



a division of **Harvard Bioscience, Inc.**

Triangle BioSystems, Int'l.

Simplicity in Neuro-Solutions

Product Catalog

**End-to-End Neural
Acquisition and Stimulation**





About TBSI

Triangle BioSystems International...

... is a biomedical device company focused on developing and manufacturing hardware and software solutions for application in animal-centric neuroscience research where bio-monitoring, recording and stimulation functions are needed.

Inspiration

Dr. James Morizio founded Triangle BioSystems, Inc. in 2001 when he perceived a growing need for more sophisticated in vivo electro-physiology equipment.

His experience with ASIC chip design and his various affiliations within the neuroscience community helped grant him the ideas and knowledge to design a unique generation of tethered recording headstages with superior specifications.

Intuition

A few years after the successful launch of the company, Dr. Morizio began work on a new wireless headstage design that would provide the same reliable data acquisition specifications as its predecessor, yet still be small and light enough for smaller animals to carry.

This work eventually resulted in the formation of the W-Series wireless headstage recording systems which have been used in numerous labs around the world and have helped revolutionize the way researchers record spikes, EEGs and other neural data.

Innovation

We like to maintain solid communication with our customers and peers in the field because we know that it's the key to understanding how we can improve the quality of our own products.

Today's researchers are limited by technology, not by their imaginations, and that's why we constantly strive to produce new and better hardware and software solutions.



Our Business

Settled comfortably between such noteworthy institutions as Duke University, the University of North Carolina at Chapel Hill and North Carolina State University, our business flourishes thanks to our determination to anticipate and adapt to the unique demands of the neuroscience research community.

Our foremost goal is to equip scientists with their optimal neural interfacing laboratory setup. Many of our customers choose our business over competitors because we take the time to understand every detail of their work to determine their most empowering solution.

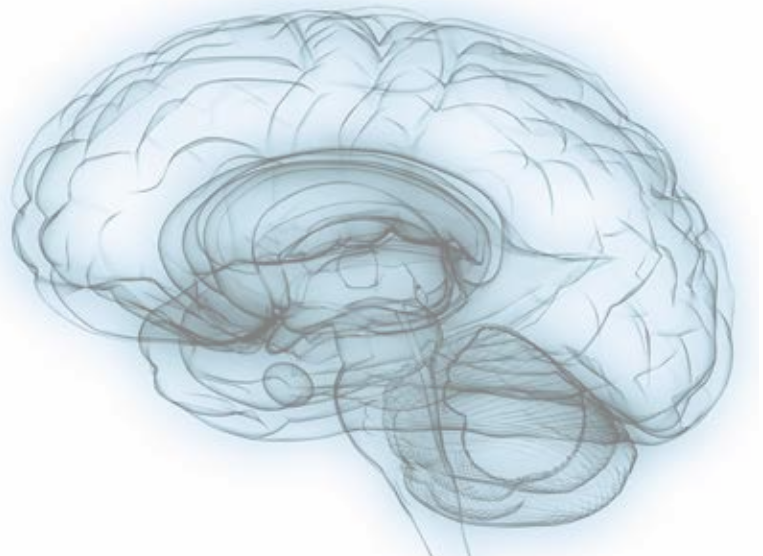
We have the capability to partner with universities, institutions and companies to develop custom products and solutions. As such, we already have affiliations with several academic institutions, but we are always willing to explore new opportunities for growth and discovery.

Our Philosophy

We understand that every experiment is unique to varying degrees. It can be frustrating trying to find equipment that will both collect quality data and help simplify your experiments as well. We take your work seriously, and we sincerely want to see you succeed.

We designed our products to make the user experience as simple as possible. If you require a customized setup, then all you need to do is give us a call to discuss your options. We offer and support a variety of accessories to expand the functionality of our equipment, so we are always prepared to meet your specific needs. Now that's...

...Simplicity in
Neuro-Solutions.





Product Applications

All of our products are designed to aid in vivo neuroscience research, especially in such fields like Electrophysiology, Psychology, Neurology and Pharmacology as well as disease origin studies.

Our neural recording equipment is uniquely tailored to collect and filter neural signals with high accuracy and low noise tolerance, and our neural stimulations accommodate flexible and precise pattern programming. We are available to accommodate your neural interface equipment needs, from electrodes to data digitization and analysis.

Just ask us one question:

How can we help you accomplish your research goals?

Our headstages, both tethered and wireless, are among the smallest and lightest available, so we can easily meet the requirements for interfacing to almost any animal model.*

Hundreds of laboratories around the world use our equipment to accomplish their research.

You should consider our products if you are working with:

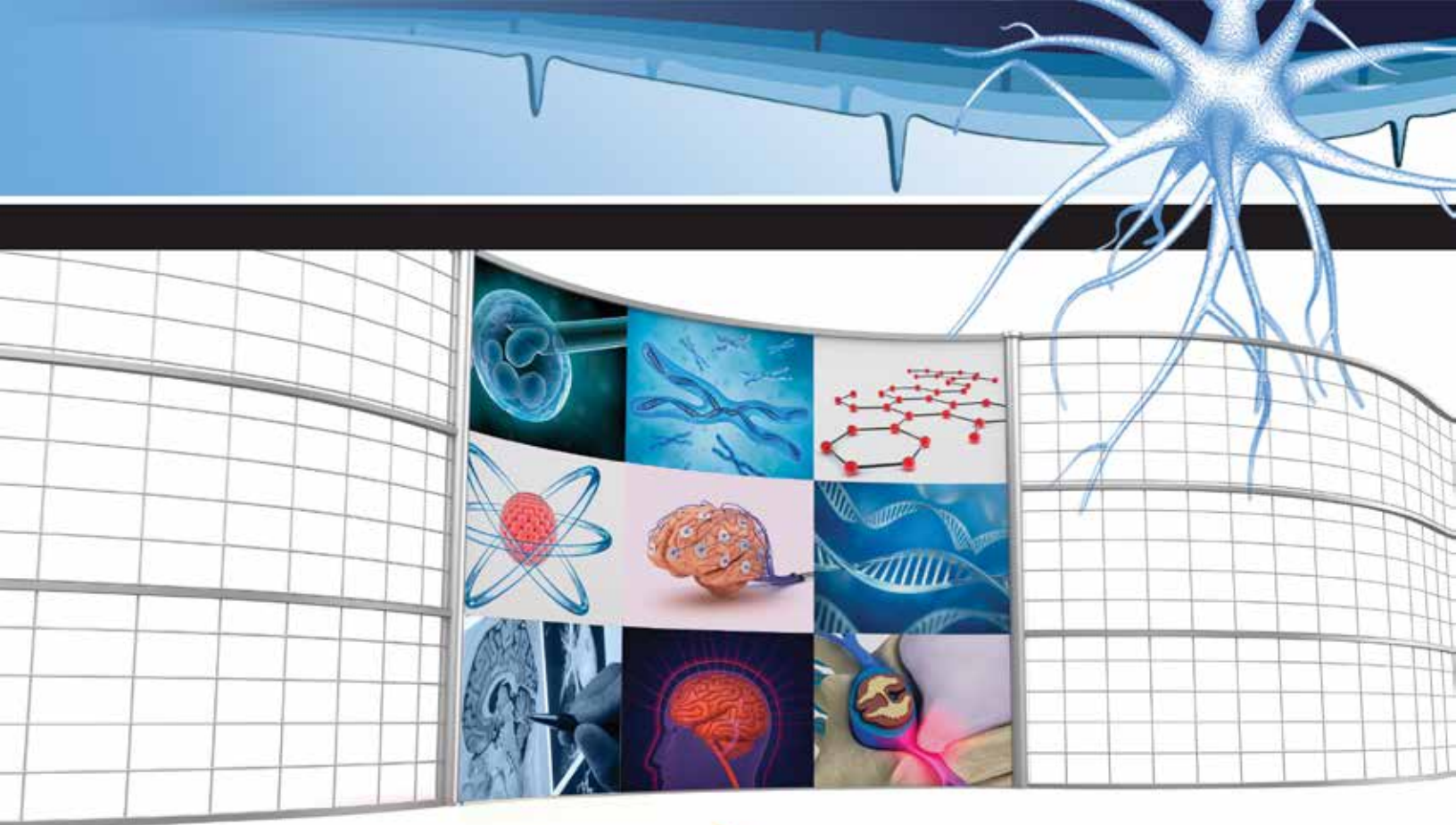
- >> Spikes
- >> LFP's
- >> EEGs
- >> ECoGs
- >> EMGs

We have helped enable projects focused on:

- >> Epilepsy
- >> Parkinson's
- >> Alzheimer's
- >> Pain & Sleep
- >> Cognition & Behavior
- >> Drug Discovery and more...



* TBSI products are not intended for clinical use.



Neural Recording

We know how important it is for your experiments to be as simple and efficacious as possible. Our equipment offers you the ability to wirelessly record any neural signal with the highest channel counts currently available.

In most cases, we can easily customize our recording equipment to be compatible with your preferred data acquisition hardware and software. And of course, we also offer complete solutions to supply those who require a fresh setup instead.

Neural Stimulation

Our biphasic dual channel stimulator solutions were designed to provide you with the precise control you need over your neural stimulation experiments. The Stimware™ pattern generation software provides you with a detailed array of easily adjustable stim pulse parameters and triggering options.

We currently offer dual channel USB programmable and wirelessly programmable stimulator solutions.

Wireless Neural Recording

With our W-Series recording system, you can obtain data from up to 126 neural electrodes without having to sacrifice form for function. Our custom single-ended ASIC amplifier design enables every channel to amplify sample low frequency waveforms and spikes alike. Your test subjects will be free to move and behave naturally in the environment of your choosing, while you can rest assured that your data will be of the highest quality.

The complete system is comprised of a wireless headstage transmitter with an integrated rechargeable battery, RF signal receiver, power supply, and basic interfacing cables.

Analog Receiver



NeuroWare® Data Acquisition Software



Headstage Transmitter

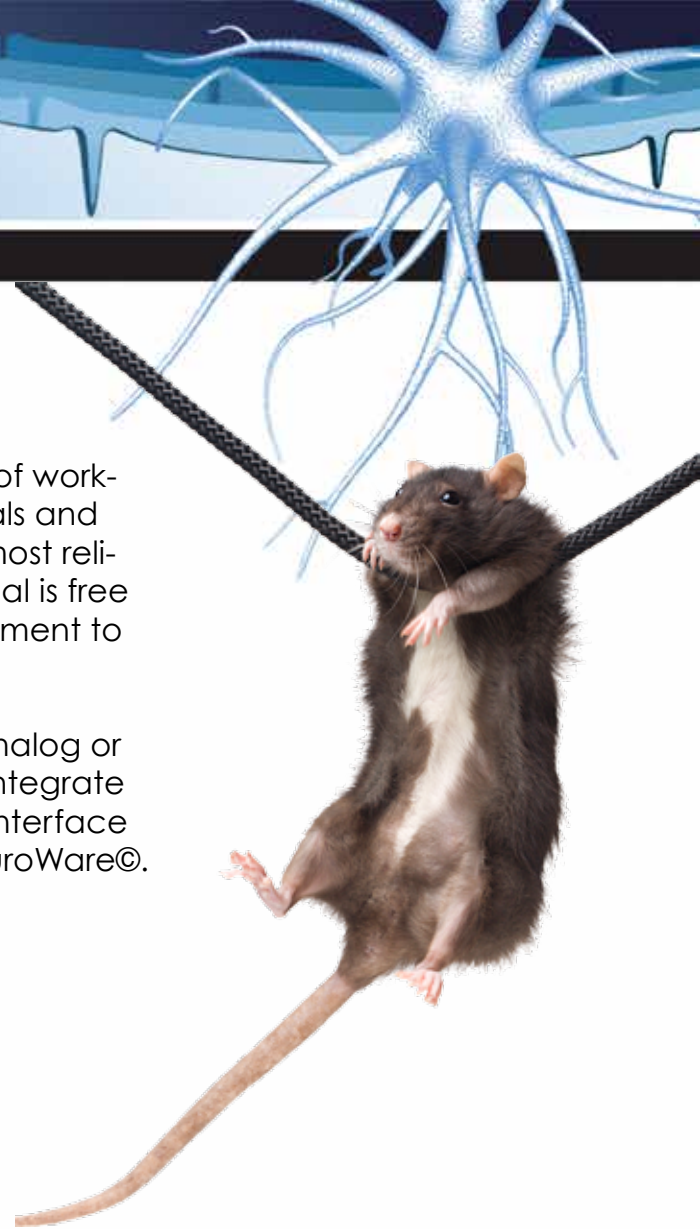


For user convenience, we implemented a magnetic switch into our headstages. With it, you can quickly and easily turn your headstage on and off without disturbing your test subject

Why go wireless?

If you are like many of our customers, you are tired of working with bulky wire harnesses that hinder your animals and distract them from their tasks. We believe that the most reliable data comes from experiments where the animal is free to behave naturally, and so we designed our equipment to provide you with the means to get that ideal data.

Our recording systems are capable of outputting analog or digital data, which means you have the option to integrate our equipment with your available hardware or to interface directly to our online data acquisition software, NeuroWare®.



W-Series

System Features

Available Channel Counts: 5, 16, 32, 64, 128

Headstage

Input Range: 4 mVpk-pk

Gain: 140

Sampling Rate: 25-50 kHz/channel

*Bandpass Filtering: .8 Hz - 7 kHz

*Average Battery Life: 4 hours

*Transmit Range: 4 meters

*Connector Standard: Omnetics

Receiver

*Gain: 8

*Output: Analog or Digital

Available Frequencies: 2.725, 3.05 & 3.375 GHz

W-Series Headstages



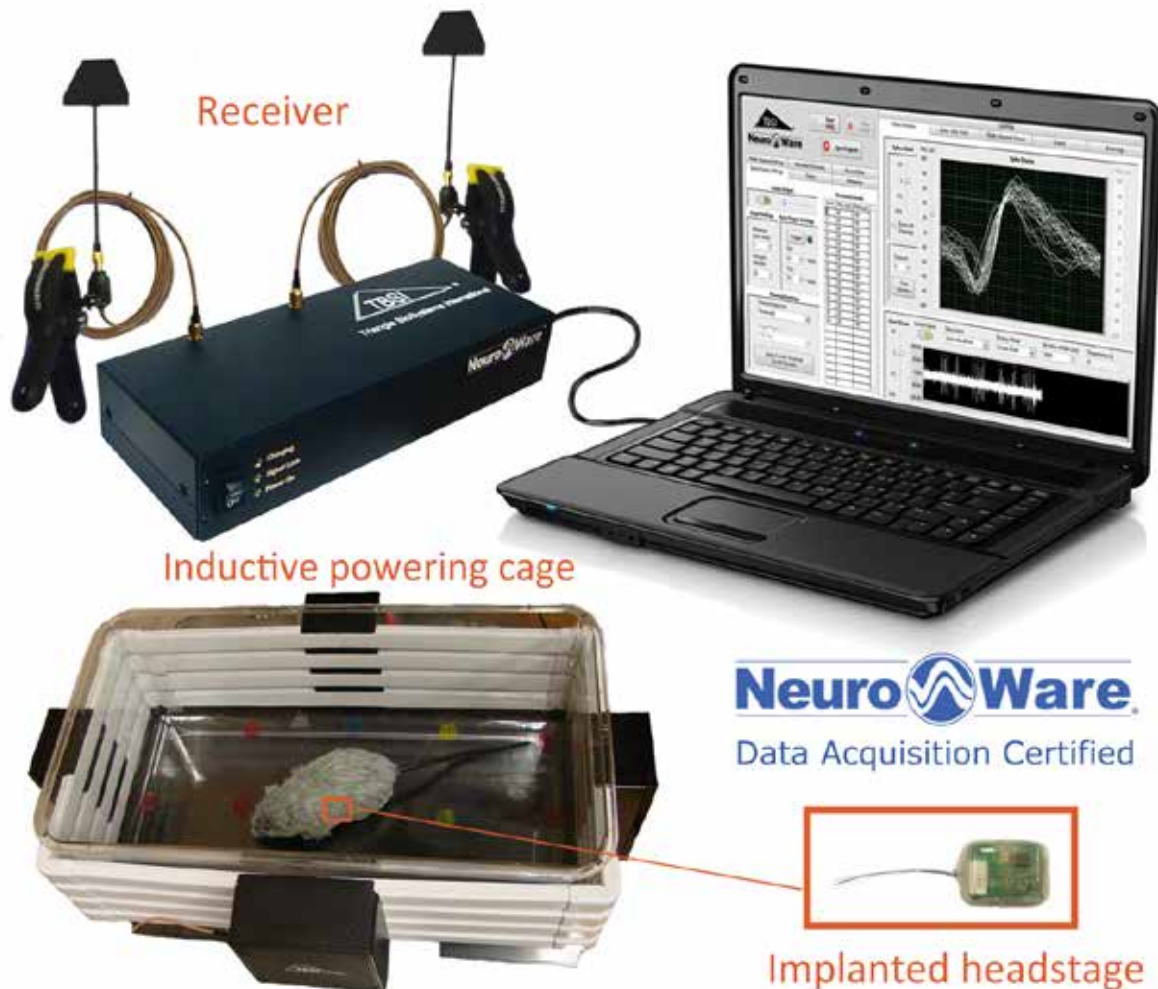
*Indicates potentially customizable feature.



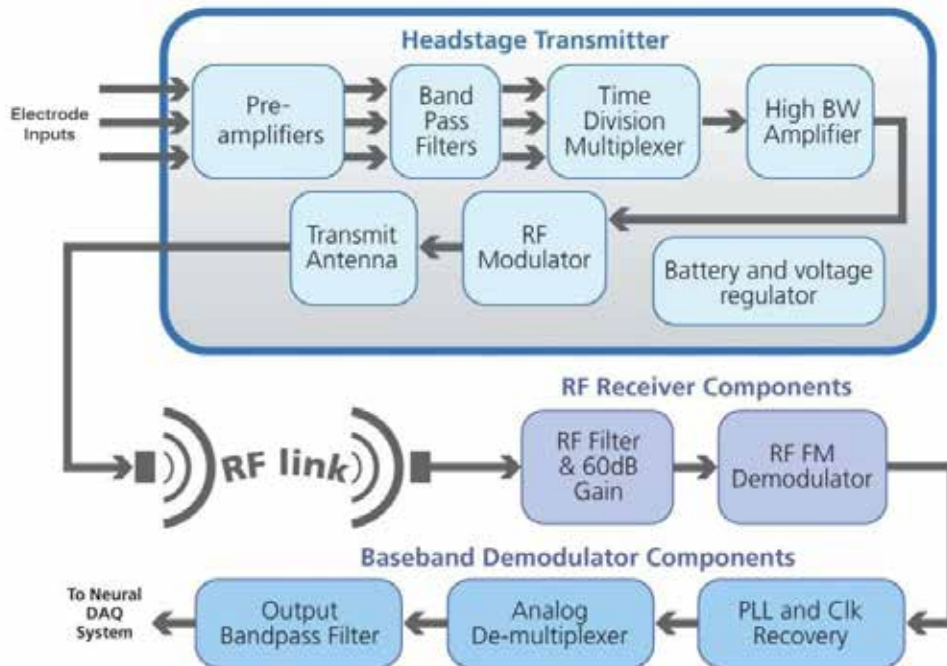
Implantable Neural Recording

Triangle BioSystems International has developed a 90-day implantable neural recording headstage system that allows researchers to continuously and simultaneously obtain biopotential data from up to 5-32 electrodes to an external receiver in real time. No longer do experiments have to be constrained by head mounted or wired test subjects to the recording system. The complete system is comprised of an implantable inductively powered wireless headstage transmitter, RF signal receiver and power supply. With an effective range of 1 meter, this system provides a wireless connection between the implanted electrodes to the data acquisition recording system.

This implantable headstage unit is implanted in a rat's peritoneal cavity using a minimally invasive surgical procedure. Additionally, this headstage can be used concurrently with our stimulation, tethered or multiplexed neural recording headstages. This system utilizes TBSI's custom ASIC technology and packaging, wireless powering and proprietary radio design to provide reliable functionality in a implantable package that is both small and light weight. This design includes the neural preamplifier circuitry to create an extremely compact and powerful transmitter with high data rates and bandwidth.



System Block Diagram



IW-Series

System Features

Available Channel Counts: 5, 16, 32

Headstage

Input Range: 5 mVpk-pk

Gain: 140

Sampling Rate: 50 kHz/channel

*Bandpass Filtering: .8 Hz - 7 kHz

*90-day package life

*Transmit Range: 1 meter

Receiver

*Gain: 8

*Output: Analog or Digital

Available Frequencies: 2.725, 3.05 & 3.375 GHz

*Indicates potentially customizable feature.



Top View



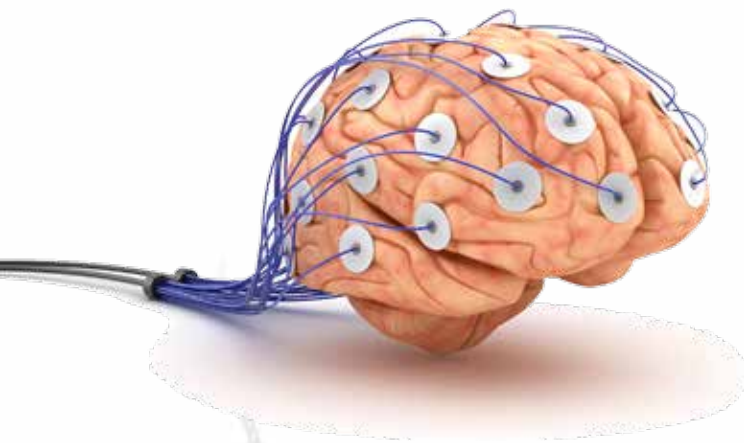
Side View



Tethered Neural Recording

Our T-Series headstage systems are capable of acquiring and filtering up to 32 individual signals, with a 1:1 channel to wire ratio.

We recommend the M-Series amplifier systems for tethered applications requiring very high channel counts and minimal wiring.



T-Series

System Features

Available Channel Counts: 8, 16, 32

Headstage

Input Range: 4 mVpk-pk

Gain: 2, 20, 100

Sampling Rate: 50 kHz/channel

*Bandpass Filtering: .8 Hz - 7 kHz

Connector Standard: Omnetics

Base Station

*Gain: 8

*Output: Analog or Digital

Standard Recording

All T-Series recording headstages provide a compact and reliable connection to your electrodes.

These headstages interface perfectly with our data acquisition equipment, but they are also adaptable and can output analog data directly to other amplifier systems.

T-Series Headstages (G20,100)

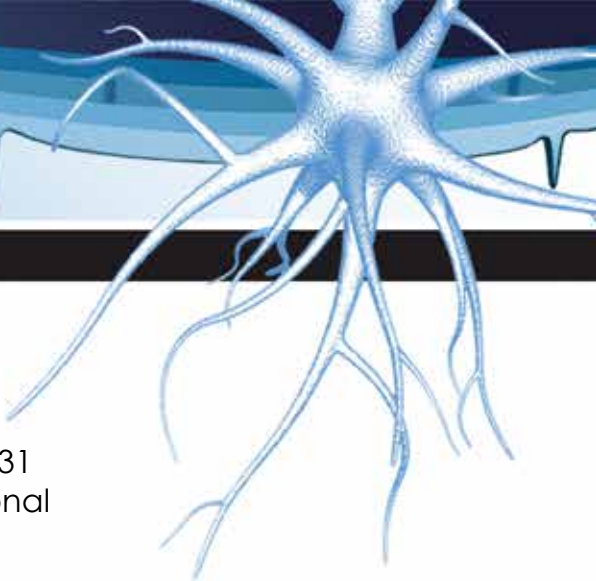


Base Station

Multiplexed Recording

With the M-Series amplifier system, you can record up to 31 channels of data using just three wires, with each additional headstage requiring only one extra wire.

Many customers take advantage of this system's minimal wiring by implementing a commutator for wire rotation management, thereby preventing the animal from tangling its tether and compromising the experiment.



System Features

Available Channel Counts:
32, 64, 96, 128, 160, 192, 224

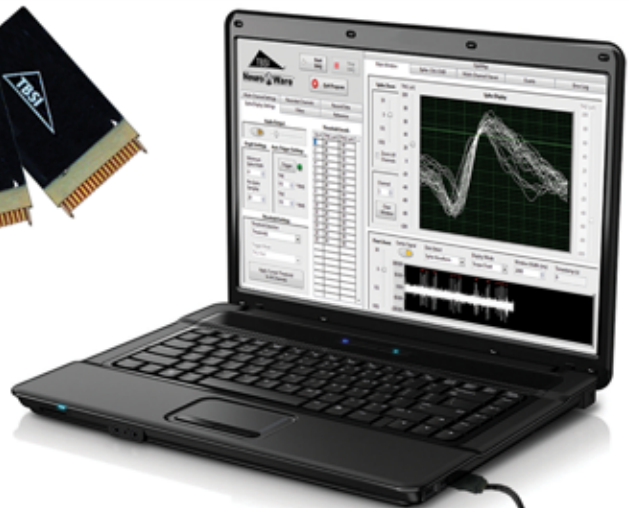
Headstage

Input Range: 4 mVpk-pk
Gain: 140
Sampling Rate: 50 kHz/channel
*Bandpass Filtering: .8 Hz - 7 kHz
Connector Standard: Omnetics

Base Station

*Gain: 8
*Output: Analog or Digital

NeuroWare® Data Acquisition Software



32 Channel Headstage (3 wires)



360° rotation Slip-ring Commutator



Demultiplexer Base Station

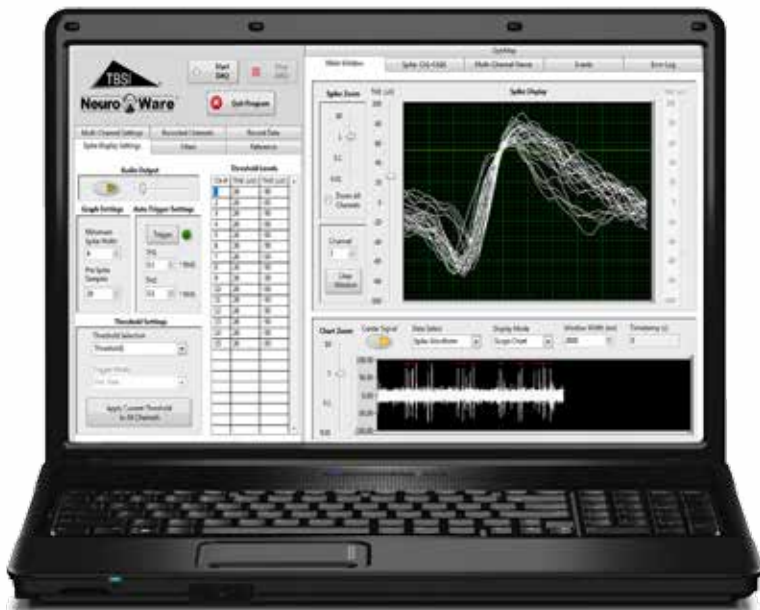


*Indicates potentially customizable feature.



Data Acquisition Software

In an effort to aid the user's experience with our recording equipment, we provide software solutions to satisfy needs for neural and visual data acquisition and organization.



NeuroWare© is compatible with Windows XP/Vista/7/8.

NeuroWare© is designed to interface with TBSI's optional data acquisition board, which can be installed inside any of our recording base stations to enable digital data output.

A TBSI base station with an internal ADC board transmits the digitized data to your computer via a USB cable, simplifying the integration process between hardware and software.



Data Acquisition Software

Program Features

- >> Realtime Waveform Display
- >> Channel Mapping
- >> Threshold Detection
- >> Multiple Spike Display
Windows and Spike Filtering
- >> Programmable Filtering and Reference Sheet
- >> Selectable Software Reference Subtraction
- >> File Output Formatting and Export (.nex, .txt, .edf*)

Base Station Back View

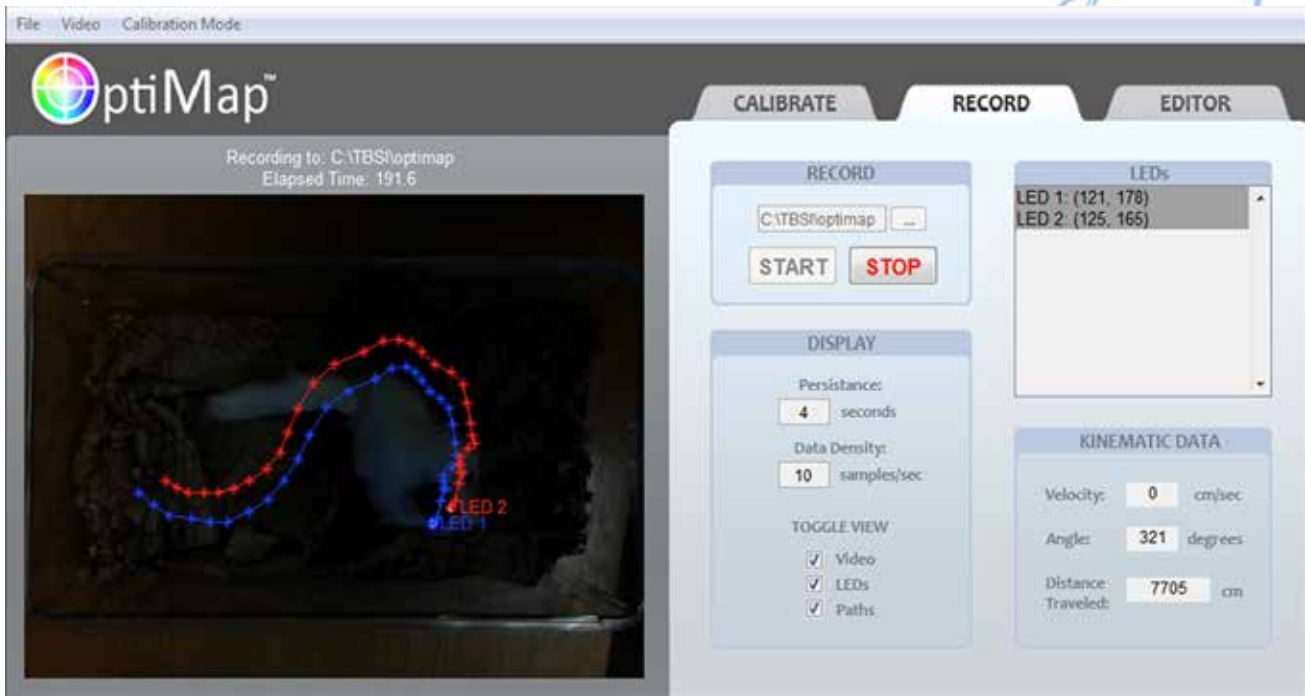
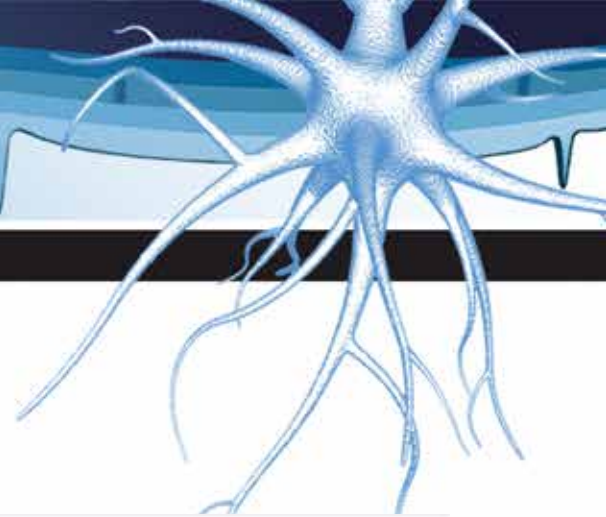


TBSI's internal DAQ provides up to 24 TTL event inputs & one analog data input, synchronizable with your headstage's data in NeuroWare©.

* Requires TBSI .nex to .edf complimentary conversion application.

OptiMap™

Video Tracking Software



Program Features

- >> Offered as standalone executable or integrated within NeuroWare©
- >> Track any number of uniquely colored points in real time or offline video, and record positions, orientations, and velocity behavioral information
- >> Uses USB webcam; no frame grabbers or compression cards required
- >> One-click automatic calibration function optimizes tracking in any light condition
- >> Easy conversion from pixel space to environmental distance, with optional user defined sub-regions
- >> Real-time display of tracked positions and paths can be synchronized with NeuroWare© DAQ sampling
- >> Automatic identification and interpolation functions for time intervals where position data is obfuscated or mistracked
- >> Offline manual and semi-automatic data editing with interval selection for individual or grouped data point position adjustment
- >> Videos stored as .avi files; position information files stored as text, binary, .xls or .mat



Simplicity in Neuro-Solutions

Electrical and Optical Neural Stimulation

Our dual channel stimulation systems allow researchers to generate and upload two separately customizable waveform patterns to a stimulator headstage, with options for tethered or wireless device interaction. Alternatively, the two supplied channels can be combined to achieve an even larger voltage differential. TBSI's StimWare® application allows the user direct control over the details of the uploaded stimulation pattern, including three optional tiers of nested patterns.

Each complete system is comprised of a stimulator headstage with integrated battery and all necessary accessories, including the Stimware® software package.

StimWare® Pattern Generator



USB Dongle
Transceiver



Wireless
Stimulator

*Electrical and Opticgenetic



System Features

Headstage

Channels: 2

Battery Life: Varies (60mAH supply)

Maximum Output Current: +/- 1mA

Minimum Pulse Width: 100us

Connector Standard: Mill-Max

User-defined variables include:

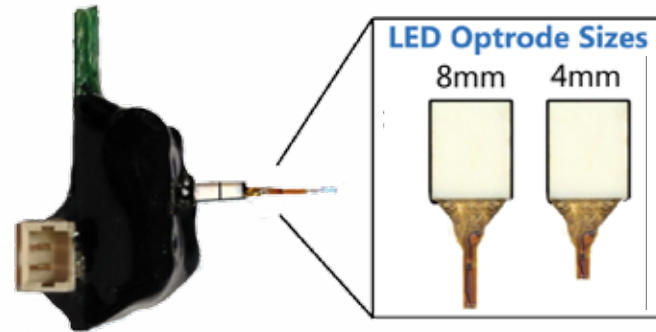
- >> Initial Delay
- >> Single Pulse Current and Duration
- >> Train Pattern (Multiple Pulses)
- >> Stimulus Pattern (Multiple Trains)
- >> External Even Triggering



StimWare® is compatible with Windows 7/8/10



Electrical Stim Headstage



Optostim Headstage with LED Optrode

Wirelessly Programmable

The wireless two channel stimulator is supplied stimulation pattern updates in real time via wireless communication with a USB dongle transceiver. StimWare® enables a range of wireless headstage interaction, including external event and user triggering, stimulator on/off control and electrode impedance measuring for chronic implant calibration.



Implantable Neural Stimulation

Triangle BioSystems International has developed a 90-day Implantable Electrical and Optogenetic stimulation system that allows researchers to generate and download two separately customizable pulse patterns via a USB dongle transceiver. The complete wireless system is comprised of an implantable stimulating headstage with inductive powering, implantable optical electrodes (for Optogenetics), a USB dongle transceiver and StimWare® pattern generation software. The StimWare® software interface allows the user direct control over the details of the uploaded stimulation pattern, including three tiers of nested pattern, on/off function and a manual trigger option.

This implantable headstage unit is implanted in a rat's peritoneal cavity using a minimally invasive surgical procedure thus providing programmed biphasic constant current for up to a 90-day package life. Additionally, this headstage can be used concurrently with our wireless, tethered or multiplexed neural recording headstages.

Stim Ware Pattern Generation Software

USB Dongle
Transceiver



Inductive powering cage



Implanted headstage



Shipped Items List

- 2 Channel Stimulation Implantable Headstage
- Stimware® Installation CD
- USB Dongle
- Headstage Charger
- 2 Trigger Interface Cables
- Stim Signal Test Load Board



Implantable Headstage



Installation CD



USB Dongle



Inductive Power Charger



Trigger Cables



Load Board



System Features

E-Stim Headstage (2, 16 ch)

Constant Current Range: Up to $\pm 1\text{mA}$ output
 90-day package life
 Transmit Range: 4 meters
 Up to 12 bits of current resolution
 Pulse width as short as $100\mu\text{s}$



Top View

O-Stim Headstage (2ch)

Output Range: 37mW max output intensity
 90-day package life
 Transmit Range: 4 meters
 12 bit brightness resolution
 Timing accuracy as short as $50\mu\text{s}$



Side View

Headstage Accessories

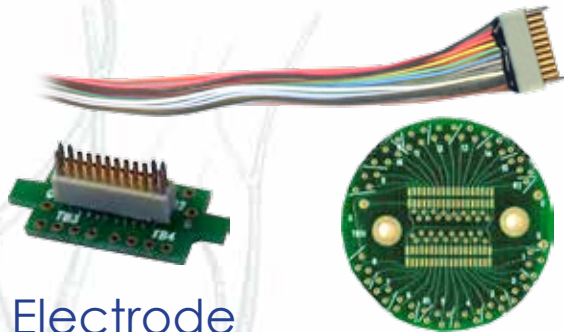
We provide a wide variety of headstage accessory options to more effectively cater to your neural recording and stimulation needs. Extended details about each item are available on our website: <http://www.trianglebiosystems.com/>

Connectors & Cables

W-Series, M-Series, T-Series, S-Series

We supply a wide variety of Omnetics brand connectors and cables. Though our headstages typically use Omnetics connectors, they have been tested for compatibility with various other connector brands. Please notify us if you wish to use a connector brand other than the standard and we will try to incorporate it into your headstage.

All of our recording and stimulation solutions include standard cables and tether, but we can also accommodate individual orders for customized cables. Just give us the details about your desired pinout and cable length and we'll take care of the rest.



Electrode Interface Boards (EIBs)

W-Series, M-Series, T-Series, S-Series

EIBs can be easily incorporated into your animal's implant to provide a sturdy anchor for your headstage and electrodes. We stock a variety of board shaped and sizes ideal for any animal, including mice. We are also capable of designing custom EIB solutions.

External Batteries

W-Series, S-Series

If you require extra battery life for longer experiments, you have the option to replace the standard internal 4 hour battery with one of our 12 hour or 24 hour external battery options. Using an external battery also helps relieve the weight from the animal's head, but it must be stored in a rat jacket or other garment.



Animal Jackets & Harnesses

W-Series, S-Series

A jacket or harness is recommended for securing external headstage components, such as a battery, onto the back of a rat or mouse.

Commutators

W-Series, T-Series

Choose from Plastics1 and Dragonfly Inc. slip-ring commutators to accommodate between 1 and 18 separate transmission lines.



Headstage LEDs

W-Series, M-Series, T-Series, S-Series, OptiMap

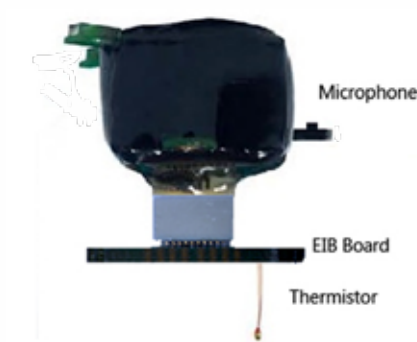
Up to two LEDs (blue, green, and red available) can be installed onto any headstage. Internal battery life is reduced by 15% when this option is enabled.



External Batteries

W-Series, S-Series, T-Series

The following accessories will replace channels typically used for neural recording on the headstage. Installation of these features will increase the headstage's length by .4 inches, its height by .2 inches, and its weight by .4 grams. The biosensor options can be installed in any combination.



Temperature

Records temperature with small thermistors which can be placed anywhere in or on the animal.

XYZ Acceleration

Monitors x, y and z acceleration at the headstage and outputs analog information along 3 active headstage channels. Animal head velocity and position can later be calculated in software.

Ultrasound Microphone

Records frequencies between 10kHz and 30kHz.

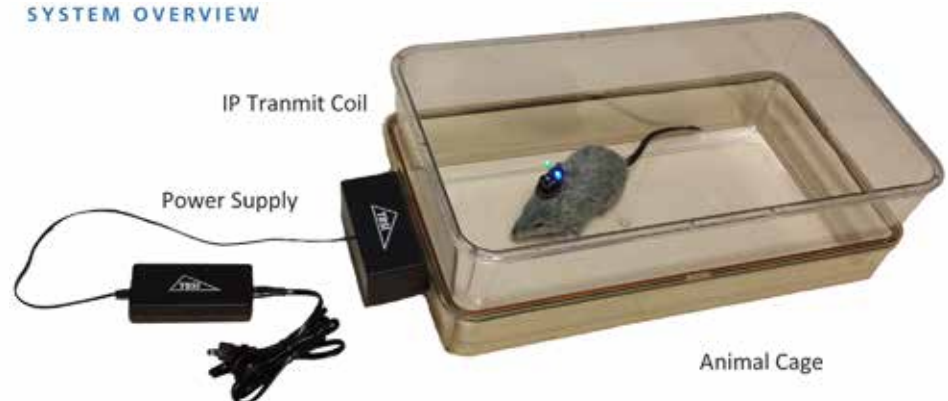
Wireless Power

W-Series, S-Series

When placed within a resonant magnetic field, the inductive power add-on assembly will keep a wireless headstage's internal battery perpetually charged, thereby facilitating indefinite and uninterrupted device operation.

Wireless power setups must be tailored to the experimental environment, therefore charging results may vary depending on the size and shape of the workspace.

SYSTEM OVERVIEW





Customer Support

We pride ourselves on our commitment to our customer service. We want to be there for you when you are looking for something unique and reliable to streamline your experiments and keep them running smoothly.

If you ever encounter any trouble with your setup, we are available to provide technical assistance however possible.

Custom Engineering

Do you have a need for a customized solution based on one of our product brands? Triangle Biosystems is available to provide custom solutions to assist you with your special projects.

If you would like to customize one of our product lines (Wireless, Tethered, Multiplexing or Stimulation), please contact our customer service department. We will work closely with you and your technical team to understand your requirements, suggest a solution, and develop the hardware that will allow you to meet your objectives.

Whether you are looking for a simple cable or connector, or even something more involved like a custom interface board, we would like to help you find what you're looking for. We have a large network of suppliers and partners to help us source a wide variety of components.



Product Warranty

All TBSI manufactured products are covered by a one-year warranty. Please visit our website for more information concerning our warranty policies.



Scientific Publications

We invite you to visit our website and review our customer publication directory for confirmation of our products' efficacy and to gain knowledge about the various uses of our technology in the field.

Research and Development

Our facilities and experience are available to you should your needs exceed our technology's capabilities. We are willing to work with investors who require timely and professional longterm custom product engineering.

Hardware

- >> Mixed-Signal VLSI Design
- >> Mixed-Signal PCB Design
- >> RF PCB Design
- >> Manufacturing Testing and Automation
- >> Test Engineering and Development

Software

- >> Embedded Software Development
- >> Application Software Engineering





Simplicity in Neuro-Solutions

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to request a
product quote.





SIMPLICITY IN ELECTROPHYSIOLOGY

Our total product solutions are engineered for simplicity. We like to envision our products as being as plug-and-play as possible. Using industry standard connectors for interfacing to electrodes, internal base-station cable connections, and a USB output to your computer/software, a TBSI recording solution is exactly what you need to start collecting data quickly and easily.



THE RESEARCH
TRIANGLE PARK





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