SpikeGadgets

HH128

128-Channel Data Logging Headstage Manual

Version 6

SpikeGadgets

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128-Channel Data Logging Headstage (HH128)

Introduction

The 128-channel data logging headstage (HH128) amplifies and digitizes 128 neural channels and either streams data to the Main Control Unit (MCU) via a cable (tethered mode) or logs it directly to a microSD card on the headstage (untethered mode). It is oriented horizontally, which means that the weight is distributed as low to the animal as possible, enabling more natural animal behavior. It also contains an integrated gyroscope, accelerometer, and radio receiver for synchronization during untethered mode.

HH128 Specifications

Channel count	128
Connector to electrode array/probe	160-pin Amphenol Lynx connector (11826-ADA). An assortment of routing boards to probes and electrode interface boards are available.
Sampling rate	30 and 20 kHz supported
Bit depth (ADC's)	16-bit and 12-bit supported
Input referred noise	2.6 µV RMS
Connector to MCU	Micro HDMI
Input range	± 5 mV
Dimensions	35mm × 22mm (footprint); 16.5mm height
Weight	10.45 grams (no battery)
Battery life	2 hours with 400 mAH battery (8.4 grams)
Sensors	3-axis accelerometer, 3-axis gyro
Radio synchronization range (during data logging)	10-20 meters

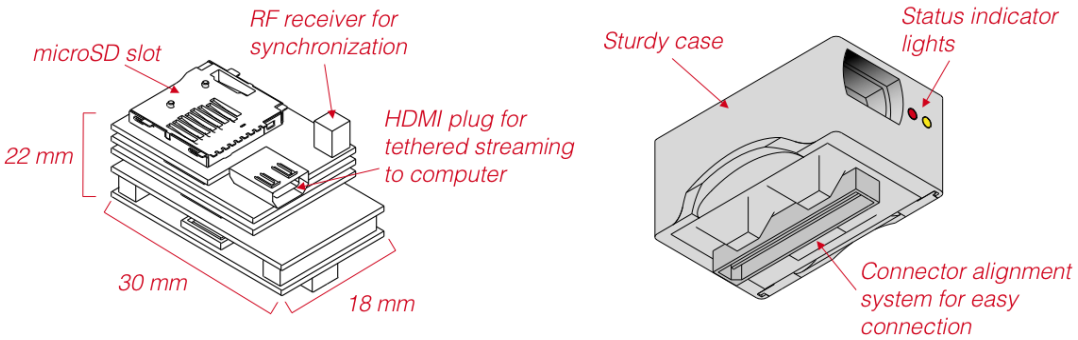

Figure 1- 128-Channel data logging headstage (HH128) diagram

Headstage Connection to Electrodes

The headstage utilizes a high-density connector (see Figure 2) with an alignment system for simple connection. Simply grip the wing tip sides of the processor and gently pull straight up to remove or press straight down to connect.

> **Note:** Connecting and disconnecting to an interface board should be done straight up/down. Do not try to connect at an angle and pry the headstage off at an angle, as this may damage the connectors.

For a demonstration of connecting/disconnecting, see the following video:

http://www.spikegadgets.com/downloads/HS128%20With%20EIB.mp4

The HH128 headstage is equipped with a 3-pin connector (Mill-max 1.27mm pitch) on the top. The outermost pins are route power and ground from the power source in order to connect an LED array for position tracking. The middle pin is a customizable I/O pin for peripheral device control.

The headstage is also equipped with two LED indicators on the side (visible through the case). These indicators are used to inform the user of system status (more details below).

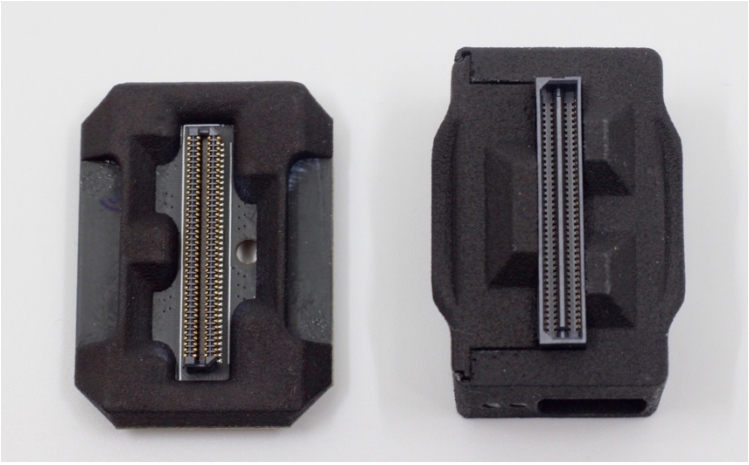

Figure 2- Hardware channel mapping of the Lynx connector- a feature that offers a simple, robust system for headstage connection.

Configuration

Tethered mode

In tethered mode, an HDMI to micro HDMI plug (see Figure 3) is used to power the headstage and stream data to the MCU. Slide the cable into the kitten case until the connector is fully inserted. If the headstage is properly detected by the MCU, the MCU power indicator will turn green. Otherwise it will blink orange. Data streaming is started using the Trodes software or the record button on the MCU (in standalone mode).

Figure 3- Micro HDMI to HDMI bent end cable for tethered mode

Headstage settings can be modified using Trodes and saved onto the headstage after it is powered off and will also be applied to untethered recordings. Settings can only be modified once a connection is made to the MCU from the computer, but not while data is actively streaming. On the HH128, the following settings are available and can be modified:

- **Auto amplifier setting.** Set a signal threshold and the percentage of channels that need to simultaneously exceed this voltage threshold in order for a 'settle' command to be triggered. This is used to prevent extended amplifier ringing after large transient events occur (stimulation or physical bumping).
- **Smart Referencing (on/off).** If the user intends to use digital referencing, then this setting is highly recommended. It eliminates temporal referencing error associated with the sequential nature at which channels are sampled.
- **3-axis accelerometer** (on/off)

- **3-axis gyro** (on/off)

Untethered data logging

The HH128 can operate without a tether, logging all data to an onboard microSD card. It utilizes a wireless link to communicate with the MCU (start/stop commands and synchronization commands are sent through the wireless link).

LED indications (untethered mode)

Figure 4- HH128 connected to 400mAH battery for untethered data logging

Light Color	Pulse	Meaning
Red	Fast	SD card is configured but not enabled
	Slow	No configuration on the SD card
	Random blip during recording	Dropped packet(s). If it happens often, consider upgrading to an SD card with faster writing speed.
Yellow	Solid	The SD card is enabled and waiting for acquisition command from wireless link.
	Blink (every 10 seconds)	Sync signal from the transceiver received

Prepare the card for recording

Trodes contains a set of helper programs to interface with the SD cards. If command prompts are preferred for more advanced SD card settings, please see the end of this manual for those instructions.

Trodes is available for download here:
https://bitbucket.org/mkarlsso/trodes/downloads/

Synchronization

Synchronization between the environmental record and the data recorded on the headstage depends on a radio signal that is sent to the headstage at regular intervals (most setups use a 10-second interval). This signal originates from SpikeGadgets' hardware (there are multiple options) that also acquires environmental data and connects to your computer. Trodes connects to this hardware to display and saves the environmental data during the recording session. If video recording is also used, the camera module set up the same way as during tethered recordings. There is not access to the neural data during the recording. After the recording session is done, there will be two files: one on the headstage SD card and one on the computer. These two files will be aligned and merged using the synchronization signals that were recorded in both files.

Recording

If a simple setup with the MCU and headstage is used, select the MCUonly_RF workspace (located in the Resources\SampleWorkspaces folder where Trodes is installed). If there is an ECU connected to the MCU for extended environmental control, select the ECUonly workspace. In either case, make sure that the SpikeGadgets radio transmitter is plugged into the correct auxiliary slot in the front of the MCU. See the hardware manual for more details. Once the correct workspace is selected, connect to the MCU. For MCUonly_RF workspace, use USB to connect to the MCU. If an ECU is connected, either a USB or Ethernet connection will work. Next, power on the headstage and make sure that the light indicators on the headstage indicate that it is ready to start recording. The system is now ready to record.

Once date begins acquiring in Trodes, the MCU will send a “start” signal to the headstage to start recording. Next, create a new recording file from the Trodes menu and start recording. When the recording session is complete, stop the recording in Trodes and close the .rec file. Then, stop acquisition (this will also stop the headstage recording) and power off the headstage. At this point the .rec file on the computer will contain the environmental record. The SD card on the headstage will contain the neural data. **Note:** the SD card on the headstage will be locked from further recording in order to protect the existing recording from accidental erasing. After data has been transferred to the computer, the card must be enabled for recording again using the transfer utility.

Transferring Data to Computer and Merging Files

The following is needed to merge to the two files into a single .rec file:

1. The file from the SD card recording
2. the .rec file containing the environmental record
3. a workspace to append to the merged file

The workspace should be the same workspace that would have been used if the recording was performed in tethered mode. **Note:** this is NOT the same workspace used to collect the environmental record. We provide a graphical utility to perform the operations of transferring data from the SD card and merging the two files here:

Data Logger GUI (https://bitbucket.org/mkarlsso/trodes/wiki/DataLoggerGUI)

Advanced SD Card Utility Configuration

Prepare the card for recording

There is a set of helper programs to interface with the SD cards. Currently, these programs require a Windows operating system, and the programs are executed via the DOS command prompt. The programs can be downloaded here:

http://www.spikegadgets.com/downloads/SDcard_filetransfer.zip

Download the compressed ZIP file and uncompress the folder in a desired location on your computer.

> **Note:** to enable maximum write speed, the datalogger does not use a filesystem on the SD card. When the card is inserted into the computer, do not allow the computer to format the card.

Open the Command Prompt as Administrator (right click on Command Prompt and choose “Run as administrator”). Then, navigate to the folder containing the SD card file transfer functions. Insert the Micro SD card into the computer (USB adaptors will usually work fine). Then, follow these steps:

1. Type “listDevices”
   This program will list all the removable storage devices plugged into the machine. It may take up to a minute for the computer to register the SD card after it’s been inserted into the machine. Keep running the listDevices program until the drive is shown. When it does, it will list the card as 'PhysicalDriveN', where N depends on how many removable devices there are. Make sure to identify correct number! This number will be referred to as 'N' below.
   Note: if you never see the card, there may be a permissions issue. In windows, you need admin permissions to run these programs (see above).

2. WriteConfig N FILENAME
   where N is defined above. **Make sure the correct number is used! This is a low-level write command and choosing the wrong number can direct the writing to the hard drive.** FILENAME is the name of the configuration file for the number of channels the headstage has. For example, a 128-channel headstage uses “config128.cfg” which is included in the file transfer folder. This function is used to write a new configuration to the SD card. This configuration defines the operating parameters of the headstage when it is untethered from the computer and logging to the SD card. The config file has 32 line entries (referring to the 32 channels of each input module), where each entry is a sequence of 8 numbers (0’s or 1’s, referring to up to the 8 possible input modules). A line entry on row 3 of 00000011 means that the 3rd channel of input modules 1 and 2 are on. In most cases, all 32 entry lines will be the same, unless you want to ignore some channels that you do not want to log. This step is done once per card.
3. CardEnable N
   This program is used to enable the SD card for recording. Once a card has been used to record data, it must be enabled again. This is to ensure that data is not overwritten before it has been extracted onto the computer.

Transfer SD recording to your computer

Once the recording session is complete, data will need to be transferred from the SD card to the computer. Plug the SD card into the computer as done above. Now, type:

extract N

This will download the data from the SD card and save it in a temporary file called ‘data.dat’.

Converting SD recording to .rec file

Once the temporary .dat file has been extracted from the SD card, the file needs to be converted into a format that is used by the Trodes suite. This means that a proper header needs to be appended to the beginning of the file the contains information about the contents. There are two ways to do this:

1. If the data does not need to be combined with a simultaneous environmental recording from the MCU and ECU, then the helper program (included in the Trodes software suite) called “sdtorec” will simply add the desired workspace info to the output file. From the command line, use the following syntax:
   sdtorec -sd [SDRECORDING.dat] -numchan [NUMCHANNELS] -mergeconf [WORKSPACE.trodesconf]
2. If the data does need to be combined with a simultaneous environmental recording from the MCU and ECU, then the helper program (included in the Trodes software suite) called “mergesdrecording” will merge the neural recording from the SD card with the environmental recording taken using Trodes. From the command line, use the following syntax:
   mergesdrecording -rec [ENVIRONMENTALRECORDING.rec] -sd [SDRECORDING] -numchan [NUMCHANNELS] -mergeconf [WORKSPACE.trodesconf]

Here is an example for the following setup:

1) 128 channel headstage with 9-axis sensor and RF sync receiver included
2) ECU and MCU data to merge with SD log

```
PATH/TO/TRODES/mergesdrecording -rec
PATH/TO/ECU/RECORDING/myRecording.rec -sd PATH/TO/RECORDING/sdFile.dat
-numchan 128
-mergeconf 128_Tetrodes_ECU_Sensors.trodesconf
```

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.