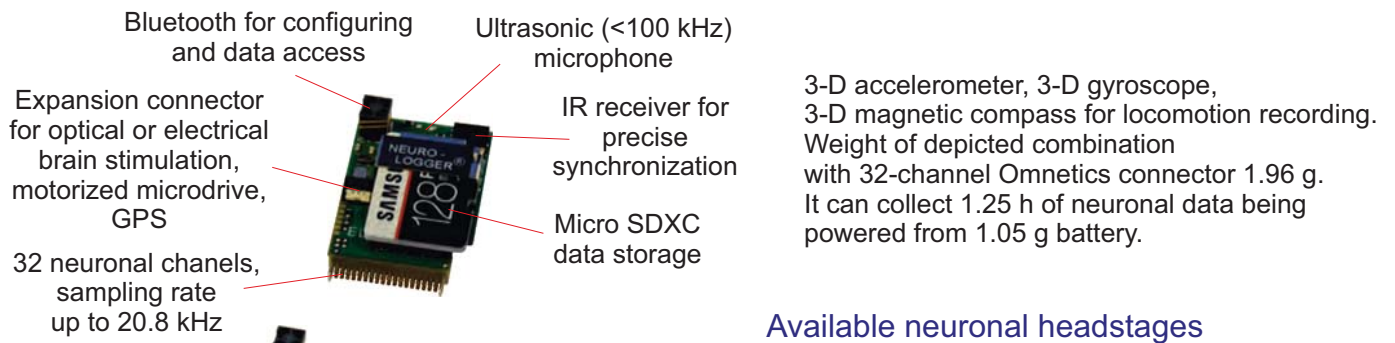


IR receiver

Version for bats



## The third generation - multichannel neuronal recording in mice, rats, etc.



Ultrasonic recorder with 3-D accelerometer, 3-D gyroscope, 3-D magnetic sensor. Weight 1.29 g

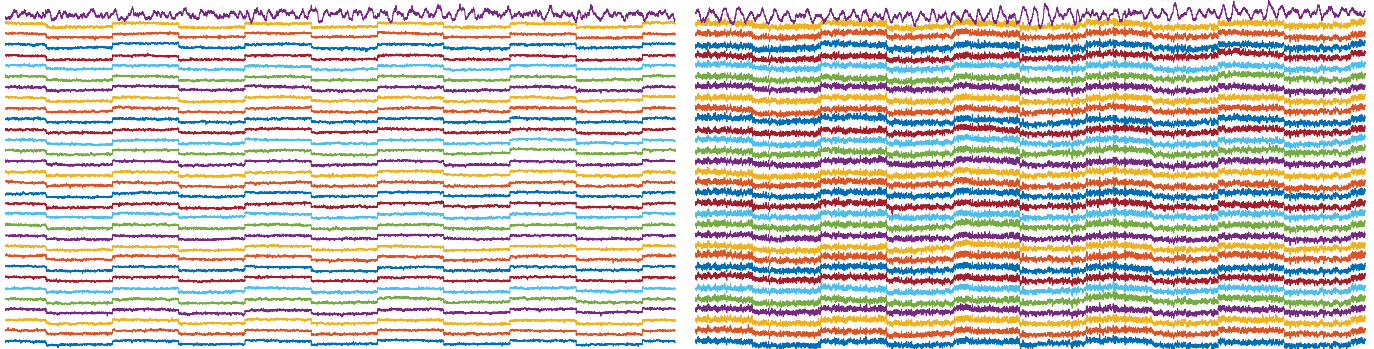
16-channel Hirose 0.35 g

32-channel Hirose 0.44 g

16-channel Omnetics 0.46 g

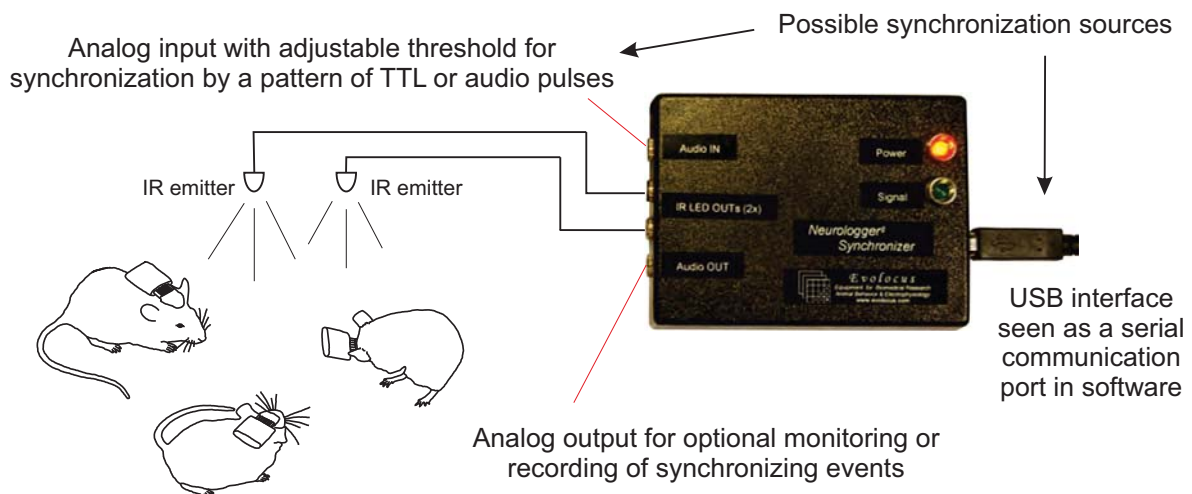
32-channel Omnetics 0.67 g

Neurologger 3 has extremely low noise and electromagnetic disturbances, see two records below,  $F = 1-3300$  Hz. Duration of each fragment is 1 second. A sequence of  $10 \mu\text{V}$  peak-to-peak rectangular pulses was given to the input of the logger either directly (left chart), or through  $1 \text{ M}\Omega$  resistor (right chart). The last (top) channel was connected to the microphone to recorded environmental sounds.  $10 \mu\text{V}$  step is clearly visible in both records.



## Neurologger Synchronizer

The tool for precise synchronization of Neurologgers of all generations with external equipment



Standard serial interface is supported in Matlab, Labview, Python and all classical programming languages. We provide Matlab examples illustrating interaction with Neurologger Synchronizer. Analog input with adjustable threshold also can be used with a push button. Pressing on this button will initiate transmission of a predefined pattern of IR pulses to the Neurologgers. Software for conversion of Neurologger data to Matlab and other environments is provided.

## Comparison of three generations of Neurologgers®

	Neurologger 1	Neurologger 2A/2B	Neurologger 3
Primary usage	EEG, EMG and LFPs recording in large animals: marine mammals, ruminants	EEG, EMG and LFPs recording in mice and larger animals; ECG, vocalization recording including ultrasonic	Multichannel neuronal recording in mice and larger animals; vocalization recording including ultrasonic
Number of channels	<b>8 differential channels</b>	<b>4 channels</b> freely assigned to two referent electrodes	<b>16 or 32 channels</b> with one referent electrode; or 16 differential channels
ADC resolution	10 bit; 2x oversampling in low-frequency modes	10 bit; 2x-8x oversampling in low-frequency modes	16 bit
Sampling rate	8 channels up to 800 Hz; or 2 channels up to 10 kHz; or 1 channel 20 kHz; higher sampling rates by request	<b>Version 2A:</b> 4 channels up to 19.2 kHz  <b>Version 2B:</b> 4 channels up to 33.3 kHz; or 1 channel up to 200 kHz	<b>32-channel version:</b> 32 channels up to 20.8 kHz; free selection of channel sequence; selected channels can be sampled more often than others <b>16-channel version:</b> Fixed sequence of 16 channels up to 25 kHz
Locomotion recording	Optional analog 3-D accelerometer occupies three channels	Optional 3-D accelerometer	3-D accelerometer, 3-D gyroscope, 3-D magnetic compass
Vocalization recording	-	Optional microphone and contact microphone are connected to neurophysiological channels; optional dynamic range expansion	Dedicated 12-bit 200 ksps microphone ADC works simultaneously with neuronal 16-bit ADC; optional dynamic range expansion; attachment of a microphone to one 16-bit channel is also possible
Expansion possibilities	Asynchronous serial bus up to 1.5 Mbps (UART) and digital input/output lines at the main CPU can be custom programmed by request.	Dedicated communication controller with different peripheral interfaces is connected to 8 Mbps synchronous bus (SPI). It can be custom programmed by request.	Inter-integrated circuit (I2C) communication bus 400 kbps makes possible chained connection of multiple custom-developed peripheral devices. Development of the following peripheral units is planned or will be done by request: optical and electrical brain stimulators, motorized microdrive, GPS. 32-ch version has 3 auxiliary analog inputs and one digital output.
Data memory	Micro SD high-capacity (4-32 GB) memory card	Soldered memory chip 1-2 GB	Micro SD high-capacity (4-32 GB) or extended capacity (64-256 GB, Micro SDXC) memory card
Maximal memory filling speed	30 kBps (2 channels, 10 kHz)	300 kBps (1 channel, 200 kHz)	1.77MBps (32 channels 20.8 kHz, sound 125 kHz, motion sensors 580 Hz)
Maximal recording duration	Limited by the battery	1 GB will be filled when 4 channels are sampled with the frequency: 100 Hz: 20 days 17 h 400 Hz: 5 days 4 h 1600 Hz: 1 day 7 h 9.6 kHz: 5 h 10 min 19.2 kHz: 2 h 35 min 33.3 kHz: 1 h 29 min One channel at 200 kHz: 59 min 39 s 3D accelerometer increases volume by 50% in low-frequency modes.	In most cases limited by the battery. 128 GB card is sufficient for recording during 20 hours in the highest data rate mode listed above. If only 32 channels are sampled with the frequency 15.625 kHz, 128 GB is sufficient for 31 hours.
Current consumption	~5.5 mA in EEG mode	<b>Version 2A:</b> 1.5 - 4.3 mA, mode-dependent; In EEG mode with 3D accelerometer. 2.0 mA <b>Version 2B:</b> in high-frequency modes ( $\geq 33.3$ kHz): 6.0 - 11.7 mA, mode-dependent	11-25 mA, mode-dependent; All neuronal modes ~25 mA.
Logger size (w/o battery)	36x31x6 mm	From 18x15x3 mm to 22x15x8 mm	From 20x15x6 mm to 24x15x8 mm
Logger weight (w/o battery)	<b>5.31 g</b>	<b>0.95 - 1.71 g</b> , version-dependent	<b>1.29 – 1.96 g</b> , version-dependent
Recommended batteries and their weights	Lithium-polymeric 3.7V 240 mAh 9.0 g rechargeable battery will be sufficient for 1 day 19h. Non-rechargeable 3.6V 1200 mAh 8.9 g LS14250 will be sufficient for 9 days.	A couple of non-rechargeable Zn-Air 1.4V batteries ZA 10 (75 mAh), ZA312 (175 mAh), ZA13 (305 mAh) with the weights per pair 0.635, 1.02, 1.66 g respectively will be sufficient for 1, 2 and 4 days of EEG recording. Lithium-polymeric batteries, for instance 3.7V 12 mAh 0.38 g GM300910, also can be used.	Lithium-polymeric 3,7V 20 mAh, 0.63 g 40 mAh, 1.05 g 50 mAh, 1.58 g Will provide duration of neuronal recording of 15 min, 1 h 15 min and 2 h 15 min respectively.



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#9,492,085. Other patents pending.