

64 CHANNEL WIRELESS NEURAL HEADSTAGE SYSTEM

Features

- Wireless operations across 4 meters
- Operates in unlicensed radio band below FCC limits
- Available with 62 channels
- Factory configurable gain of 800
- Rechargeable battery power with 5 hour battery life
- Bandpass filtering per channel
.8Hz to 7 kHz
- 50kHz sampling rate per channel
- Weight < 5.0 grams
- Dual 36pin double row nano connector
- Dipped or covered headstage cover

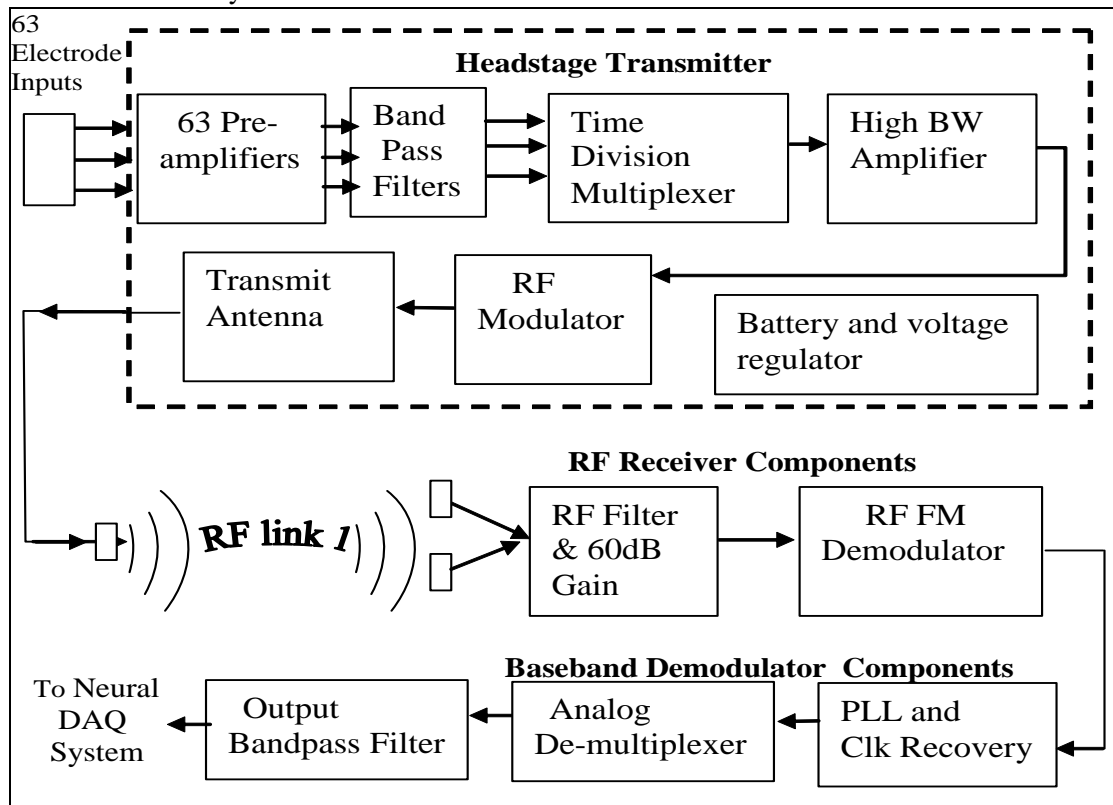
General Description

Triangle BioSystems, Int'l. has developed a high channel count wireless neural headstage system that allows researchers to continuously and simultaneously monitor up to 62 neural electrodes. No longer do experiments have to be constrained by wiring a test subject to the recording system. The complete system is comprised of a wireless headstage transmitter with integrated battery, RF signal receiver/baseband demodulator, power supply and all required cables. With an effective range of 4 meters, this system provides a wireless connection between the implanted electrodes and the data recording system.

In the development of this system, TBSI utilized custom ASIC technology and proprietary radio design techniques to provide high channel count functionality in a wireless headstage that is both small and light weight (5.0 grams). This design also incorporates neural preamplifier circuitry to create an extremely compact and powerful transmitter.

System Block Diagram

The wireless neural headstage system consists of a wireless transmitter headstage, an RF receiver and baseband demodulation subsystems as shown below:



Dipped headstage



Receiver with Dual Antennae

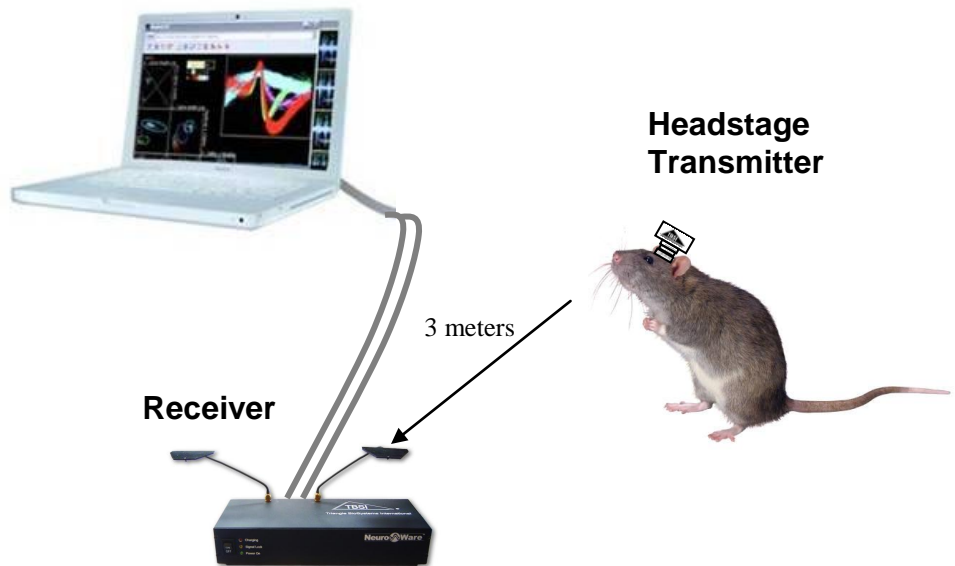
NOTE: These products are not for human use.

1.0 System Configuration

Neural recording system

The receiver has to be within 3 meters from the animal at all times. It can be positioned next to the cage or sit on a shelf inside the cage. See page 9, Section 10.0 for more details on system setup.

Be careful not to obstruct the line of site path between the animal and the receiver antenna with any material except for glass, plastic or Plexiglas.



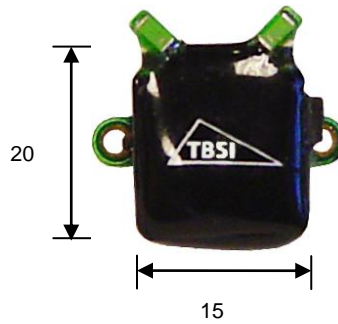
2.0 Headstage Transmitter Specifications

Parameter	Min	Typ	Max	Units	Notes
Power Supply					
3 volt supply		2.95	3.0	Volts	Power consumption 11.0ma (typical)
Battery life		5		Hours	Re-chargeable battery with 2 hour recharge time
Analog Input Specs					
Input voltage range		5		mVolts	Maximum Input voltage Vp-p
Common mode center		.9		Volts	At ACgnd potential
Gain selection	790	800	810		Factory selectable gain
Bandwidth	.8		7000	Hz	-3dB input signal level BW
Input impedance		11M		ohms	At 1kHz
Input referred noise		8.5		µVrms	for DC - 10kHz frequency
Input referred noise		5.5		µVrms	for 500Hz – 5kHz frequency
Sampling Rates		50		kHz	Headstage and DAC sampling rates per channel
Mechanical Specs					
Length		20		mm	Edge to Edge
Width		15		mm	Edge to Edge mounting holes (#0-80 screws)
Height		12.2		mm	Not including connector
Weight			4.8	grams	With connector
Connector Option 1		68		Pin	Dual, Omnetics Female 36 pin dual row nano A9094 with fixed mechanical spacing
Radio Specs					
Center frequency		3.05		GHz	With +/- 30 MHz bandwidth
Transmit power			300	µW @ 4 meters	FCC Sec.15.109B(a)
Transmit antenna		3.05		GHz	Tuned chip antenna with circular diversity
Transmit range		4.0		Meters	With receiver on top of cage



3.0 Headstage Mechanical Overview

	Top View	Bottom View
Dual Vertical Connector		



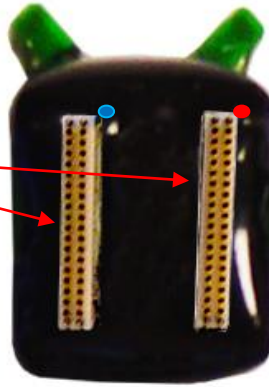
Note1: all dimensions are in mm (millimeters)

Note2: Complete headstage weight is 4.8 grams and the total height is 12.2mm

4.0 Wireless Headstage Pinout

Dual 32 channel Omnetics, Female, Dual Row 25 mil

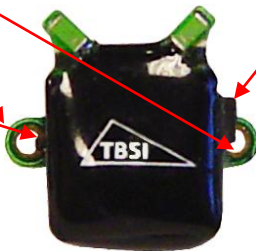
Double, 36pin, Nano, A9409 Connectors



Mounting Holes

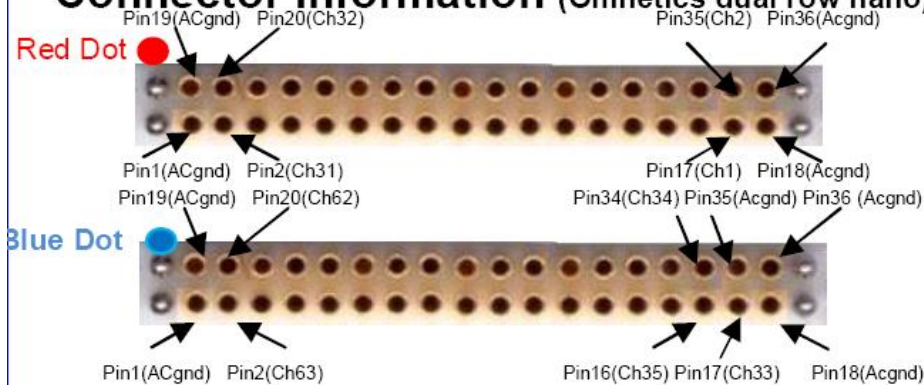
Charger Connector

On/Off switch



Pin	Pin Names	Pin	Pin Names
1	ACgnd	1	ACgnd
2	Channel 31	2	Channel 63
3	Channel29	3	Channel 61
4	Channel27	4	Channel 59
5	Channel25	5	Channel 57
6	Channel23	6	Channel 55
7	Channel21	7	Channel 53
8	Channel 19	8	Channel 51
9	Channel 17	9	Channel 49
10	Channel 15	10	Channel 47
11	Channel 13	11	Channel 45
12	Channel 11	12	Channel 43
13	Channel 9	13	Channel 41
14	Channel 7	14	Channel 39
15	Channel 5	15	Channel 37
16	Channel 3	16	Channel 35
17	Channel 1	17	Channel 33
18	ACgnd	18	ACgnd
19	ACgnd	19	ACgnd
20	Channel 32	20	Channel 62
21	Channel 30	21	Channel 60
22	Channel 28	22	Channel 58
23	Channel 26	23	Channel 56
24	Channel 24	24	Channel 54
25	Channel 22	25	Channel 52
26	Channel 20	26	Channel 50
27	Channel 18	27	Channel 48
28	Channel 16	28	Channel 46
29	Channel 14	29	Channel 44
30	Channel 12	30	Channel 42
31	Channel 10	31	Channel 40
32	Channel 8	32	Channel 38
33	Channel 6	33	Channel 36
34	Channel 4	34	Channel 34
35	Channel 2	35	ACgnd
36	ACgnd	36	ACgnd

Connector Information (omnetics dual row nano)





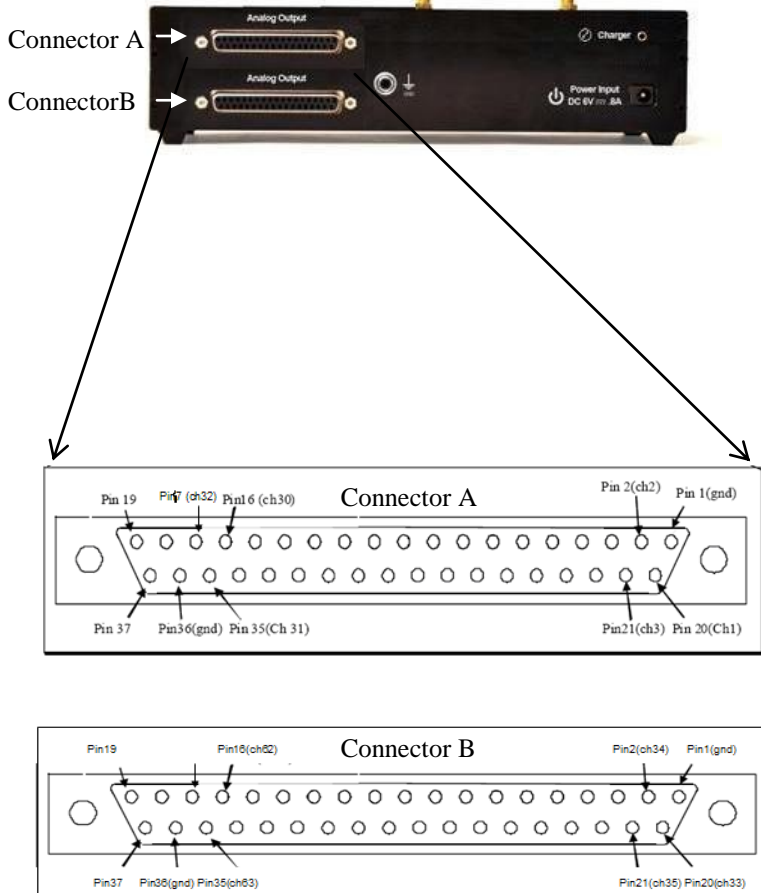
5.0 RF Receiver

Specification summary

- 3.05GHz center transmit frequency with +/-30MHz FM bandwidth
- 2.0 meter max. range between headstage transmitter and receiver (assuming Plexiglas cage)
- Cable for headstage battery recharging
- Front-end Gain: 60 dB
- Intermediate gain, 10-20 dB
- Input referred noise, typical 4 uVrms
- Input voltage range, +/- 0.5V
- Analog Channel bandwidth 20 kHz
- DC offset, < 100uVdc
- Phase delay typ. 30 usec at 10kHz
- Receive antenna - black square area on bottom of box
- Signal lock indicator LED on front panel

6.0 Demodulator/Signal Processing Unit

The RF receiver signal is demodulated by a custom digital signal processing system. The signal processing system incorporates a high speed analog to digital converter for demodulating the receiver signal. The demodulated signal is then conditioned via the DSP and converted to an analog output signal. The analog interface is available via a DB37 female connector, connector pin-out below:



Pin #	Description (DB37 A)
1, 36	GND
2	Channel 2 Output
3	Channel 4 Output
4	Channel 6 Output
5	Channel 8 Output
6	Channel 10 Output
7	Channel 12 Output
8	Channel 14 Output
9	Channel 16 Output
10	Channel 18 Output
11	Channel 20 Output
12	Channel 22 Output
13	Channel 24 Output
14	Channel 26 Output
15	Channel 28 Output
16	Channel 30 Output
17	Channel 32 Output
20	Channel 1 Output
21	Channel 3 Output
22	Channel 5 Output
23	Channel 7 Output
24	Channel 9 Output
25	Channel 11 Output
26	Channel 13 Output
27	Channel 15 Output
28	Channel 17 Output
29	Channel 19 Output
30	Channel 21 Output
31	Channel 23 Output
32	Channel 25 Output
33	Channel 27 Output
34	Channel 29 Output
35	Channel 31 Output
18,19,37	No Connect

Pin #	Description (DB37 B)
1, 36	GND
2	Channel 34 Output
3	Channel 36 Output
4	Channel 38 Output
5	Channel 40 Output
6	Channel 42 Output
7	Channel 44 Output
8	Channel 46 Output
9	Channel 48 Output
10	Channel 50 Output
11	Channel 52 Output
12	Channel 54 Output
13	Channel 56 Output
14	Channel 58 Output
15	Channel 60 Output
16	Channel 62 Output
17	Channel 63 Output*
20	Channel 33 Output
21	Channel 35 Output
22	Channel 37 Output
23	Channel 39 Output
24	Channel 41 Output
25	Channel 43 Output
26	Channel 45 Output
27	Channel 47 Output
28	Channel 49 Output
29	Channel 51 Output
30	Channel 53 Output
31	Channel 55 Output
32	Channel 57 Output
33	Channel 59 Output
34	Channel 61 Output
35	Channel 63 Output
18,19,37	No Connect

*Please note Pin 17 on Channel B is shorted to Channel 63 (pin 25)

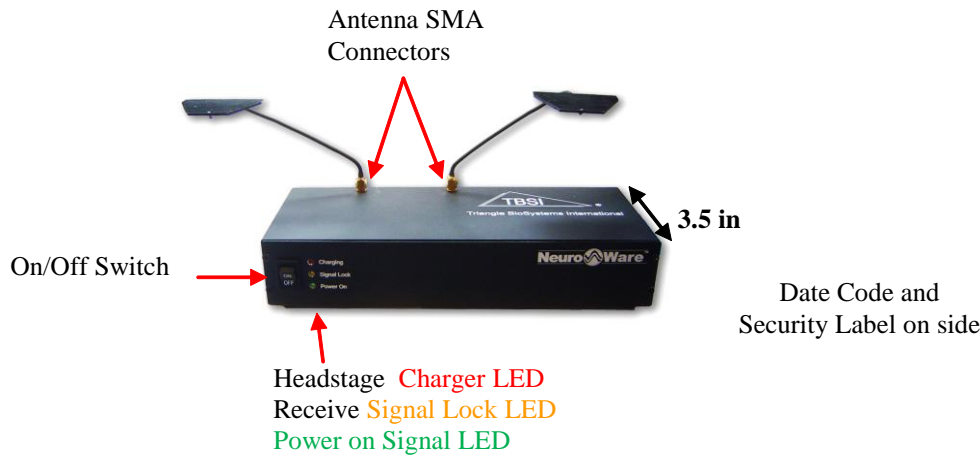


7.0 Power Supply

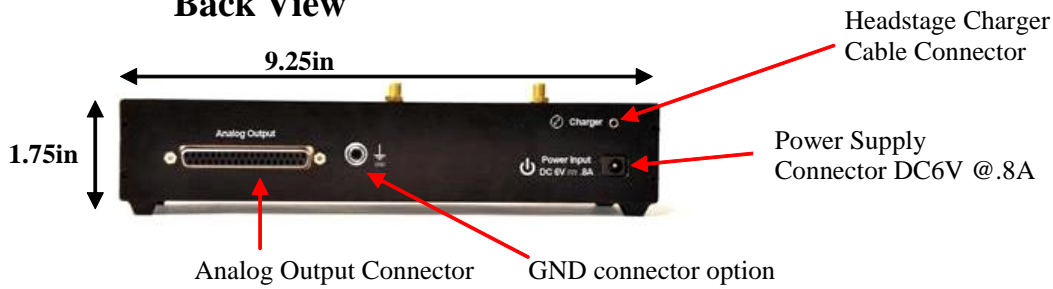
The recording system is powered by an AC line adapter transformer/regulator manufactured by Cincon Electronics. This power unit connects to a 100-240V, at 47-63 Hz and is rated at 6Vdc at .8 amps AC power source and is UL approved. The model number of this wall unit is TR25150.

8.0 Receiver Mechanical

Front View



Back View





9.0 Wireless system parts ship list:

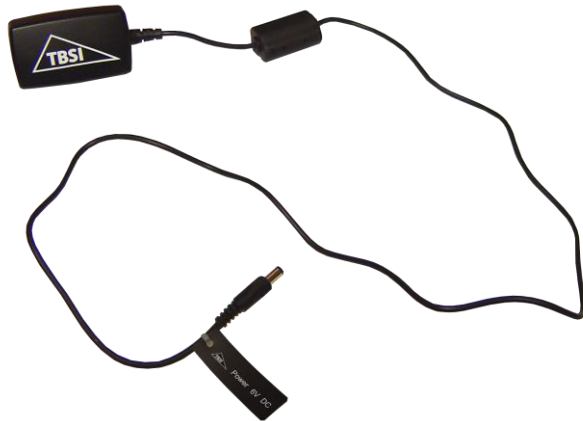
64 channel headstage



64 channel receiver



Power Supply



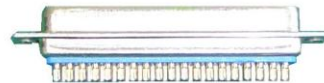
Headstage Charger Cable



**Electrode Mating Connector Omnetics Male
Dual row Nano 10 Pin Vertical P/N A11862**



Analog output mating connector (DB37)



Headstage Signal cable for Testing



2 Receiver Antennas with extender cable



10.0 System Setup and Test:

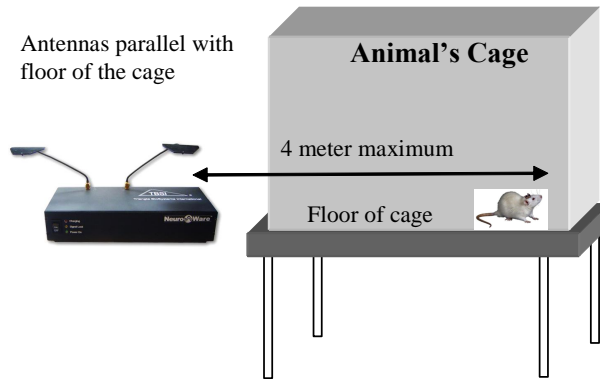
Below are 6 instructions to validate radio system setup and transmit range:

1) Correctly Position the Receiver near or inside the animal's cage:

It is critical for transmission performance to correctly position the receiver next to or inside the animal's cage. First screw the antennas snugly onto both antenna gold input SMA connectors at top of receiver. The antenna connector shafts can be bent either at 90 degrees or left straight depending on the position of the receiver to the animal. Position the receiver as shown below with either option 1 or option 2 with respect to the headstage transmitter:

Option 1: Receiver next to cage

Receiver antennas should point to the side of the cage height and should be positioned so that the animal is horizontal from the antenna. The maximum distance the animal can be away from the antenna is 4 meters.

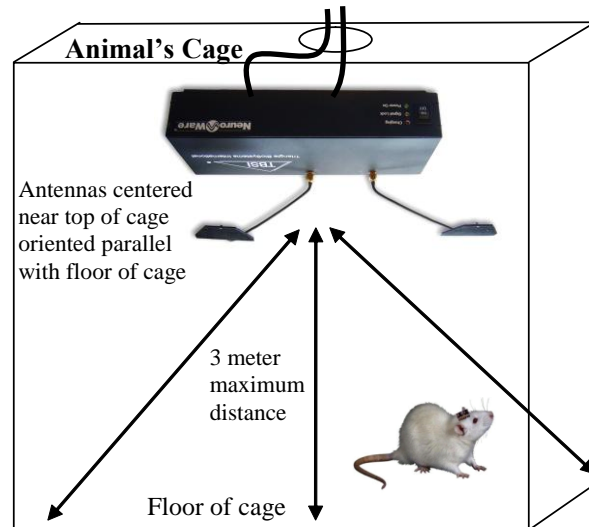


Option 2: Receiver inside cage

Receiver antenna should point vertically downward and the receiver should be rotated on its side and mounted near the top side of the cage. The analog output connector of the receiver should point upward. The antenna location is top and center inside the cage which means the receiver is placed off center by 9 inches or so.

Note the maximum distance the animal can be away from the antenna is 4 meters.

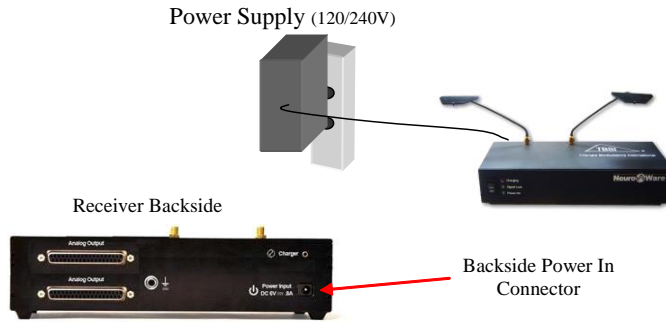
The power cable and analog output cable should exit the cage at the top.



Be careful not to obstruct the line of site path between the animal and the receiver antenna with any material except for plastic, glass or plexiglass. If any ferrous materials are used such as steel, wire mesh, or most metals and any materials that have water such as wood then the range and RF signal dropout may be compromised. Depending on the cage set-up within the lab and location of the receiver, signal dropout or a "dead spot" may be seen at an exact headstage angle and distance from the receiver. This is due to RF transmission multi-path phenomenon. If a deadspot occurs within the active space of a freely moving animal pathway, one can slightly adjust the receiver distance or angle to move the deadspot to a new space outside the animal's pathway.

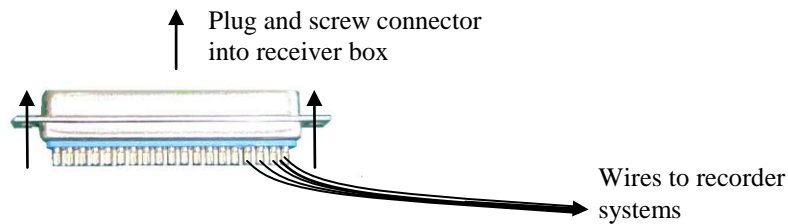
2) Connect power supply to receiver

The power supply cable will plug directly into back of receiver into the power jack connector.



3) Connect signal cable to receiver analog output DB37 connector

4 signal wires and a ground wire can be added to the DB37 mating connector to check for signal output. The length of the wires is not critical and depends on how far the wires need to be routed to the recording system. The analog output wire channel position is described on page 4 of this document.

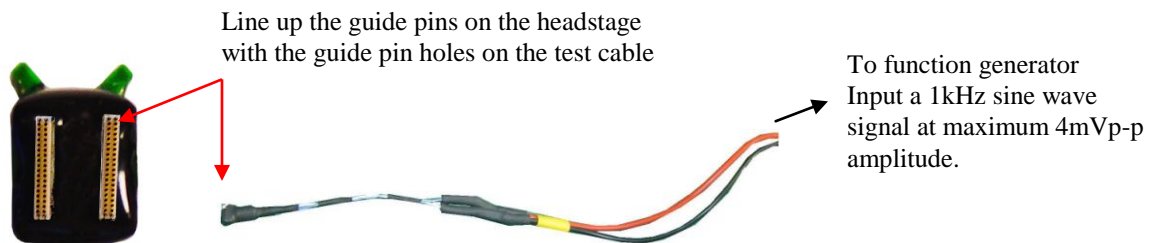


4) Turn on Receiver

Push the Green on/off button of the receiver to turn the receiver on and off. The button will light up green when the receiver is turned on and the light goes away when the receiver is turned off.

5) Connect a function generator to the headstage via headstage signal cable

A function generator can be attached to the headstage signal cable. Since this is a battery powered headstage, it doesn't matter which signal wire (either red or black) from this cable will connect to the function generator's ground or signal wire. Note the function generator signal output voltage cannot exceed 4 mVp-p otherwise the headstage input voltage range will saturate. The frequency of the input signal can be set to 1 KHz. Also be sure the white dot of the cable lines up with the white dot of the headstage.



When the cable is attached to the headstage, the headstage will TURN ON and start to transmit. Hence do not forget to unplug the headstage when not being used. Otherwise the battery will be drained.

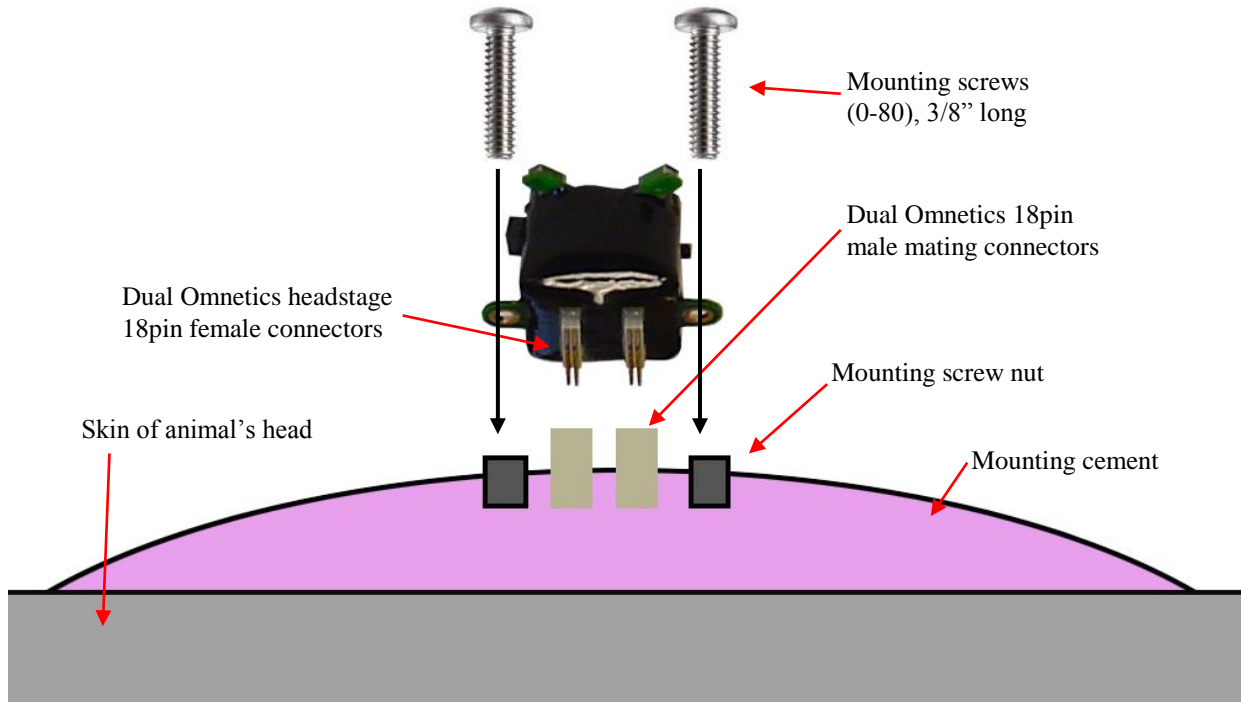
6) Signal Lock LED and measure analog output signals

Once the headstage is turned on by connecting the signal cable to the headstage from Step 5, and the receiver is turn on, the "Signal Lock" LED in on the receiver front panel should light right away. Once lit, you can measure the analog output signals using an oscilloscope. Please note the system gain is 600 so the analog output values should be $\sim 600 \cdot V_{p-p}$ of function generator output.

11.0 Application notes

11.1 Mounting the headstage onto the animal

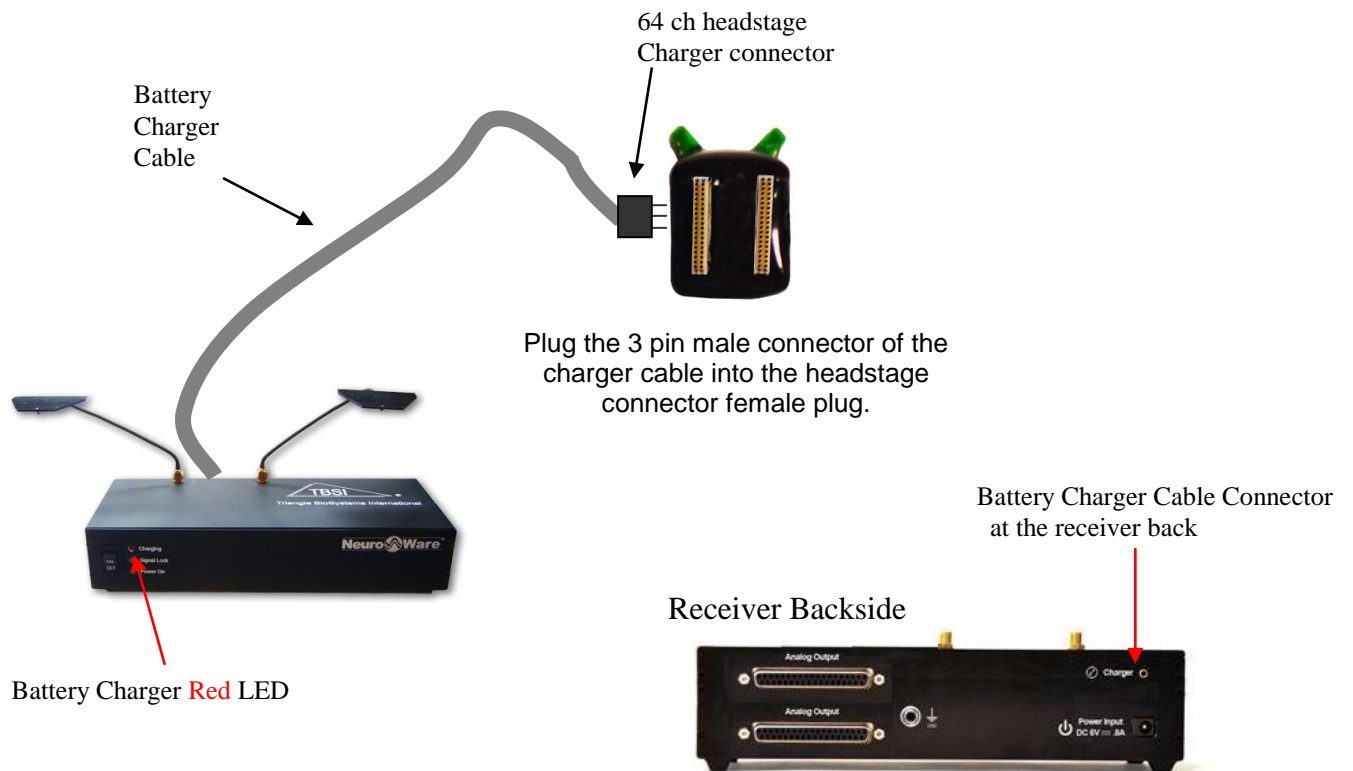
Depending on the animal test and particular experiment, the friction of the Omnetics headstage connector male pins While place into the electrode female connector maybe sufficient to keep the headstage mounted securely to the animal. However, if additional mounting support is required, optional mounting screws can be used to securely mount the 31 channel headstage to the animal



11.2 Charging the headstage lithium ion battery

The wireless headstage includes an integrated rechargeable battery which must be recharged after approximately 5.0 hours of use. Recharging is accomplished by the following procedure:

1. Turn off receiver unit.
2. Connect battery charging cable to the “Charge Cable” connector on the back panel of the receiver. This cable connector is keyed and can only be plugged in one way.
3. Plug opposite end of the charging cable into the headstage connector on the wireless headstage (see diagram below). Make sure the 3 pins of the charging cable line up to the charger connector of the charger headstage connector.
4. Turn on the receiver (the “Charge” Red LED on the front panel of the receiver should now be illuminated)
5. The battery will be fully charged in approximately 1.5 hours. The “Charge” red light on the receiver will turn off when battery is fully charged.



12.0 External Battery and Accessories

External 24 hour and 96 hour rechargeable battery options are available for all wireless headstages to provide enough battery life for overnight sleep and 4 day long recording studies. For this external battery headstage scenario, the battery is outside the headstage is removable for recharging via a connector. Usually the external battery is mounted in a jacket or pouch on the animal usually away from the animal's head. Since the battery is external to the wireless headstage, the 64ch headstage weight is reduced by 1.8 grams to 3 grams versus 4.8 grams. In addition, the 64 ch headstage height is reduced by 4mm for a total height to 8.2mm versus 12.4mm. Below are the accessories for the external battery options, the battery charger, plug adapters and mice and rat jackets to house the battery.



12 hr battery
Weight: 8.4 grams
Size: 1.4 x .4 x .2 inches



24 hr battery
 12 grams
 1.5 x 1.1 x .2 inches



90 hr battery
 44 grams
 2 x 1.5 x .4 inches



Battery charger
 and battery connector



Multi-plug adapters for
 Europe and Asia

Mice and Rat jackets are required for external battery option

Opened Jacket with pocket

Closed Jacket with pocket

Pocket and front leg jackets
 Large, med, small sizes



Order all rat jackets direct to Teresa Woodger-Price teresa@lomir.com at Lomir Medical.

The address is below:

Lomir Biomedical

458 East Main Street

Malone, NY 12953

Tel toll free 877-425-3604, or 518 483 7697; Fax 518 483 8195

The part numbers for the rat jackets are

RJ 02 Medium (250-300g)

RJ 03 Large (300-500g)

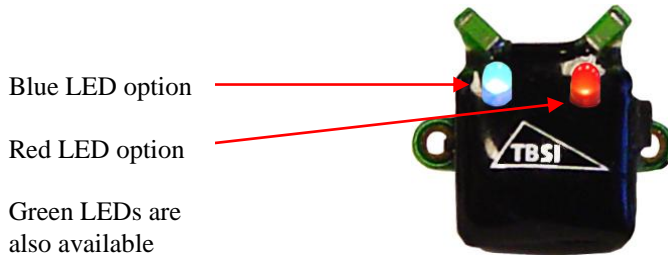
RJ 04 X-Large (500g+)

RJ INP Rat jacket insert/pocket



13.0 LED Headstage Options

Red and blue LED options are available for the 15 channel headstage for video tracking. The LEDs are placed facing upward on the top headstage and plenty bright enough to allow for video tracking. Both LEDs turn on with the On/Off switch. Please note that with the use of these LEDs, the battery life is reduced by 30%.

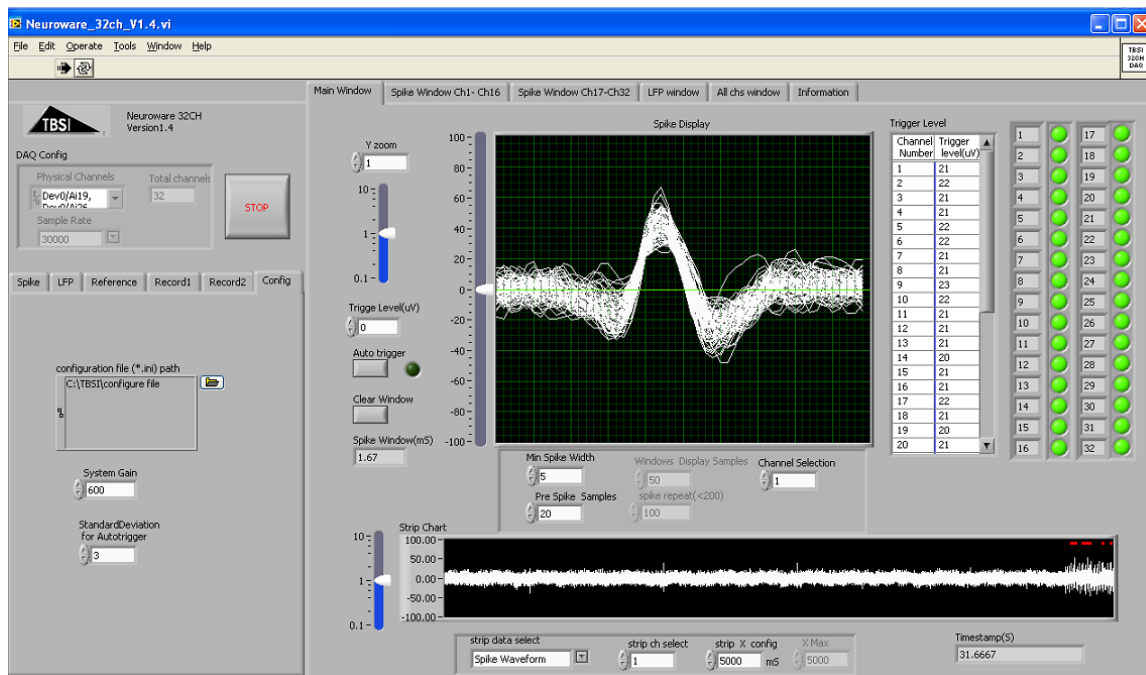


14.0 Electrodes

Microprobe Inc., NeuroNexus, Neurolync and CD Neural Technologies offer a variety of electrode arrays that connect to all of our headstages. Please visit our website <http://www.trianglebiosystems.com/Products/Electrodes.aspx> to connect to all the vendors' websites.

15.0 Data Acquisition Board and Software

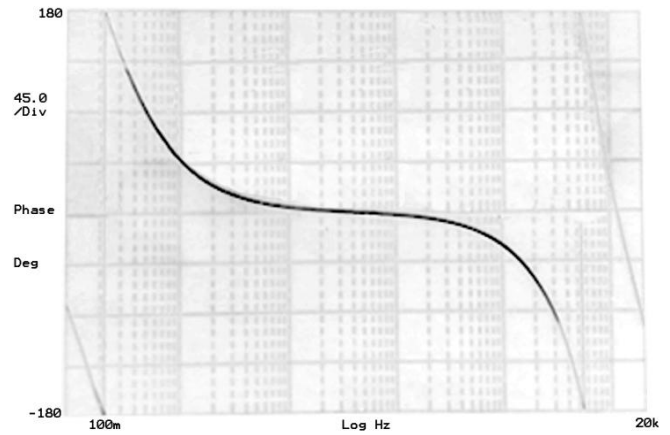
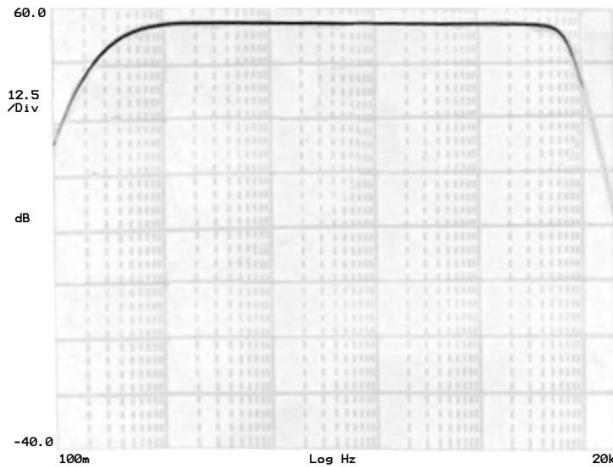
TBSI offers a DAQ board for our receiver and NeuroWare software for the 5ch, 16ch and 32ch receivers which can be used for signal data acquisition and analysis. For this DAQ option the receiver box has an internal DAQ board and USB output cable to connect to a PC. Please see the URL <http://www.trianglebiosystems.com/Products/DataAcquisition.aspx> for more information about NeuroWare and our data acquisition products.





16.0 Gain and Phase Response

Please refer to section 2.0 of this document for numerical data on bandwidth and input referred noise.



17.0 Troubleshooting

Problem: No neural signals are visible on any of the Analog Outputs at the DB37 connector.

Solution: Verify the AC power connection is in place and the Green “Power” LED is illuminated on the RF Receiver Box, as well as the Green LED on the power button on the Signal Demodulator Unit. Also, verify that “Signal Lock” light is illuminated which confirms that the receiver is receiving the transmitted signal from the headstage.

Problem: Visible neural signal is missing information.

Solution: Keep the animal within the 3 meter range of the receiver. If you exceed this range, the radio signal from the headstage will not be strong enough to maintain reliable signal monitoring of the animal. Also, be sure to keep the area under the RF Receiver unit’s antenna free from metallic objects, which will reduce signal range.

Note: The Wireless Headstage is a low-power device, it is critical that the RF receiver be carefully located for the system to operate. DO NOT place the Receiver on outside a metal wire cage. Try to minimize the distance between the Receiver and the Wireless Headstage. The best orientation is the Receiver is shown on page 9.

Problem: Not all channels are visible on the neural signal.

Solution: Make sure the headstage connection is secure to the animal.

Call customer TBSI customer support (919) 361-2663 if there are any problems with system setup and function.