SpikeGadgets

Sprite32 Headstage Manual



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Sprite32 Headstage



Introduction

The Sprite32 headstage offers fully featured data logging and headstage monitoring in an ultralightweight package suitable for experiments with anything from mice to macaques. The Sprite32 wirelessly logs 32-channels of full data-rate broadband neural data while also weighing in at a tidy 3.8 grams, including the integrated battery.

Sprite32 offers 75 minutes of continuous record time with a low-power standby mode ideal for experiments where habituation is required. The headstage also features wireless battery and headstage status monitoring via Trodes 2-way communication, enabling independent monitoring and control for up to 8 recording headstages simultaneously.

Unlike other SpikeGadgets headstages, the Sprite32 has been designed exclusively for untethered data logging applications in freely-moving animals. The ultralightweight and compact design makes it ideal for multi-animal experiments requiring natural movement and/or social interaction .

The Sprite32 is USB chargeable using the Omnetics PZN to USB adaptor and records all neural data and sensor (accelerometer and gyroscope) data directly to micro-SD storage on the headstage. Probe compatibility is also a breeze with the standard 36-pin Omnetics connector, mating to any passive neural probe or array with standard channel mapping.

Sprite32 works in conjunction with the SpriteDock via the Trodes software suite. The Dock is used to start and stop recordings and facilitates wireless communication with the headstage for real-time status and battery monitoring, as well as headstage pinging.

Neural data recorded with Sprite32 is synced with any environmental data recorded using the Logger Dock 2 or ECU digital and analog IOs.

Sprite32 Headstage Specifications

Channel Count	32 Channel
Dimensions	21 x 18 x 10 mm
Weight	3.8 grams (battery included)
Record Time	75 minutes*
Sampling Rate	20kHz
Bit Depth	16-bit
Sensors	3-axis gyroscope; 3-axis accelerometer; Battery charge and health
Input range	±5 mV
Battery	45 mAh
Data Logging	Full data-rate broadband data
Charging Connector	4-pin Omnetics PZN
Probe Interface Connector	36-pin Omnetics connecter
Simultaneous Recording	6 headstages/Logger Dock

*Recording time is dictated by battery health, which slowly changes with use over time. This results in an expected but modest decrease in recording time over the lifespan of the headstage.

Headstage Connections

The Sprite32 is powered using a rechargeable integrated battery. This battery is charged using the Omnetics PZN to USB adapter cable provided with the unit. The headstage can be charged via the Logger Dock USB port, or any 5-volt USB port.

The Omnetics PZN connector is also used for configuring headstage settings and deploying firmware updates.

The Omnetics 36-pin connector connects to any passive neural recording probe or array using the standard 36-pin Omnetics connector with 4 guide pins.

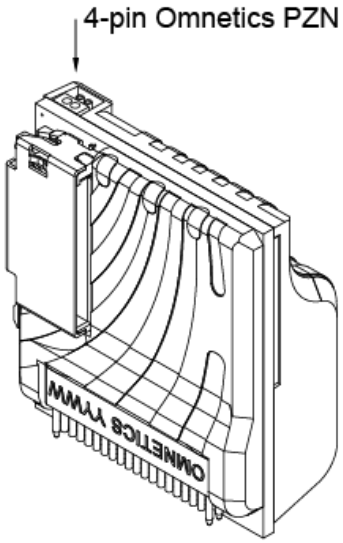


Figure 1 *Omnetics PZN connector*

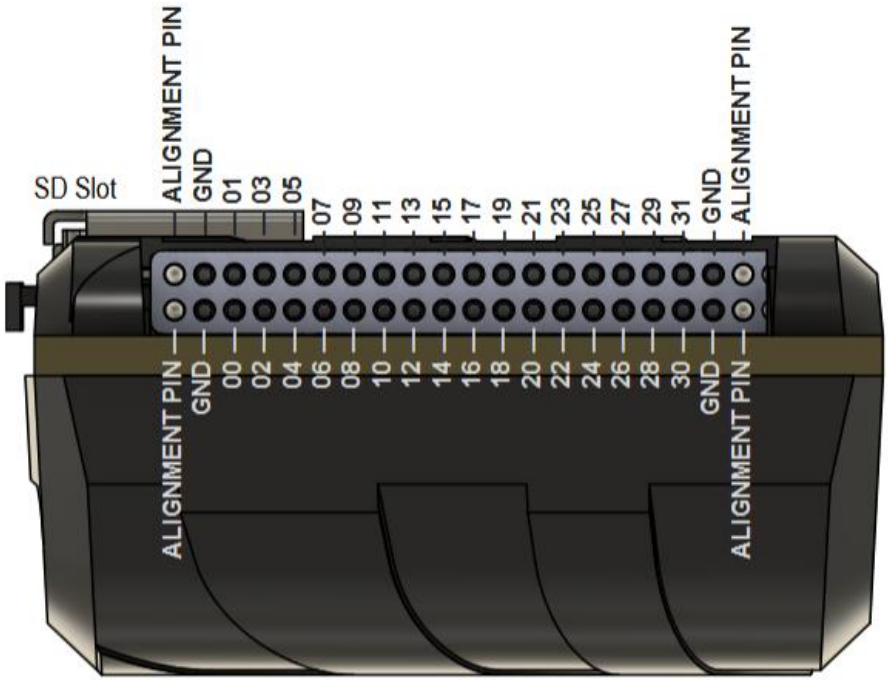


Figure 2 *Bottom view of the Sprite32 displaying the channel map on a 36-pin Omnetics connector with 4 guide pins.*

The numbers indicate the corresponding amplifier hardware channel (which also corresponds to the HW Channel in Trodes). These can be remapped by assigning them to different nTrodes in the workspace editor.

Implant Omnetics Clearance

The analog input Omnetics connector on the Sprite32 is inset by 2.5mm in order to lower the center of mass of the system. This means that there must be 2.5mm of clearance between the top of the input connector (on the animal) and the cement used to bond it in place.

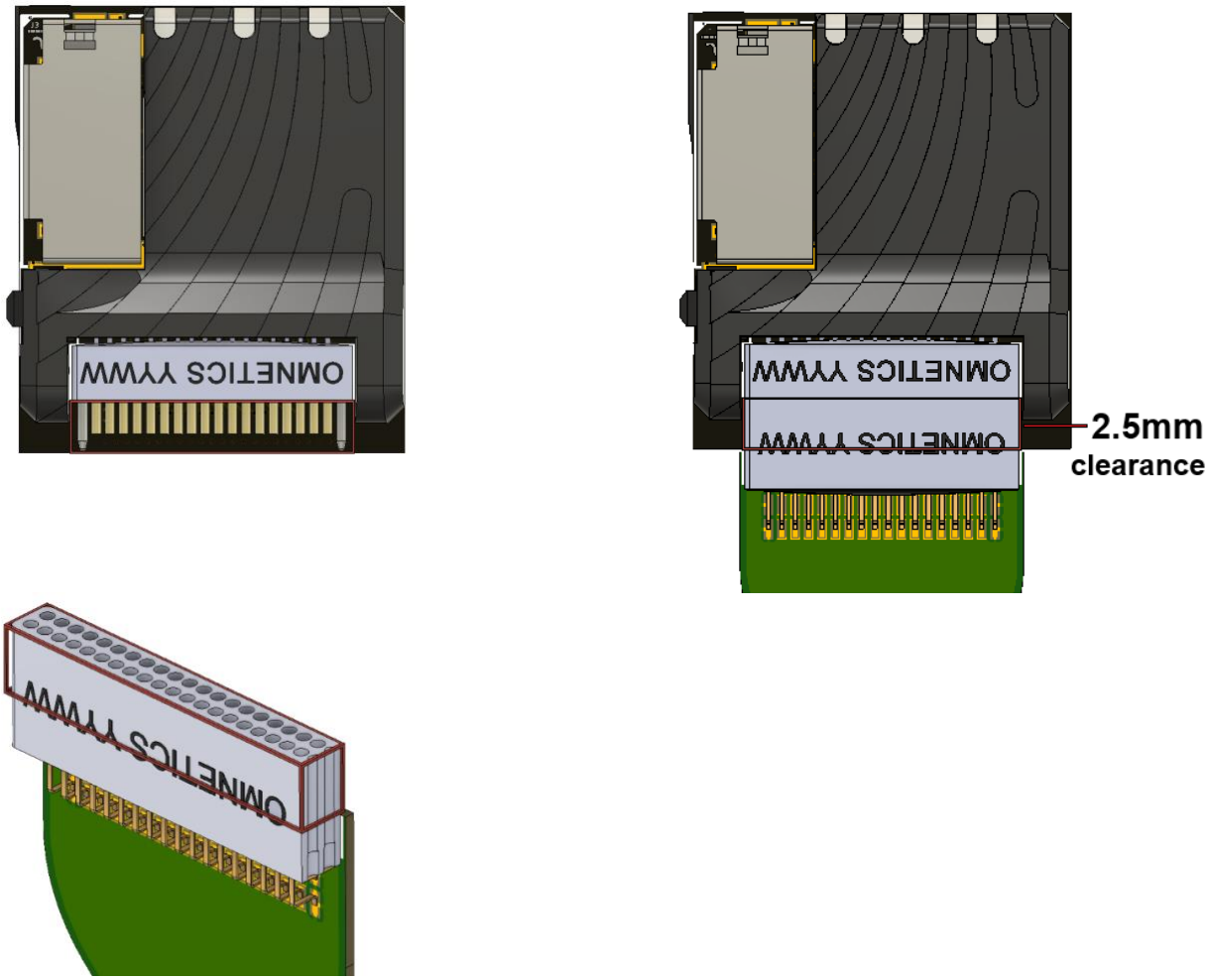


Figure 3 Top Left: *Inset of analog input connector*
Right: *Required cement clearance of connected input*
Left: *Required cement clearance on input connector without headstage*

Headstage Powering and Standby

The Sprite32 is powered on/off using the button on the left side of the unit below the SD card slot.

To power the system on, hold the button down for 3 seconds. The system will indicate power by flashing the 3 system LEDs white. The system is powered off by holding the power button down for 3 seconds. All 3 status LEDs will turn red to indicate that shut down will occur when the power button is released.

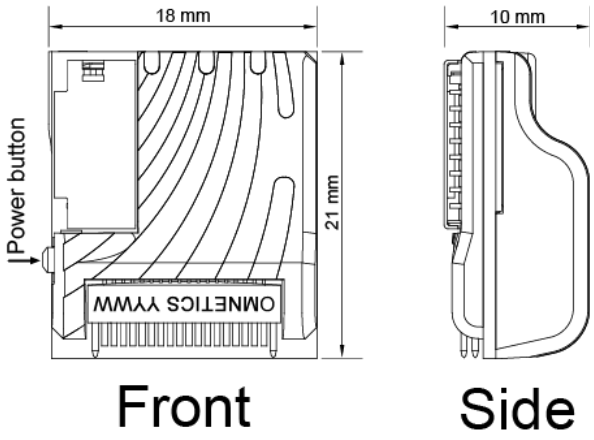


Figure 4 *Sprite32 dimensions and power button location.*

Low Power States: If the Sprite32 is powered on with less than 10% battery power remaining, the headstage's Hardware Status LED will show yellow illumination to warn the user that the battery needs to be charged. A recording cannot be initiated in this state.

To achieve maximum recording time, it is common to record until the device powers down due to battery expenditure. This does no harm to the device. It should however be noted that in some situations, this can cause recording noise for the last 20-30 seconds of a recording. Sprite32 will simply power down when a low power state is reached. Trodes reports this as a lost connection.

Standby Mode

After headstage initialization and system checks are complete, the Sprite32 enters standby mode to await commands from the Dock it has been paired with. Standby mode has been optimized for low power consumption. Leaving the headstage in standby mode for moderate periods of time will have minimal impact on the overall battery life. One hour in standby will drain ~10% of the battery, resulting in a similar percentage decrease in the overall possible record time.

Battery Health

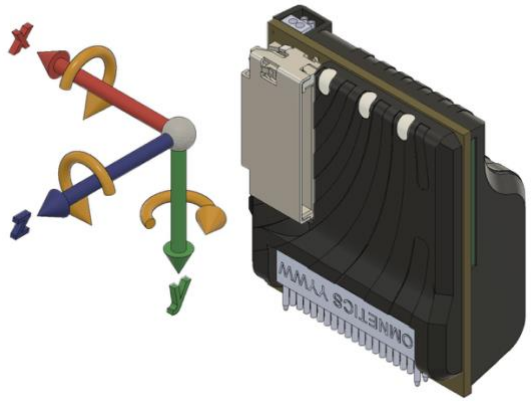
As with any lithium-based battery technology, the capacity of Sprite32's integrated battery is expected to decrease over time. To help slow this process and ensure the longest lifespan we recommend the following:

1. Avoid charging the Sprite32 for prolonged periods of time (beyond the time needed to reach a full charge).

2. Charge the battery to ~1/2 capacity before storing. Leaving the battery in a very low or empty charge state for extended periods can degrade battery capacity.

Onboard Sensors

The headstage has an integrated accelerometer and gyroscope. The diagram below shows the orientation of these sensors.



LED Indications

Sprite32 simplifies headstage status signaling and streamlines setup by displaying recording readiness for each logger system using 3 different LEDs.

Hardware Status - Indicates the overall status of the headstage hardware. This includes the hardware systems responsible for digitization and amplification, data processing, and system control.

Wireless Status - Indicates RF connection status with the Logger Dock.

SD Card Status - Indicates the SD card readiness to record. Before each session, the SD card must be enabled for recording. If the SD card is not enabled, the SD Status LED will indicate this. Data extraction and SD card enabling is discussed in more detail in a later section.

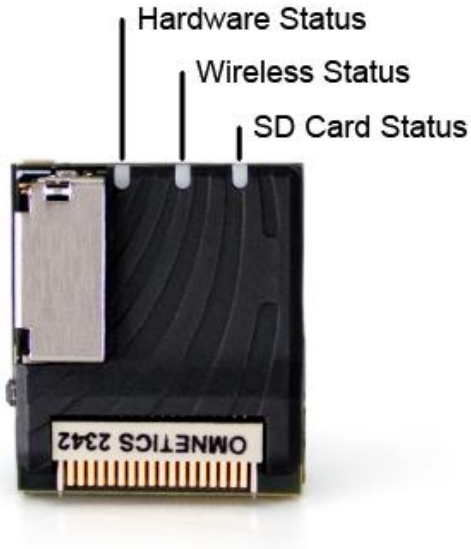


Figure 5 *Sprite32 Status*

Initialization and Startup

When the Sprite32 is powered on, all 3 status LEDs will blink white simultaneously. This indicates the headstage has completed initialization and is now in the active state. The headstage status LEDs will now report system readiness to record using the following color-coded indications:

LED Color	Hardware Status LED	Wireless Status LED	SD Card Status LED
Blue	Hardware OK	Connection to Dock OK	SD card ready
Yellow	Battery charge <10%	Waiting for RF communication from Dock	SD card not enabled for recording
Red	Hardware error detected; contact Support	-	No SD card detected **OR** SD card error

All LED must show a blue indication before a recording can be initiated. Once this occurs, the LEDS will stay on briefly, then turn off to conserve power. **NOTE:** Logger system statuses are displayed hierarchically. This means that a status issues must be resolved sequentially as follows: Hardware Status issues must be addressed before Wireless Status can be addressed, and Wireless Status must be OK before an SD Status issue can be resolved.

In practical terms, this means that if the Wireless Status LED is yellow (waiting for RF signal), enabling your SD card will not cause the SD Card status LED to change until the Wireless Connection is established.

Recording Indications

When a recording is started, all status LEDs will flash white (4x) simultaneously to indicate the Start command has been received. Status LEDs remain off for the duration of the recording. Status LEDs will flash white (2x) again when the Stop command is received. LEDs will remain off unless a hardware or SD cards state change is detected.

LED Color	Hardware Status LED	Connection Status LED	SD Card Status LED
Red	Hardware error detected; contact Support	-	No SD card detected SD card error SD card full

Headstage Charging

Sprite32 automatically begins charging when connected to a 5V USB port or Logger Dock via the Omnetics PZN to USB cable. All 3 indicator LEDs will flash white when plugged in. Charge state is indicated in blue by the Hardware Status LED. Blue LED "breathing" indicates the device is actively charging; solid blue indicates the device is fully charged.

Charging status can also be viewed in Trodes. As with any headstage status monitoring in Trodes, the Logger Dock must be connected and actively streaming for status to be viewed.

Powering on/off

Sprite32 is powered on by pressing and holding the small power button on the device for 3 seconds. The device can be powered off by holding down the same button for 3 seconds. When 3 seconds has been reached, all LEDs will turn red, indicating the device will power down when the button is released. Sprite32 can also be powered down using the Shut down button in Trodes (Seen in Fig. 6).

SD Card Setup

Before an SD card can be used for data-logging it must be enabled for recording. Once data has been written to the card, the card must be manually enabled by the user before another recording can be taken with the card. This helps safeguard against accidentally overwriting data that has not yet been extracted. Enabling the card doesn't erase the data, but it does make it possible for the data to be overwritten. This can be done using either a control unit, the DataLoggerGUI or the headstage itself.

Enabling via Control Unit

- Mount the SD card into the card reader slot on either the MCU or Logger Dock, then press and hold the left button on the front of the control unit. The indicator LED will rapidly flash red indicating the card is being enabled. When the LED turns green the card has been enabled and it is safe to release the button. (MCU requires firmware version 3.19 or later)

Enabling via DataLoggerGUI

- Mount the SD card into the card reader slot on either the MCU, Logger Dock, or a direct access card reader, then open the DataLoggerGUI application. The SD card will be listed as a storage device with the status, "not enabled for recording." Simply select the device in the list and hit "enable for recording."

Enabling via Sprite32

- To enable the SD card mounted to a paired Sprite32, simply click the "Enable SD" button in the Logger Status menu for the corresponding logger. The logger must be powered on and operating wirelessly. This feature is disabled when the logger is connected via USB. The Enable SD Global command enables all SD cards mounted to paired and connected devices. This command should be used with caution.

IMPORTANT NOTE: SD cards cannot be read or enabled by the Logger Dock while streaming, and streaming cannot be initiated while an SD card is mounted. As such, SD cards should be unmounted once they have been read and/or enabled.

2-way Radio Link

Sprite32 features headstage status and battery monitoring facilitated by 2-way radio link. This enables back-and-forth communication between the headstage and control unit. This provides detailed real-time information about the status of all connected headstages and empowers the

user to make informed experimental decisions on the fly. The Logger Status window is accessed by clicking the Remote Control button in the upper left of the Trodes interface.

Each paired and connected headstage will have its own info card in the Logger Status window, and the window will expand based on the number of connected loggers. Devices are always displayed in order based on pairing slot assignment.

Each connected logger is controlled individually using the command buttons within its designated info card (as seen in Fig. 6).
Additionally, commands can be issues to all connected devices simultaneously using the Global control buttons found at the top of the Logger Status window.

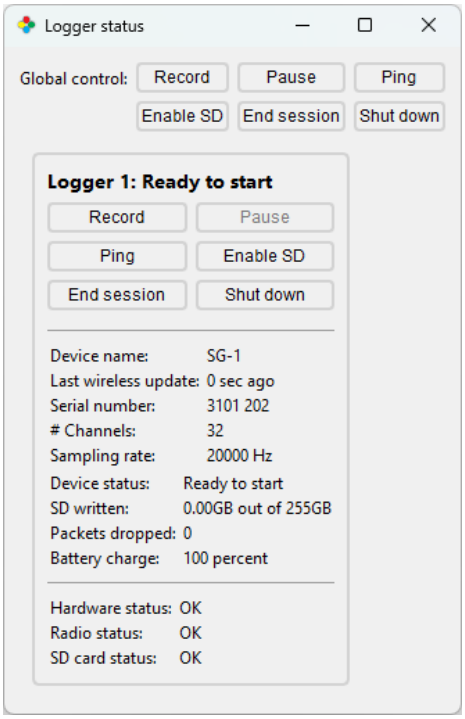


Figure 6 *Trodes Logger Status*

The headstage Ping command causes the logger's LEDs to illuminate briefly for easy visual identification of one or all connected devices with a single button press.

Headstage Pause leverages the low power standby mode to enable multiple recording epochs within a single session with minimal impact on overall record time.

NOTE: Streaming in Trodes is required for 2-way communication with the logger. This means the Dock must be powered and connected and Trodes must be streaming from source before status can be viewed or commands can be issued. Powering down the Logger Dock will immediately end the recording session for any connected devices.

Floating channel noise

When recording with Sprite32, any channels left floating are susceptible to electrical noise generated by the device itself. This is expected behavior and should not impact data acquisition as the noise is significantly attenuated when channels are connected to a recording device such as an electrode array.

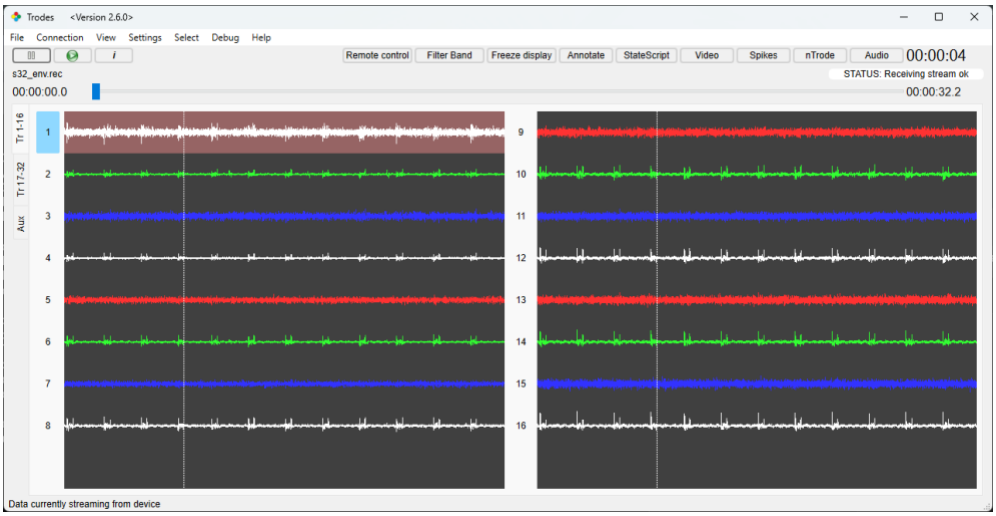


Figure 7 *Floating channel noise viewed in playback mode with spike band filter turned on. All neural channels shown are floating.*

Headstage Pairing

Initial headstage pairing requires a hardware connection with the control unit. During pairing, each headstage is assigned a specific "slot" in Trodes (1-8). The slot assignment is selected by the user and saved to the headstage for future recording sessions. Once paired, the logger will automatically be recognized by the Dock and Trodes. Slot assignment and device pairing can be updated by the user at any time.

The following hardware and software are required for 2-way Radio Link:

- Sprite32 & Logger Dock 2
- Trodes 2.6.0

Pairing and Hardware Settings

1. Open Trodes and create a new Workspace with channel count set to zero.

2. Connect Sprite32 to the Logger Dock 2 using the provided USB to Omnetics PZN cable.

3. Connect to your Dock in Trodes by selecting the following from the Connections dropdown menu:

   Source > SpikeGadgets > Logger Dock > USB

4. Open the Hardware Settings window under the Settings dropdown menu.

5. Select the 2-way checkbox and 20 kHz sampling rate from the dropdown menu under the Controller Settings heading.

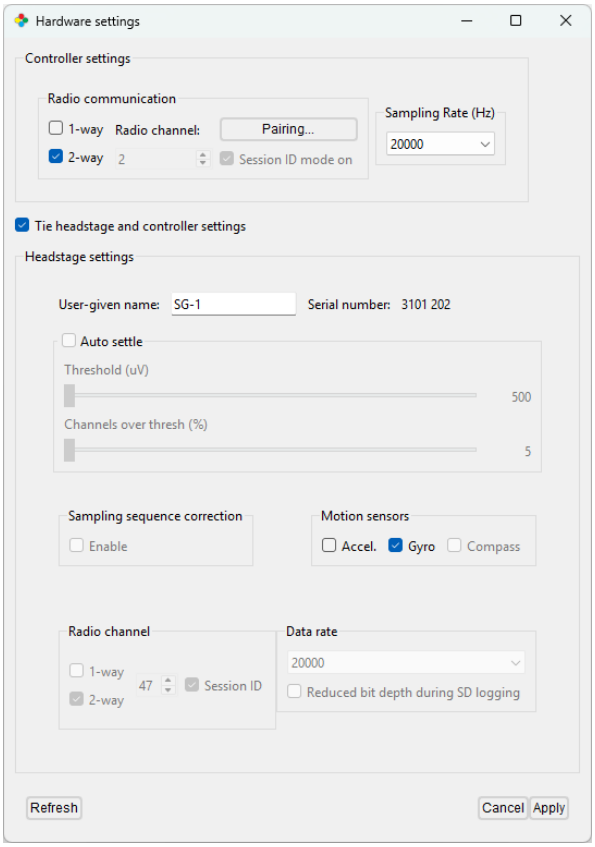


Figure 8 *Trodes hardware settings.*

6. Selecting the "Tie headstage and controller settings" checkbox is recommended as this ensures consistent settings for both the environmental and neural recordings.

7. Hit Apply to save settings to the headstage.

8. Open the Pairing menu using the Pairing button and select the preferred headstage slot by clicking Add/replace. Paired headstages can also be pinged or disconnected using this menu.

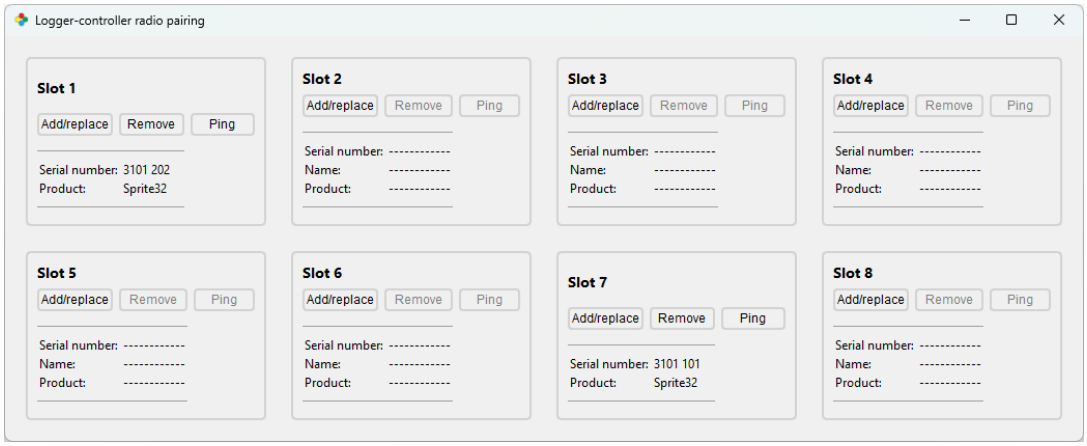


Figure 9 *Headstage Pairing menu showing all 8 available slots.*

Sprite32 can also store a User-given name. The name is saved to the logger and persists through power cycling. Headstage name can be up to 12 characters and can be changed at any time.

The Trodes hardware settings menu is used for configuring both 1-way and 2-way radio link capable headstages. As such, not all settings in the menu apply to all headstages. For instance, Sprite32 does not support Auto Settle, Sample Sequence Correction or reduced bit depth during SD logging.

Recording Workflow

Sprite32 logs neural data to removable microSD storage on the device. Environmental data are recorded by the control unit (Logger Dock 2) and saved to the local computer using Trodes. Neural and environmental data are merged and synchronized following the experiment. Once data has been merged, specific data bands such as Raw, Spike band, LFP, or environmental data can be extracted for further analysis.

Sprite32 can also be used to take multiple recording epochs during a single session using the recording Pause feature. When recording is paused, the headstage goes into low-power standby mode, minimizing the impact on available record time. The data extraction and merge process is the same as with single epoch recordings.

1. Open Trodes and create a zero channel workspace with the following settings:

    - Under Amplifier/Probe technology select “None (environmental recording only),” and set the sampling rate.

- Under the Auxiliary Display tab remove Controller_Din4-6 and add Controller_Ain1. These are the digital and analog environmental data input channels on the Logger Dock.

2. Save and open the workspace.

3. Connect your Dock in Trodes by selecting the following from the Connections dropdown menu: Source > SpikeGadgets > Dock(USB)

4. If you have not done so already, pair your headstage with Trodes using the instruction in the previous section.

5. Begin streaming in Trodes by selecting "Stream from source" under the Connections dropdown menu.

6. Click the Remote Control button on the upper left of the Trodes interface to open the Logger Status window. All headstage monitoring and command takes place here. Each headstage will automatically appear in the slot it has been paired with when connection is established.

7. Disconnect your Sprite32 from the USB charging cable, insert your microSD card and turn the Sprite on using the power button on the device. All 3 LED indicators will flash white when the device initializes. You should then see the following:

    - If all systems are ready to record, all 3 LEDs will turn blue then turn off. The device is now in standby, awaiting a command from Trodes. You should now see your device information in the Logger Status window.

    - If the Sprite32 status LEDs read BLUE, BLUE, YELLOW from left to right the SD card needs to be enabled before recording can take place. This can be done by clicking the SD Enable button in the Logger Status

    - If the Sprite32 status LEDs read BLUE, YELLOW, BLUE, this indicates the Sprite32 does not detect a control unit within range. If this occurs, make sure the Logger Dock antenna is connected, and is within range.

    - Tables including all LED indications can be found in previous sections of this manual.

8. Initiate your environmental recording in Trodes by selecting “New recording” under the File dropdown menu, then hitting the record button.

    - If you do not intend to record environmental data, this step can be skipped. Trodes must however remain streaming for the duration of the neural recording. Sprite32 will automatically stop recording if the Dock is powered down, or if streaming is ended in Trodes.

9. Initiate your Sprite32 recording by clicking the Record button in the Logger Status window.

10. To end the Sprite32 recording simply click the end session button. The environmental recording can be ended by selecting Close File in the File dropdown menu; Trodes will continue to stream.

    - To end the recording and stop streaming simultaneously, click Stop streaming from source under the Connections dropdown menu.

Synchronization

Synchronization between the environmental recording taken by Trodes on your local computer and the neural data recorded to SD on the Sprite32 is done via a 2-way radio link. Logger Dock 2 can be paired with up to 8 Sprite32 headstages simultaneously and sends sync signals at 80 Hz. The Dock sends sync signals to each headstage by cycling through each of the 8 pairing slots. This results in a 10 Hz sync signal for each headstage. Each sync signal is recorded by both the headstage and Logger Dock at the same sampling rate as the neural and environmental data.

During the data merging process, the sync signal timestamps recorded in both data files are aligned, and the sample count between signals is compared. If a difference in sample count is identified, small local adjustments are made to the environmental record to maintain alignment. This eliminates drift and results in high alignment precision throughout the merged recording.

Transferring and Merging Data

Before analysis can occur, data recorded to SD must first be extracted or merged to .rec using the DataLoggerGUI application packaged with Trodes. Extraction appends the data with Trodes workspace settings such as channel mapping and saves the data in .rec binary format. Merging combines and synchronizes the neural and environmental data using the alignment process mentioned above to produce a single .rec file containing all data.

The following files are required when merging data:

1. The neural data file recorded to microSD on the Sprite32.
2. The environmental event data file recorded by Trodes to the local computer.
3. A Trodes Workspace file to append to the merged file*. This workspace file must contain all neural and environmental data channels.

***NOTE:** This is NOT the Workspace file used to record the environmental data, but rather a Workspace that contains both environmental record settings as well as the probe and channel setting used by the headstage when logging the neural data.

Merging data with DataLoggerGUI and Logger Dock

1. Power down the headstage, remove the SD card and insert it into the SD card reader provided with the unit, or the Logger Dock.

    - While both options mentioned above work, it should be noted that data transfer is faster when using the SD card reader provided or a dedicated SD card slot on your computer.

2. Open the DataLoggerGUI application found in the Trodes application folder.

3. The Logger Dock/SD card reader will be listed under the Detected Storage Devices with storage size, type and SD card status listed.

4. Under Extract, select your .rec file and corresponding Workspace .trodesconf file, and set your extracted data directory.

5. Hit START.

More information about merging your data files can be found in the data extraction subsection of the DataLoggerGUI documentation in the Trodes Wiki.

Items Included with Shipment

Item	Description
Sprite32 Data-Logging Headstage	32-channel data logger with amplification, digitization, and SD data storage
18” USB-PZN Cable	Cable for charging and configuring the headstage

32-Channel Signal Test Board	PCB routing single input to all headstage channel for signal testing
USB-C to microSD adaptor	Adaptor used for transferring SD data logged to the headstage
Right-angle adaptor	Adaptor which allows the headstage to be mounted horziontally
SD Card and clip	SD card and retention clip
Omnetics Surgery Mask	Placed on the Omnetics connector during surgery to ensure adequate cement clearance for the logger following surgery.

About SpikeGadgets

SpikeGadgets is trying something new. Our hybrid approach is to design and sell powerful hardware that interfaces with an open-source software platform supported by a large community of scientists and developers. Our goal is to support the efforts of the open-source community in a commercially-sustainable way.

Technical Support

If you would like technical support, please email us at support@spikegadgets.com.