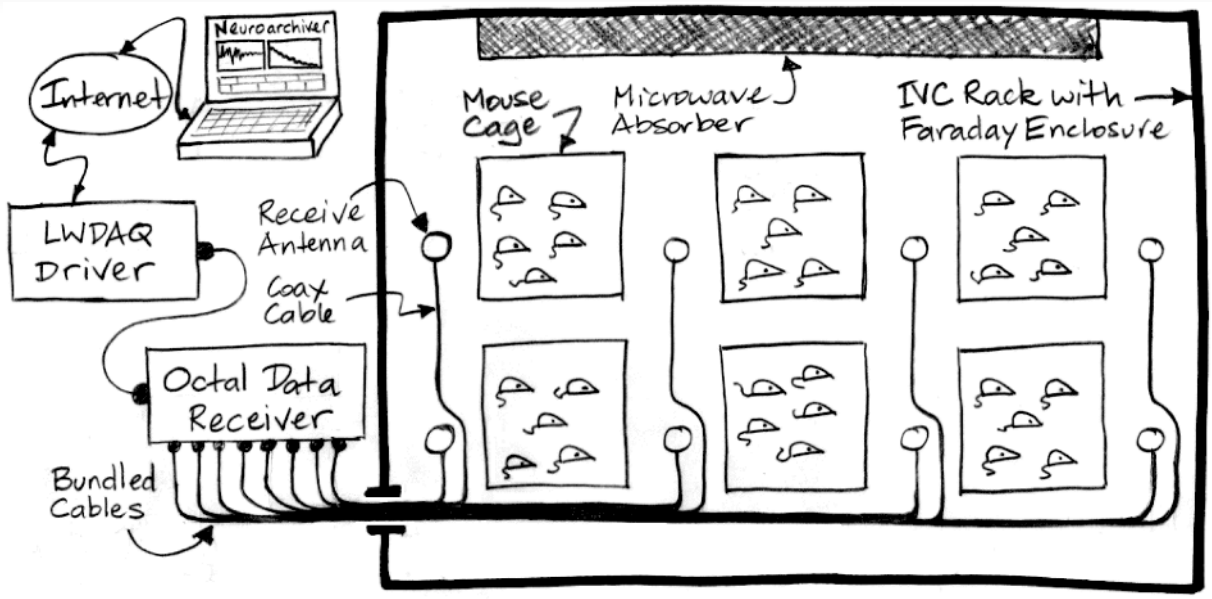
Wireless Telemetry by Open Source Instruments

24/7 Recording with **Cohabiting Animals**

Capability

Open Source Instruments' wireless telemetry system provides continuous recording of biopotentials **24 hours per day without supervision**. Data can be collected from cohabiting animals exercising free behavior. Biopotentials are low-pass filtered, but are otherwise **undistorted by digitization and transmission**. So long as the electrodes are well-secured, EEG signals will be entirely free of movement artifact. The fidelity of the signal, combined with OSI's event-detection software, allows researchers to **find rare events automatically** in tens of thousands of hours of recordings, or to detect events automatically as they occur. All hardware and software is **well documented and open source**.

System Overview



Subcutaneous transmitters are surgically implanted in rats or mice. The transmitters broadcast biopotential measurements to antennas placed outside of cages. The system can be used with IVC racks or on a bench top.

A complete set up can be purchased for $9,500. This will permit simultaneous recording from up to 196 animals. Ten transmitters can be purchased for $5,000.

High Quality Recordings

"In 20 years of recording rodent EEG, I have found that the wireless telemetry equipment from Open Source Instruments enables unparalleled quality EEG recordings in real time in many animals with high sampling over extended periods of time, and importantly, the programs and equipment are easily adaptable for purpose"

Dr. Matthew Walker, *Head of Department*
Department of Clinical and Experimental Epilepsy
Institute of Neurology, University College London

Transmitters

Transmitters are implanted in the abdominal cavity of the rodent where they do not interfere with behavior. Subcutaneous leads connect the transmitter body to electrode screws or depth electrodes mounted on the skull.

- Fully implantable
- Maximizes animal welfare
- No operator supervision required
- No battery charging or changing required
- Volume as low as **1.4 mL**
- Records on 1 or 2 channels
- Up to **2048 samples per second**
- **0.3 - 640 Hz** Bandwidth
- Collects up to **7000 hours of data**

Two-Channel Subcutaneous Transmitter
Model A3028A is a 2.7 gram transmitter with a **volume of 1.4 mL**. It will record **360 hours of continuous data from both channels at 512 samples per second**.

The black body contains electronics. The colored leads are electrode leads made of durable, helical, stainless steel wire. The silver loop is the antenna. All elements are encapsulated in biocompatible silicone.

Data Quality

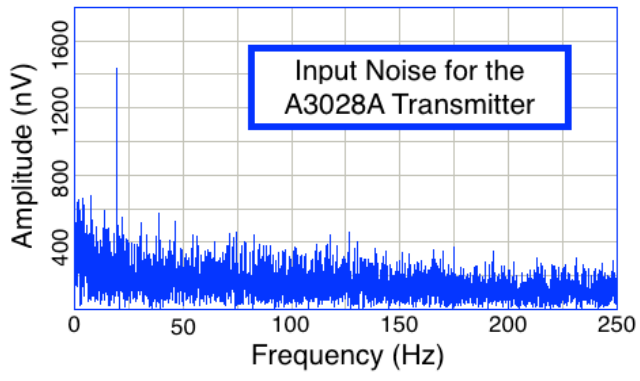
Reliable, Continuous Operation

"As well as allowing us to monitor the power of oscillations across all frequency bands, the EEG traces from these devices were of sufficient quality to allow us to identify specific behavioral events. Recordings were consistently reliable 24/7 over the full three weeks of our experiments"

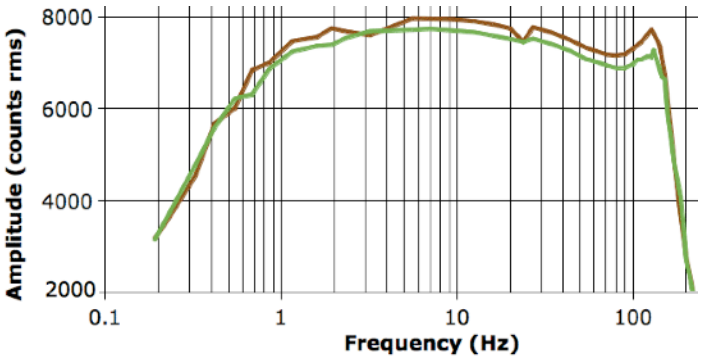
Dr. Louise Upton
Senior Research Scientist
Department of Physiology, Anatomy and Genetics
University of Oxford

OSI Transmitters consistently provide data suitable for publication. Our instruments' performance is fully characterized.

- Total Noise **less than 12 µV rms** (measured at 0.3 - 160 Hz)
- Main's hum noise **less than 1 µV** (60 Hz noise source in USA)
- No instrument movement artifacts
- **Flat frequency response**



Input noise spectrum for the Model A3028A



Frequency response for the two channels of a Model A3028A transmitter (optimized at 1-160 Hz)

Software

Open Source Instrument's data acquisition software is free, open source, and distributed under the **GNU Public License**. It runs equally well on Linux, Windows, and MacOS. The acquisition hardware may be controlled by a single computer or be configured for access over a local area network or the internet.

OSI provides several programs for collecting and analyzing data:

Neuroarchiver – Writes raw data to disk and reads and displays raw data from disk

Event Classifier – Allows scientists to develop detection patterns for event classification

Batch Classifier – for applying the detection pattern to the tens of thousands of hours of recordings that are produced by continuous, long-term recordings

Open Source

"Our demonstration of successful gene therapy for focal neocortical epilepsy would not have been possible without the Open Source Instruments' wireless EEG system. It is a versatile and cost-effective solution. The fact that all the designs are open source gives the ability to integrate the system with other hardware and software"

Dr. Dimitri M Kullmann
Head of the Experimental Epilepsy Group
Institute of Neurology, University College London

The event classifier comes with advanced classification metrics for recognizing ictal events. The Neuroarchiver and Event Classifier can be used simultaneously to **classify real time data** as it is collected. The software is continuously expanded to meet scientists' new requirements. Publications [3] and [5] highlight OSI's event classification software.

Support

As a company founded by scientists, Open Source Instruments, Inc. values collaboration and transparency. We assist our customers in choosing the right equipment for their experiment and provide support throughout all stages of use.

All of OSI's instruments have been designed at the request of our customers. We continue to offer custom engineering services and modifications to our core products.

Collaborative Approach

"I can only highly recommend the Open Source Instruments Subcutaneous Transmitter System. It is a reliable and cost-effective solution for acquiring rodent EEG telemetry. Moreover, the technical support provided by Open Source Instruments has been exceptional. From honest advice prior to acquiring the system, through to assistance with system setup and creative solutions for system customization, Open Source Instruments has always responded quickly and efficiently"

Dr. Iris Oren
Principal Investigator and Chancellor's Fellow
Centre for Cognitive and Neural Systems
The University of Edinburgh

Products and Prices

A fully capable telemetry system can be set up with the following three items.

1. The **Data Receiver (A3027E)** comes with eight antennas. Two antennas are necessary per animal cage. The A3027E is capable of recording signals from up to 196 rodents simultaneously. Large installations will require additional antennas.

2. The **LWDAQ Driver (A2071E)** is used to connect up to eight Octal Data Receivers to the network or personal computer. A single LWDAQ Driver is sufficient for almost all labs.

3. A **Faraday Enclosure** is usually required to guarantee robust telemetry signals. Our Faraday Enclosures use transparent metal mesh fabric to block interference from radio stations and cell phones. OSI sells Faraday enclosure models for bench top use and for use with IVC racks.

2017 Price List Summary	
Data Receiver (A3027E) and eight antennas	$5000
LWDAQ Driver (A2071E)	$3000
Bench Top Faraday Enclosure	$1500
Ten Subcutaneous Transmitters (A3028) - any version	$5000

Subcutaneous Transmitter Versions (SCT)

SCT Version	Volume (mL)	Operating Life (hours)*	Sample Rate (SPS)	Number of Channels	Bandwidth (Hz)
A3028A	1.4	360	512	2	0.3-160 Hz
A3028B	1.4	600	512	1	0.3-160 Hz
A3028C	1.4	950	256	1	0.3- 80 Hz
A3028D	3.0	1900	512	2	0.3-160 Hz
A3028E	3.0	3200	512	1	0.3-160 Hz
A3028F	1.4	180	1024	2	0.3- 320Hz
A3028L	6.5	4000	1024	2	0.3-160 Hz
A3028Q	5.0	7000	512	1	0.3-160 Hz
A3028V**	1.4	600	512	2	0.3-160 Hz

* Operating life = hours of data that may be recorded. This period typically begins after the animal model has recovered from surgery and the researcher turns the SCT on with a magnet. (SCTs can also be switched off magnetically)

** The A3028V is designed for studies requiring sleep data. One of the two channels records electromyography (EMG) measurements. The EMG channel records the bandwidth 30 - 320 Hz at 16 SPS.

Publications

OSI's telemetry system has been used to collect data for the following publications:

[1] The Development of Nociceptive Network Activity in the Somatosensory Cortex of Freely Moving Rat Pups (Oct 2016) Chang et al., Oxford Journal Cerebral Cortex, Volume 26 Issue 11, doi: 10.1093/cercor/bhw330.

[2] Epileptogenic effects of NMDAR antibodies in a passive transfer mouse model (Aug 2015) Wright et al., BRAIN Journal of Neurology, Oxford University Press, 138(9).

[3] Chemical-genetic attenuation of focal neocortical seizures (April 2014) Kaetzel et al., Nature Communications 5, Article number: 3847, doi:10.1038/ncomms 4847.

[4] Ceftriaxone Treatment after Traumatic Brain Injury Restores Expression of the Glutamate Transporter, GLT-1, Reduces Regional Gliosis, and Reduces Post-Traumatic Seizures in the Rat (August 2013) Goodrich et al., Journal of Neurotrauma, 30(16): 1434-1441.

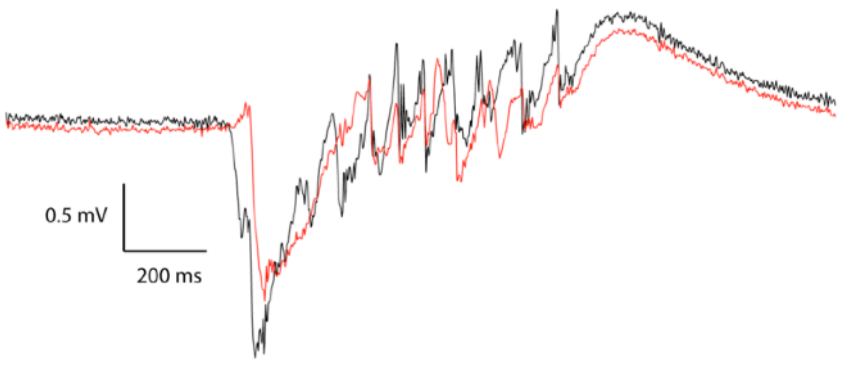
Practical

"Documentation on the OSI website covers both basic mechanisms (e.g. the source of EEG signals) and in-depth technical information about hardware and software. This information is exceptionally detailed and thus very helpful for comprehension of scientific background and practical use of their products"

Dr. Sebastian Bauer
Head of Experimental Epilepsy Section
Philipps-University Margburg

[5] Optogenetic and Potassium Channel Gene Therapy in a Rodent Model of Focal Neocortical Epilepsy (Nov 2012) Wykes et al., Science Translational Medicine, DOI: 10.1126/scitranslmed. 3004190.

[6] A Novel Telemetry System for Recording EEG in Small Animals: description of the subcutaneous transmitter system (September 2011) Chang et al., Journal of Neuroscience, 201(1): 106-115.



Seizure event recorded by Dr. Rob Wykes (Institute of Neurology - University College London) using OSI's dual channel A3028A transmitter