Deuteron Technologies Ltd

Electronics for Neuroscience

Using the LoggerCommand3 program

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1 The LoggerCommand Program

LoggerCommand is the main computer program used to control Deuteron's neural and audio loggers. It is used to control the settings of the logger, to start and stop recordings, and to run a variety of diagnostic functions. It is also used to control the features of Deuteron's synchronizing transceivers such as the STX4.

The exact appearance of the various screens of LoggerCommand depends on the available features of each specific neural loggers. In general, controls for features of a given logger will only appear if that logger has the feature in question.

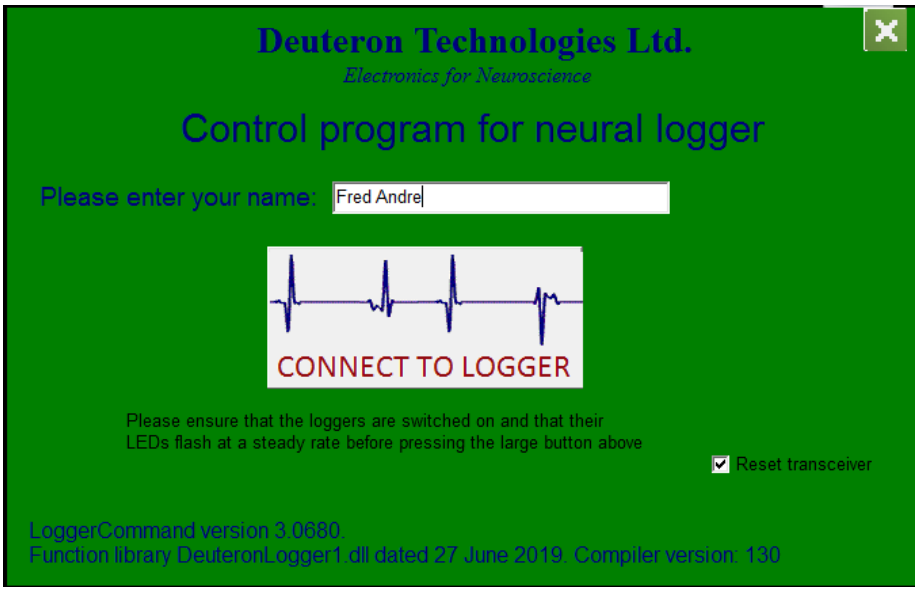
1.1 Installing the software

For instructions regarding installation of this software, see here (LINK)

1.2 Starting the Software

Clicking on the icon of the shortcut or the LOGGERCOMMAND3EXE file will start the LoggerCommand program.

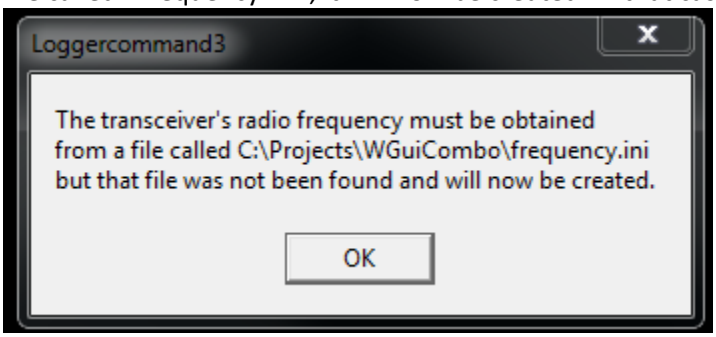
When the LoggerCommand program starts, you will see a start screen that looks like this.



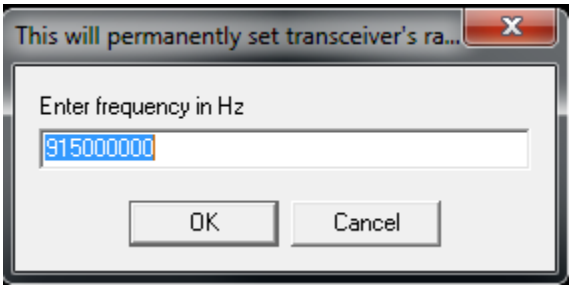
Enter your name, or at least three characters, and the large button "Connect to Logger" will appear. Press the "Connect to Logger" button.

1.2.1 Creating the "Frequency.ini" file, if absent

Frequency.ini is the name of a small text file that stores the frequency used for radio cammunication with the logger, and possibly other configuration settings, on the host computer. If you did not have a file called “Frequency.ini”, it will now be created. In that case you will see this:

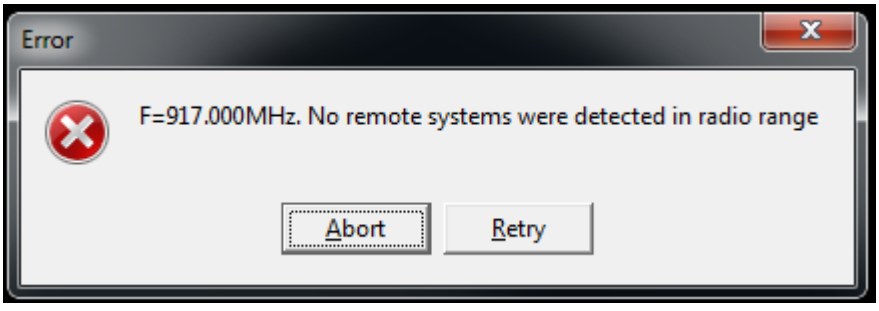


Press “OK” and you will then see this:



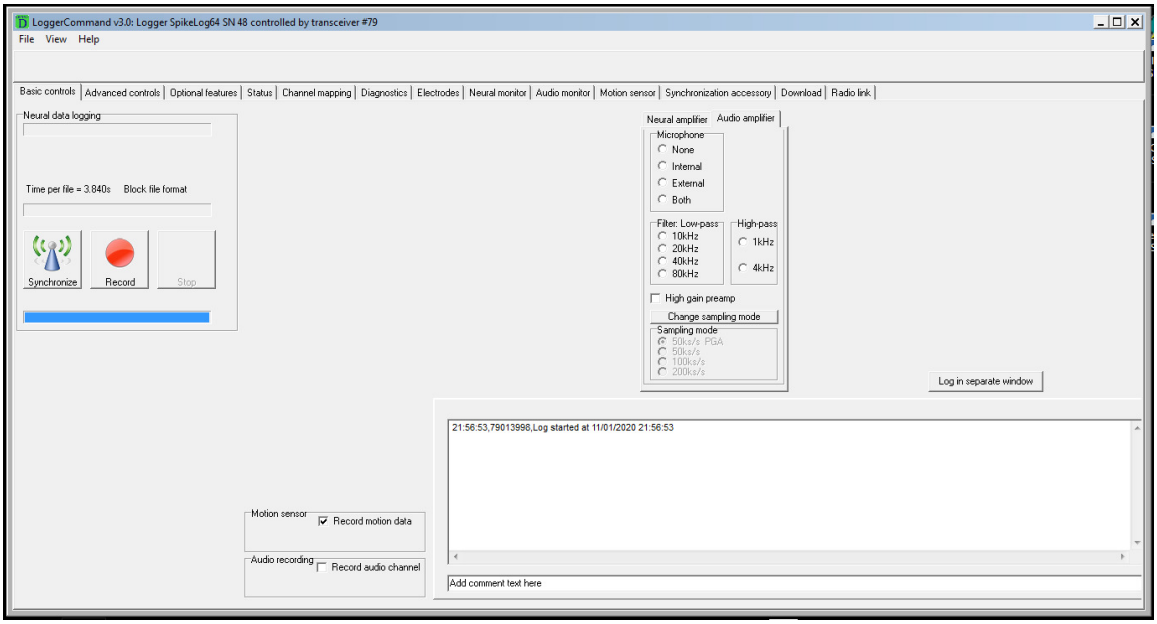
Enter the radio frequency of the logger. The default frequency in North America and Asia is 917000000 (Hz). In Europe it is 868250000 (Hz). If you are unsure of the correct frequency, please contact Deuteron. If you enter the wrong frequency, or press OK with the frequency 915000000 showing, you will not be able ot communicate with your logger. The frequency 915MHz is not usually used with Deuteron loggers. If, at a future date, you need to select a different frequency, you can manually edit the “frequency.ini” file using any text editor such as “Notepad”.

After pressing the “Connect to logger”, the transceiver will attempt to make radio contact with loggers that are switched on, within radio range, and set to the selected radio frequency. If no loggers set to the appropriate frequency are detected, you will see this:



If no logger is switched on, switch it on, wait a few seconds, until its LED flashes red at a regular rate and press “Retry”.

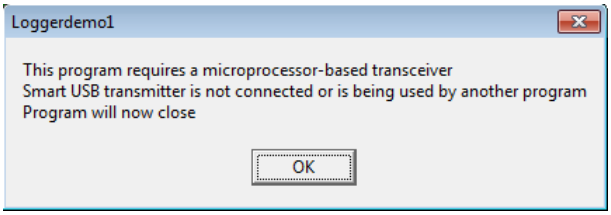
If the transceiver and logger are communicating properly, you should see something like this. The LoggerDemo program has several tabs. The tab of the Basic Controls is the one that is now visible.



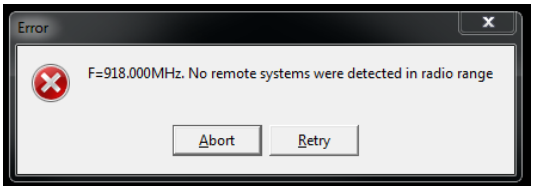
1.2.1.1 If communication is not immediately established

The message box shown below could indicate any of the following:

- The LoggerDemo program is already in use
- The transceiver is not properly connected
- The transceiver is being used by a different program
- The driver installation was incomplete



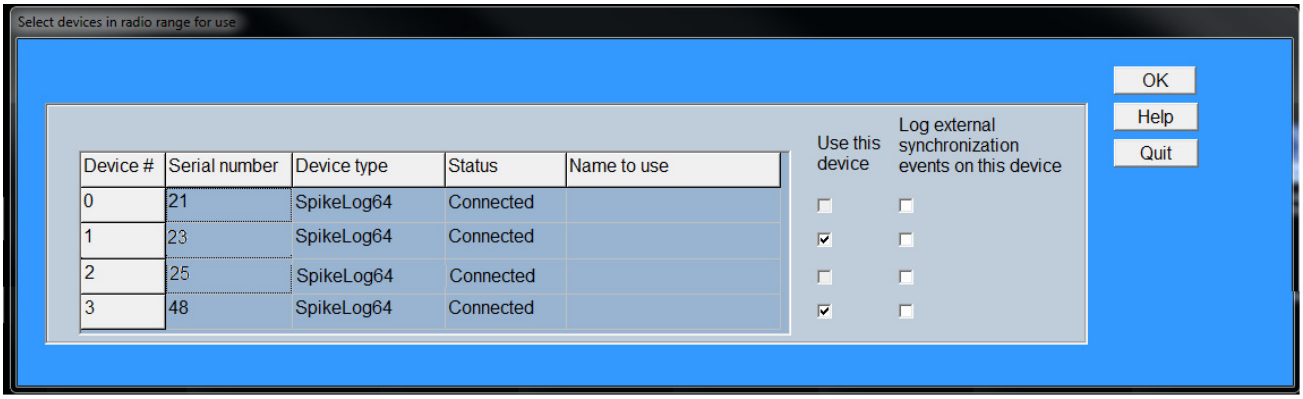
If the transceiver is connected and installed correctly, but it cannot establish radio communication with the logger, you will see the following message:



Several issues could cause this, as listed below:

- The logger might not be switched on, or its battery is discharged
- The antenna of the transceiver or that of the logger might not be attached
- The logger is too far from the transceiver, or is separated by shielding that stops the radio communications. In free space, the separation distance would have to be about 50 meters for this to happen.
- There is a strong source of radio interference in the vicinity, such as another logger using the same frequency and operating in monitor mode.
- The radio frequency setting of the transceiver and that of the logger do not match. The message above shows that the communication was attempted at 918.00MHz. The frequency at which the transceiver attempts to communicate is found in a file called “frequency.ini,” which must be kept in the same location as the executable program.

If more than one logger is switched on and is in radio range of the transceiver, you will see a screen that looks like this:

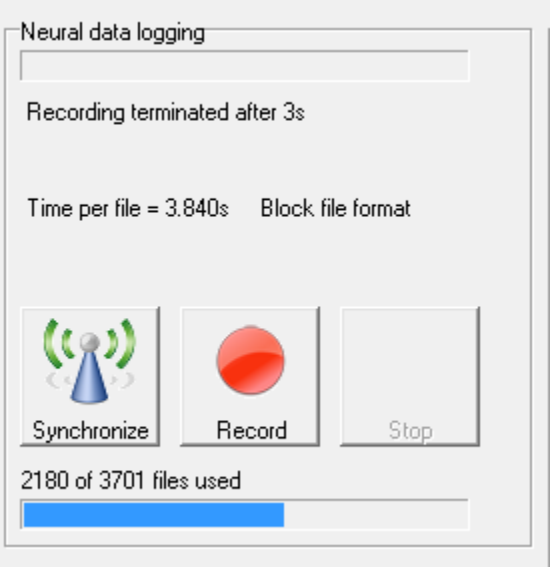


If you wish to control just one of the loggers shown, check the box corresponding to the device you want to control in both of the columns “Use this device” and “Log external synchronization events...”, and uncheck the other boxes. then press “OK”. If you wish to control more than one logger, see the chapter on “controlling multiple loggers” for more information.

1.3 The Basic Controls Tab

1.3.1 The Neural Data Logging Panel

This panel of controls is part of the basic controls tab. It holds the most basic controls for recording neural data:



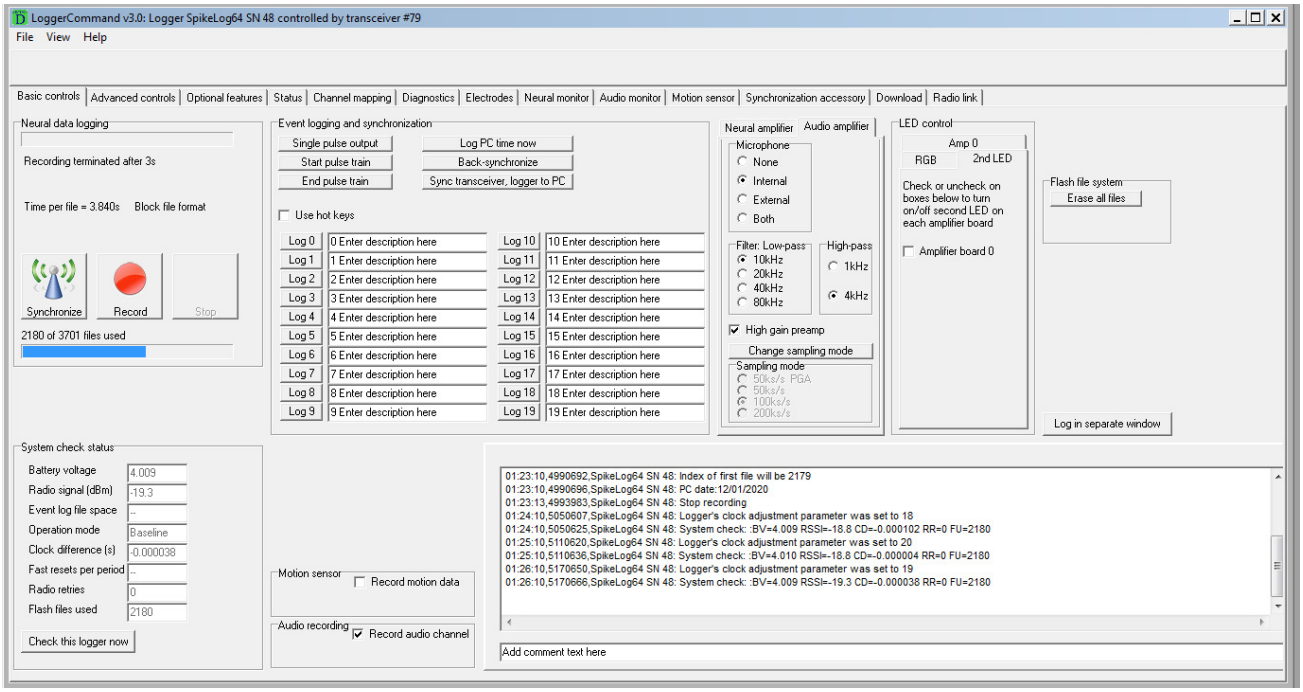
1.3.1.1 The Synchronize Button

Pressing the “Synchronize” button does the following:

- The clock of the logger and that of the transceiver are synchronized to each other and to the clock of the host computer
- The host computer reads the all the control settings of the logger and the transceiver, and displays them as states of corresponding controls in the main control panel.
- The standard system tests are executed. See sections xxxx and 1.4.1xxxx for details
- The full set of controls become visible, thereafter the main control panel appears as shown below

If you are controlling more than one logger, see details for the action of the Synchronize button under “controlling multiple loggers”.

These operations should take about one second to complete. Once this is complete, all the controls in the Basic Controls tab should appear, and it will appear as shown below.



This tab of the LoggerDemo program is the one that will be visible most often when operating the logger, and has all of the principal controls on it. These will be described in the following section in greater detail.

1.3.1.2 The Record Button

At this point it is possible to start a neural data recording session by pressing the “Record” button

When this button is pressed, all the processes described above that occur when “Synchronize” is pressed are executed, and about one second later, when they complete, the neural recording begins. When neural recording is in progress, the signals present at every input are continually amplified and digitized and the results are continually stored in files inside the logger’s main memory.

1.3.1.3 The Stop Button

Pressing the stop button ends a recording session. During a recording session, neural data are recorded, sequentially filling data files of 16Mbytes (16777216 bytes) each. A recording session always begins at the start of a new file, but the recording session ends as soon as the stop button is pressed. Thus generally, the last file of a recording session contains some space that contains no recorded data. During

the recording session, data is written to the main flash memory in pages of 64 kilobytes, and this corresponds to a few milliseconds of recorded data. Thus whenever a recording session is stopped, for any reason, only a few milliseconds of recorded data is lost. This is true for any reason, even if the logger is suddenly turned off, or if the battery becomes discharged.

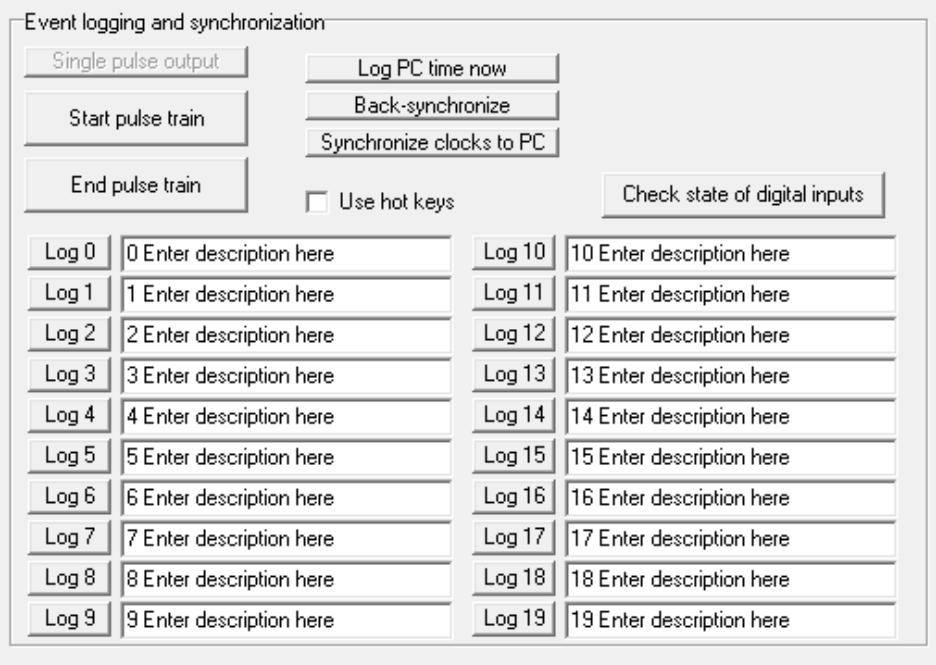
1.3.1.4 Other items in this panel

This panel also displays:

- The duration of the present recording
- A grow-bar showing the proportion of the total number of files used
- The amount of time that it takes to fill one 16MB file of recorded data
- A grow-bar showing the number of files in the present recording. Note that this is an estimate made by the host computer based on time. The actual number of files used is indicate in the area showing the results of the periodic checks. In general these should be the same. If they differ, and error windwo will display.
- The file format used. There are two possible file formats, flat file format or blcok file format.
- A stats message after recording stops.

1.3.2 The Event Logging and Synchronization Panel

This panel is part of the Basic Controls tab and allows one to control several synchronization features.



1.3.2.1 String logging fields

There are twenty spaces in which one can enter a short text. When the adjacent button is pressed, that text is sent by radio link to the logger and is logged, together with a time-stamp, both in the memory of the logger and in the "local log" of the host computer. The most normal usage of these fields is to prepare texts that describe behavior of the animal, (for example: "On hind legs", "found food", "nose

poke") and to press the button when that behavior is observed. In order to make logging such events even quicker, you can check the "Use Hot Keys" box, and then press on one of the keypad keys A to T to save the time spent manipulating the computer mouse. Note that the hot keys only work when the check-box is the control on which the computer mouse has been most recently clicked (the "Active control"). In that case, there will be a dotted line around the check box.

1.3.2.2 Start and Stop pulse train buttons

Pressing these will start or stop the pulse output train or the IRIG timing signal train, as defined in the Synchronization accessory tab.

1.3.2.3 Single Pulse output button

Pressing this button fires a single digital output pulse as defined by the "Single pulse output button function" panel in the Synchronization accessory tab.

1.3.2.4 Back-Synchronize Button

Pressing this button will set the clock inside the synchronization accessory according to the clock inside the logger. See under clock synchronization section **Error! Reference source not found.**.

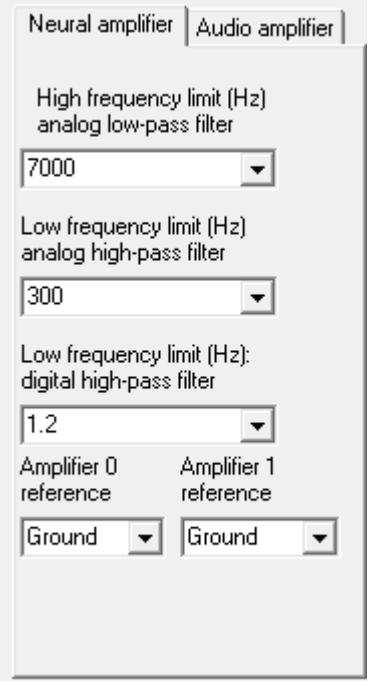
1.3.2.5 Log PC Time Now button

Pressing this button reads the time of the host computer and sends it to be logged by the logger.
Synchronize Clocks to PC Button

Pressing this sets the logger's clock and that of the synchronization accessory to that of the host computer. Its effect is the same as that of the large "synchronize" button but its action is quicker since it only synchronizes the clocks but not the hardware settings. This function is not available when a recording session is ongoing.

1.3.3 Digital neural amplifier control panel

Instruments with a preamplifier that has an integrated analog-to-digital converter (ADC) will display a control panel for the preamplifier that appears as follows



This panel allows you to control the analog low-pass and high-pass filters of the preamplifiers, as well as the electrode source of the analog signal reference.

The low-pass filter that determines the high-frequency limit of the preamplifier is implemented with a 3-pole analog filter. The high-pass filters that determine the low frequency limit each use a single-pole filter. One high-pass filter is implemented as an analog filter function that is part of the preamplifier. The other is a digital filter that acts on the digital signals coming from the analog-to-digital converter prior to their storage or transmission over the radio link. It is always possible to implement further numeric filters when processing the recorded data. It is generally preferable not to set these analog filters too close to frequencies that may be of interest, but rather to use digital filtering on the recorded data and there are two main reasons for this:

a) Once analog filters remove signal frequency components, the recordings will lack those components and nothing can be done to restore that information

b) The analog filters will cause some distortion to signals that contain strong frequency components close to the cutoff frequency.

On the other hand, you should use analog filtering if you think that without filtering the signals prior to amplification, you may cause saturation of the preamplifiers.

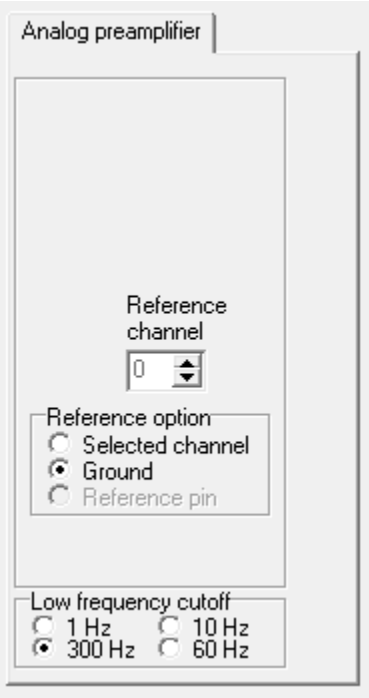
1.3.3.1 Reference Selection

On each headstage you can select a variety of options for the reference signal. Analog circuitry subtracts the reference signal from all other inputs of a headstage prior to amplification, so this is one way for removing unwanted common-mode signals. If you can make single ended recordings, that is, recordings

with the reference set to “Ground” without risk of saturation of the preamplifiers, this will often be preferable in situations where the electrode impedances are high, since the use of a differential input will cause the random noise to be increased by about 40% (a factor of √2).

1.3.4 Analog neural amplifier control panel

Deuteron’s smallest loggers, particularly those with 16 or fewer neural channels, have amplifiers ICs and a separate ADC. For such loggers, the control panel for the preamplifier appears as follows:

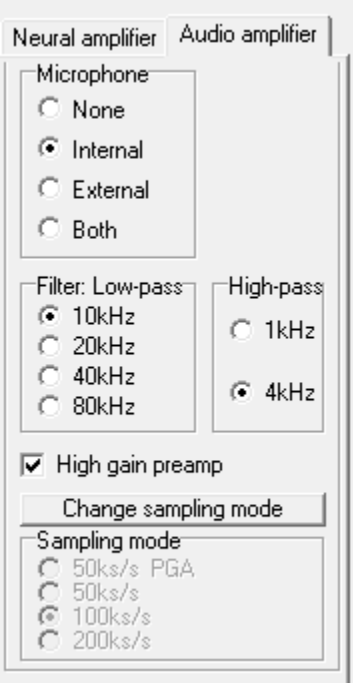


Select a suitable low-frequency cutoff (high-pass filter) using this control. Note that the analog filters here are first-order filters, so the cutoff is not particularly sharp. When in doubt, or close to the limit of a filter it is advisable to select a broader bandwith. For example, if signals around 70Hz may be of interest, it would be better to choose the 10Hz setting rather than the 60Hz setting.

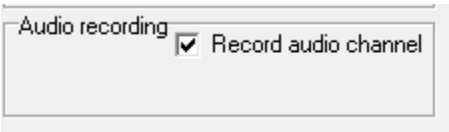
This panel also controls the selected reference channel. See the “Reference Selection” above for details.

1.3.5 Audio amplifier control panel

Instruments that can record audio and ultrasonic signals will display the panel for controlling the audio amplifiers as shown below. If the logger can record both adio and neiral signals, the two panels will be in selectable tabs, as shown.



The Microphone selector selects whether the on-board ("internal") microphone is used, or whether an externally connected microphone is used. It is also possible to select "both", in which case a weighted sum of the signals of the two sources is recorded. If you chose "none", no signal spource is selected, but data is still recorded. This is only used for testing the noise level of the neural preamplifier and would not usually be used in actual experiments. To turn off audio recording, uncheck the box marked "record audio channel" that is near the bottom of the main control tab and is not part of the audio amplifier control panel.



The Low-pass filter control selects which analog low-pass filter is used to couple the microphone's preamplifier to the ADC. Control of this filter and the sampling rate of the ADC are independent. In general, one would use the 10Khz filter with a sample rate of 50ks/s and likewise the 20kHz with the 100ks/s sampling rate and the 40kHz or 80kHz filter with the 200ks/s. This ensures that the sampling rate is higher by a reasonable factor (2.5) than the Nyqist frequency. The Nyquist frequency is defined as half of the sampling rate. The low-pass filters are generally 4^{th} order, but see the specific specification manual for the logger used for greater detail.

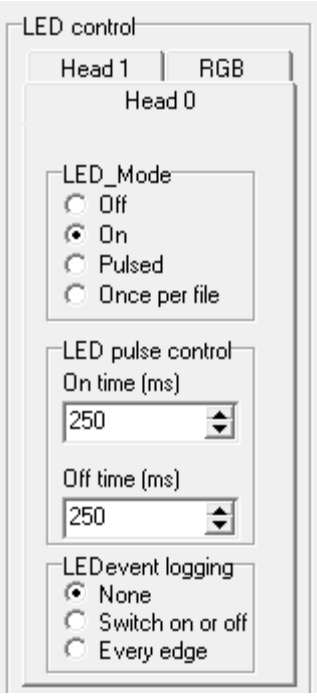
The high-pass filter determines the lower limit of frequencies of signals from the microphone that will be amplified. A lower or higher limit can be selected. The exact frequencies of the high-pass filter are often customized for a particular researcher's needs, so these may differ from those displayed here.

The preamplifier has two levels of gain, typically differing by a factor of 6.5. It is recommended to select "High gain preamp" unless the audio is very loud and amplifer saturation has been observed.

To change the sampling rate, press the “change sampling mode” button and select the desired sampling rate. Note that this will not take effect immediately. In order to activate the new sampling rate, one must re-start the logger and the LoggerCommand program.

The AL2 audio logger is not a neural logger but a dedicated audio logger. It offers the use of a programmable-gain amplifier (PGA) that precedes the ADC. Other loggers that record audio do not offer this feature. With the AL2, the PGA is only selectable at the 50ks/s sampling rate.

1.3.6 The LED control Panel



Different loggers offer differing LEDs, and the controls for these will vary according the specific hardware being controlled. Some loggers have one or two pairs of omnidirectional LEDs that can be used for camera tracking and synchronization. The LEDs of each pair are placed on either side of the circuit board, opposite each other, so that their combined light is viewable from almost all angles. On systems with separable amplifier boards, one LED pair on each amplifier board offers controlled flash-timing patterns, and LED switching events can optionally be logged. This panel has one tab for each controllable LED, with controls for the on and off time of each. If you select “once per file”, the LED will light for exactly one second every time a new neural file is started.

Many loggers also offer a multicolored LED with internal red, green and blue LEDs. You can control the color of this LED or switch it off using the RGB tab.
One further way that the LED can be used is to estimate the speed of an animal’s movement from individual photographs or video frames. If the LED on time is significantly less than the camera’s effective exposure time, then the speed of the animal can be estimated by dividing the length of the streaked image of the LED divided by its on-time, which is accurately controlled.

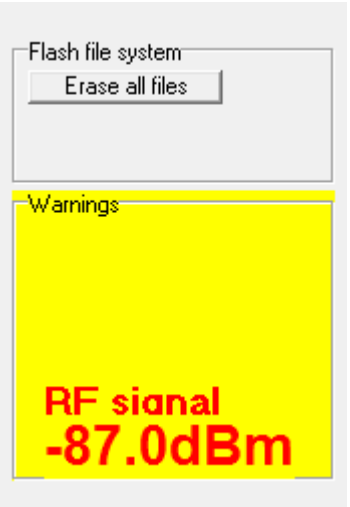
1.3.7 Flash File System Panel and Error Warning Area

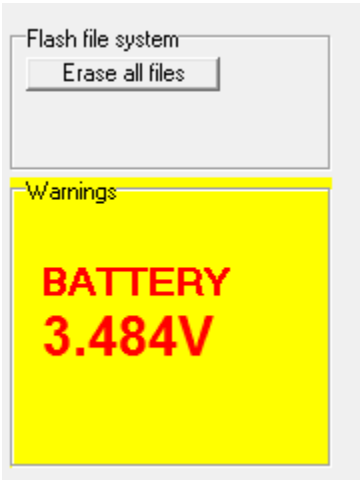
Normally, there is just one button visible in this area:

Press this button to erase all the files on the memory card and start a new even log file. This is the ***only*** way that one should erase the data on a file. When preparing a memory card for the first time, the procedure is:

1) Obtain a memory card of a type recommended by Deuteron Technologies
2) Use FAT32FORMAT.EXE to format the card with 128 sectors per cluster
3) Use the "Recover file table" facility (Advanced control tab)
4) Use this button to erase all files

This area also holds the warning area used to catch the user's attention if the radio signal is unusually weak or the battery voltage is unusually low. A brightly colored warning appears in this area. It will also appear in the same place on other tabs of the user interface. For example, if the radio signal is weak, or the battery is nearly discharged, you will see warnings like those shown below:





1.3.8 Local Log Area

This area shows the “Local log”, that is the log of the events that are initiated by the host computer or by the synchronization accessory. As such it is not a copy of the log of events that is stored by the logger: Some local events are not sent to the logger to be logged there, and some events that occur on the logger are not sent back to the host to be logged in the local log.

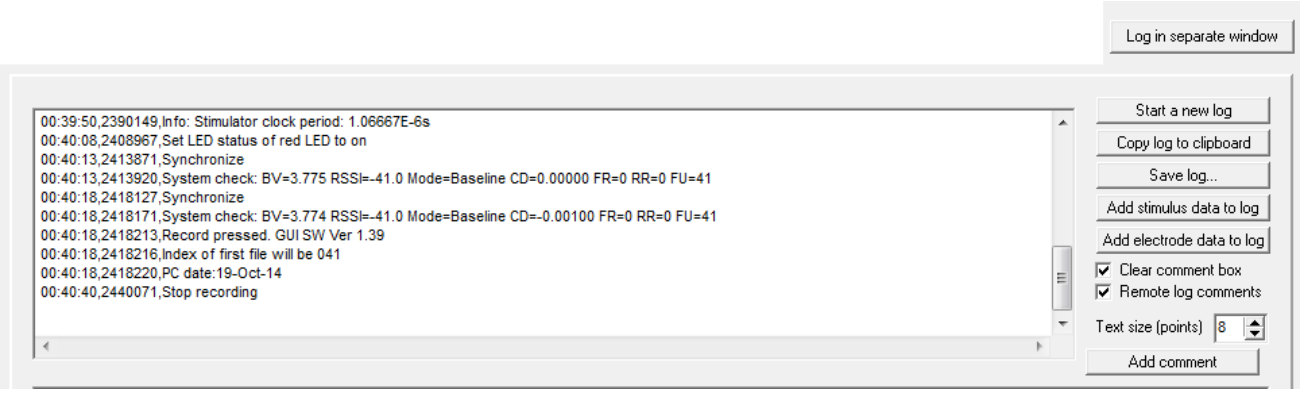
The local log provides a useful way to keep track of changes to settings and the general conduct of an experiment.

You can add a line of text to this log by entering it in the blank field below the main text area.

All lines in the local log start with a timestamp: the hours, minutes and seconds, a comma, and the number of milliseconds since midnight. These times are taken from the clock on the synchronization accessory.

You can move the entire local log area to a different window that you can then re-size, by pressing the button marked “Log in separate window”.

The other controls in this area, such as the buttons marked “Start a new log” and “Save log” refer to actions on the local log, not the log of events stored on the logger.

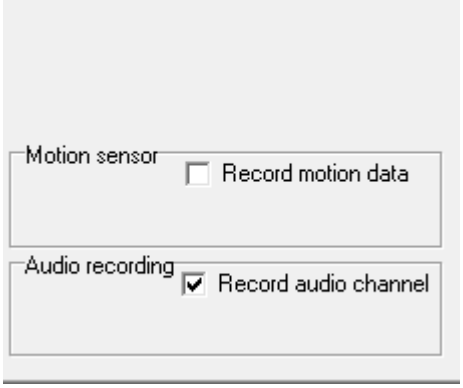


Additional data can be added to the log by pressing the buttons to the right of the log window. You can also save a log to a text file, or copy its contents to the Windows clipboard. At any time, you can add text to the local log without it going to the logger’s event file by typing it into the space at the bottom of the screen and pressing “Add Comments”. Three asterisks (“***”) will be added before and after such comments.

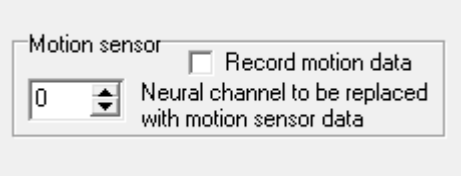
1.3.9 Activating additional types of sensor

If your logger supports additional types of sensor, such as ultrasonic audio recording, or recording of data from motion sensors, you need to select whether data from these sensors will be included in the recording. Note that in some cases, using such sensors does increase the battery consumption. Loggers that use older “flat” file format can only record data from additional sensors by replacing the data from one or more neural electrode channels, in which case you will need to specify the neural channel to be replaced. Loggers using the newer “Block” file format will record all neural channels alongside the additional sensors without need to replace neural channels

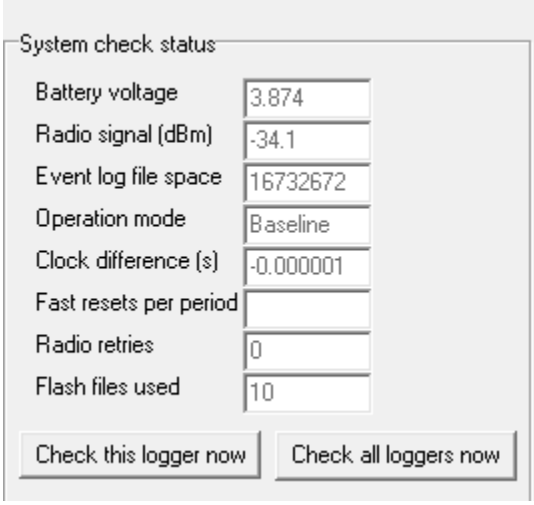
The controls below are those use to enable the additional sensors.



When using a logger that uses “flat” format, the control will appear as shown below. Note that ultrasonic audio recording is not supported by the flat file format.



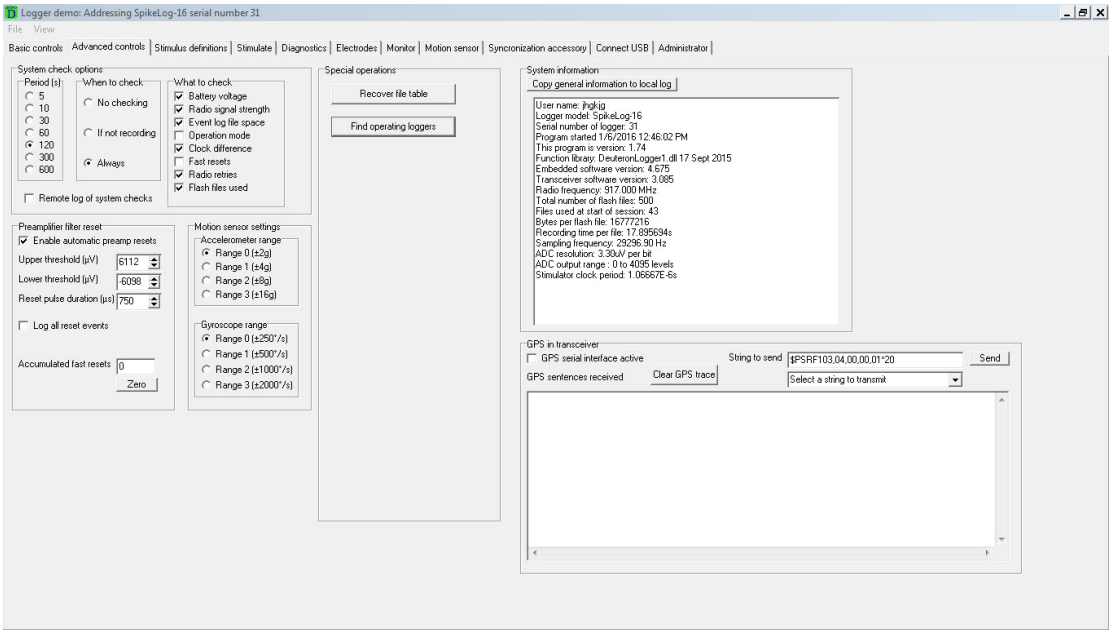
1.3.10 System Check Status Panel



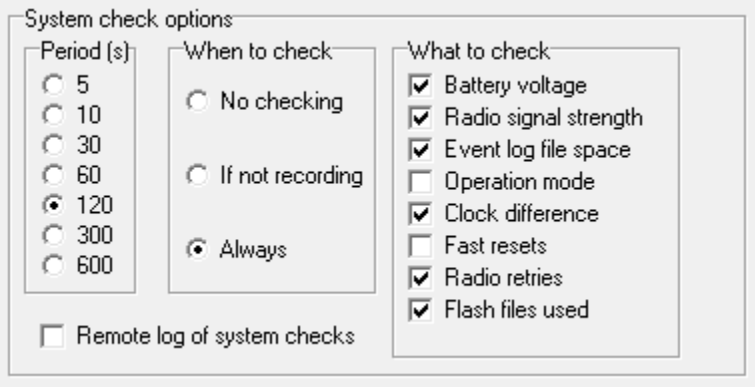
This panel shows the results of the most recent system check. This is a check of 8 important parameters of the system. You can initiate such a check by pressing “Check this logger now”, or you can schedule automatic system checks by using the “System check options” panel of the “Advanced controls” tab. (See section 1.4.1). You can also chose which parameters to include in a system check using the “System Check Options” panel of the “Advanced Controls” tab.
When controlling several loggers with a single transceiver, an additional button appears marked “Check all loggers now”. Pressing this will check each active logger in turn.

1.4 The Advanced Controls Tab

Additional controls for the logging system exist on the Advanced controls tab:



1.4.1 System check Options Panel



This panel allows you to control when the general system checks are conducted, and which of the parameters are included in these checks. If the "Remote log of System Checks" box is checked, then the results of each check will be recorded as a text string in the logger as well as the local log. The format of such a string is, for example, as follows:

```
System check: BV=3.726 RSSI=-38.5 Mode=Baseline CD=-0.00100 FR=0 RR=0
FU=43
```

The abbreviations used are:

BV: Battery voltage in Volts.
RSSI: Radio signal strength indicator in dBm (Decibels relative to 1mW)
CD: Clock difference in seconds: Logger clock time minus transceiver clock time
FR: Number of "Fast Reset" events. See section **Error! Reference source not found.**
RR: Number of radio retries. This counts the number of times that how many times a radio message had
to be repeated since it arrived with digital errors .
FU: The number of data files used so far, out of the total capacity of the SD card.

1.4.2 Special Operations Panel

This has some buttons that allow the user to conduct special operations.

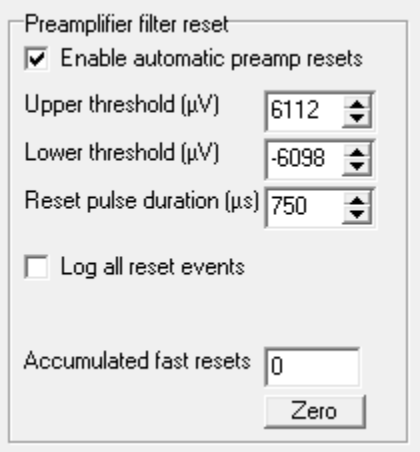
1.4.2.1 Recover File Table Button

In the unlikely event that the file allocation table (FAT) in the logger becomes corrupted, this button will restore the FAT to allow recorded data to be recovered. The FAT might become corrupted if a host computer attempts to write data to the logger. As mentioned elsewhere, data files should only be copied from the logger to a computer, and no attempt should be made to edit, erase, re-name etc any data files on the SD card. Doing so could potentially corrupt the FAT table. Pressing this button will restore the FAT table to a state where it contains all of the data files, even if only a smaller number of data files were recorded. All other files will contain all binary "1"s (0XFFFF in hex). The restored files will have default file names and arbitrary date-stamps, but the event log file will remain intact, so the times can be obtained from there.

1.4.2.2 Find Operating Loggers Button

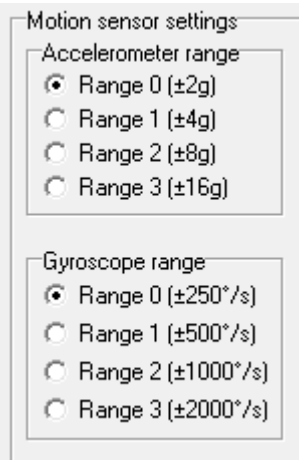
Pressing this button will check how many other loggers are switched on within the same radio range and using the same communication frequency.

1.4.3 Preamplifier Filter Reset Panel



This panel provides control for the fast-reset facility. This is generally useful only when using the 1Hz low frequency bandwidth limit. If a signal (generally an animal-generated artifact) causes a sudden and strong shift of the signal baseline, such that it may take a while for the signal to reach a level where it will not saturate the preamplifiers, the logger can perform an automated “fast reset” operation in order to speed up restoration of the signal baseline. You can use this panel to control the thresholds at which such an operation will be triggered, and whether such events are logged on the logger. Note that such events do not appear in the local log. In addition, the total number of such events is accumulated in the counter shown, and pressing the appropriate button will reset this accumulated total.

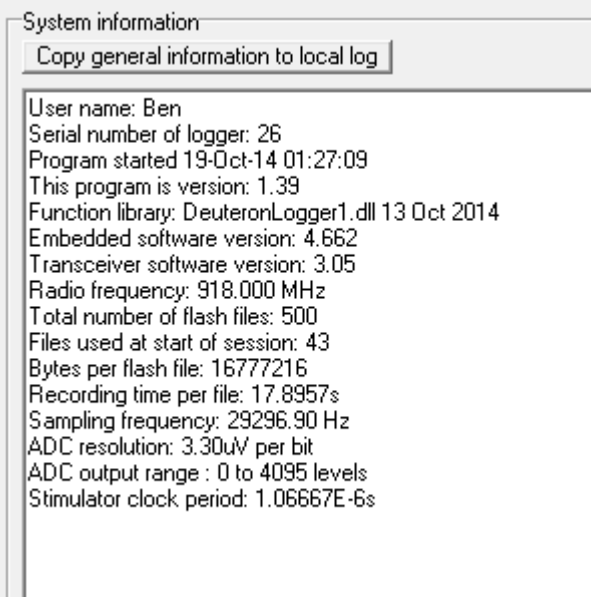
1.4.4 Motion Sensor Settings Panel



This panel is only displayed if the motion sensor is implemented.

The panel allows the user to set the ranges for the accelerometer and the gyroscope functions of the motion sensor.

1.4.5 System Information Display Panel



Some important general information, such as software version numbers, is shown in this panel. It is useful to copy and paste this information to any enquiry concerning the system. You can also copy the information to the local log by pressing the appropriate button.

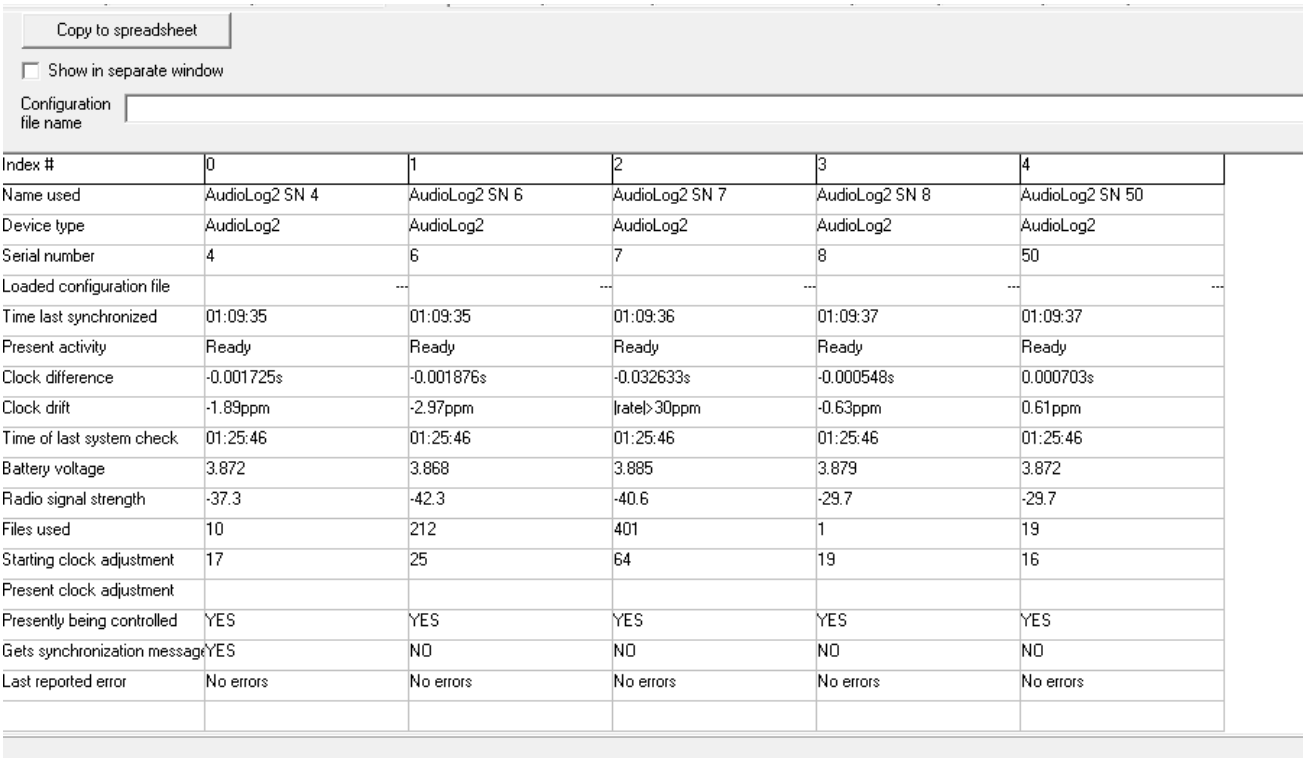
1.5 Optional Features Tab

Some loggers have optional features whose settings are controlled by controls on this tab

1.6 Status Tab

When using multiple loggers at the same time, this tab provides a table that allows you to view the some important status variables of all the loggers in one place, without need to select the tab for each logger in turn.

A typical view of the Status tab is shown below.



Index #	0	1	2	3	4
Name used	AudioLog2 SN 4	AudioLog2 SN 6	AudioLog2 SN 7	AudioLog2 SN 8	AudioLog2 SN 50
Device type	AudioLog2	AudioLog2	AudioLog2	AudioLog2	AudioLog2
Serial number	4	6	7	8	50
Loaded configuration file	---	---	---	---	---
Time last synchronized	01:09:35	01:09:35	01:09:36	01:09:37	01:09:37
Present activity	Ready	Ready	Ready	Ready	Ready
Clock difference	-0.001725s	-0.001876s	-0.032633s	-0.000548s	0.000703s
Clock drift	-1.89ppm	-2.97ppm	Irate\>30ppm	-0.63ppm	0.61ppm
Time of last system check	01:25:46	01:25:46	01:25:46	01:25:46	01:25:46
Battery voltage	3.872	3.868	3.885	3.879	3.872
Radio signal strength	-37.3	-42.3	-40.6	-29.7	-29.7
Files used	10	212	401	1	19
Starting clock adjustment	17	25	64	19	16
Present clock adjustment					
Presently being controlled	YES	YES	YES	YES	YES
Gets synchronization message	YES	NO	NO	NO	NO
Last reported error	No errors	No errors	No errors	No errors	No errors

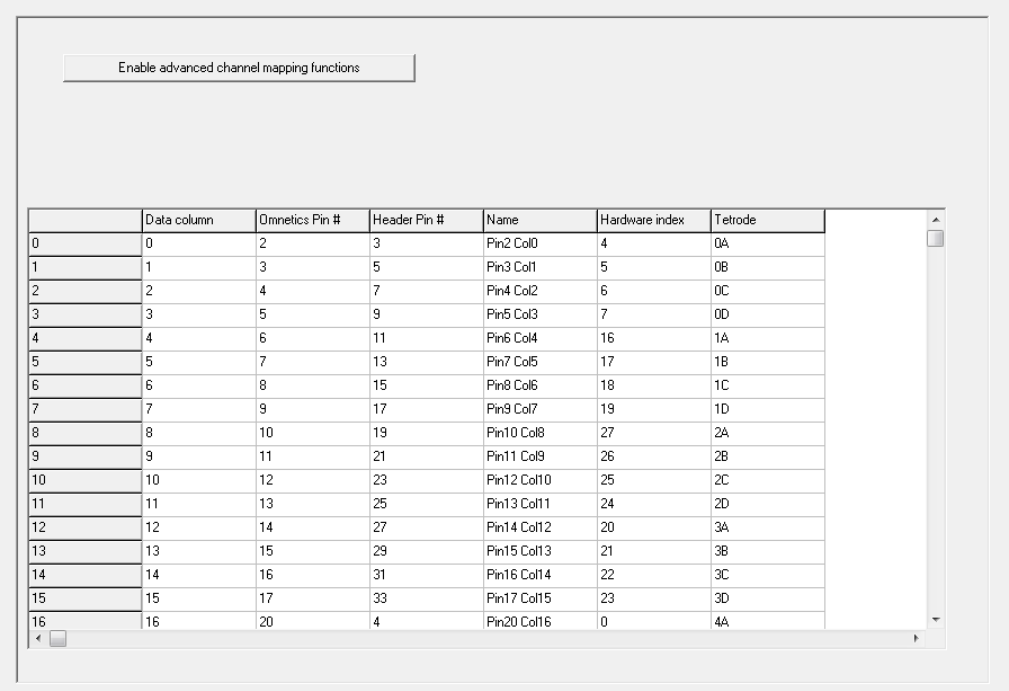
1.7 Channel Mapping Tab

The channel mapping tab provides features for viewing and changing the relationship (mapping) between the pins on the neural connector of the headstage and the order in which the neural channels are sampled and stored on the memory card. The columns of data stored on the memory card always follow the exact order in which the neural channels are sampled. However, the logger can be configured to scan the neural input pins in any desired order.

In general, there is no need to change the configured order; whenever a logger is matched to a particular headstage, it is configured to scan the pins of that headstage according to a logical default mapping such that the pins of one row of the connectors pins are scanned in order, then the second row is scanned in the same order. You may wish to change the mapping for any of the following reasons:

- You wish the mapping to match that of a different electrophysiology system that you use.
- You change from one kind of head-stage to another kind that has a different hardware mapping
- You need to digitize some channels at double the usual sampling rate (64kHz), while other channels need not be digitized at all

If you do not need to change the mapping of your system, then you may still need to view the Channel Mapping in order to understand the mapping order that your system uses.

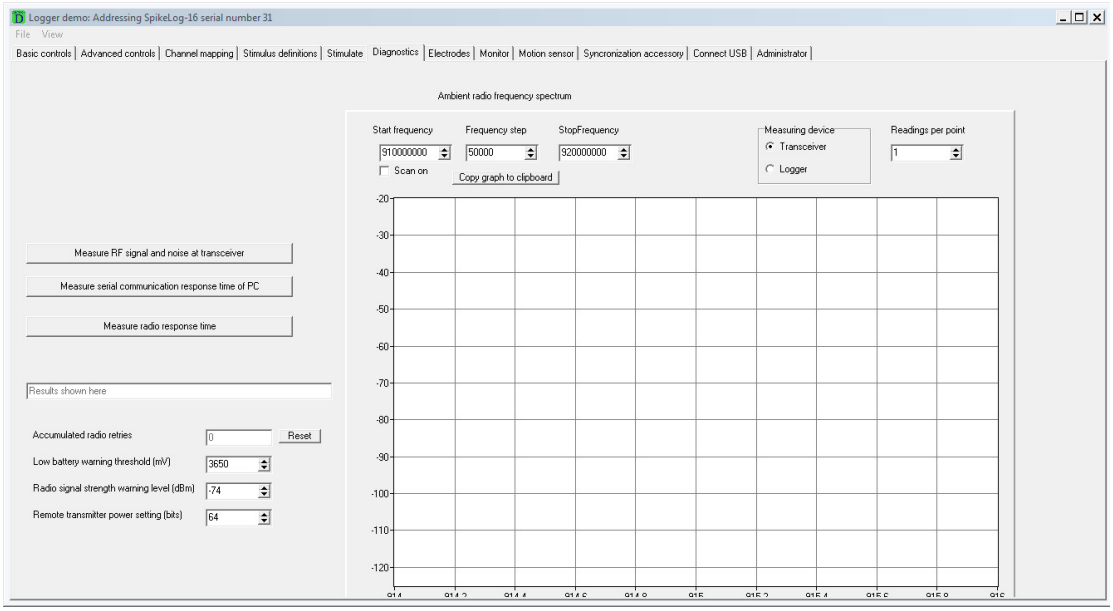


	Data column	Omnetics Pin #	Header Pin #	Name	Hardware index	Tetrode
0	0	2	3	Pin2 Col0	4	0A
1	1	3	5	Pin3 Col1	5	0B
2	2	4	7	Pin4 Col2	6	0C
3	3	5	9	Pin5 Col3	7	0D
4	4	6	11	Pin6 Col4	16	1A
5	5	7	13	Pin7 Col5	17	1B
6	6	8	15	Pin8 Col6	18	1C
7	7	9	17	Pin9 Col7	19	1D
8	8	10	19	Pin10 Col8	27	2A
9	9	11	21	Pin11 Col9	26	2B
10	10	12	23	Pin12 Col10	25	2C
11	11	13	25	Pin13 Col11	24	2D
12	12	14	27	Pin14 Col12	20	3A
13	13	15	29	Pin15 Col13	21	3B
14	14	16	31	Pin16 Col14	22	3C
15	15	17	33	Pin17 Col15	23	3D
16	16	20	4	Pin20 Col16	0	4A

The channel mapping tab shows a table of the system's channels. Note the column marked "Data column" shows the order in which the neural channels are scanned, which is the same as the order of the columns of stored data on the memory card. The channel numbers go from 0 to 31 or 0 to 63. The next column shows the number of the corresponding pin on the Omnetics connector of the headstage, using the Omnetics pin numbering convention as shown in section **Error! Reference source not found.**. The Omnetics pin numbering convention is different from that generally used for numbering the pins of a 2-row header connector in the electronics industry. See the image in section **Error! Reference source not found.** for clarity.

1.8 Diagnostics Tab

Some diagnostics facilities and a few advanced settings are provided under the diagnostics tab. In general you will not need to use any of these. However, it you are experiencing difficulties, some of the provided diagnostics tests may prove useful. A very short description of these follows.



1.8.1.1 Measuring the radio signal at the transceiver

If you press the button marked “Measure RF signal and noise at transceiver”, you will get a measurement of the signal strength received by the transceiver from the logger. The normal radio signal strength indicator measures signals received by the logger. An SNR of about 50dB is normal for a 6m separation between the transceiver and logger

1.8.1.2 Measuring the serial communication latency of the PC

Pressing the button marked “Measure serial communication time of PC” will measure and indicate the time to send a command between the PC and the transceiver, using the USB link that emulates a serial communication device. Some systems report about 3ms, others about 15ms, though both operate the logger normally.

1.8.1.3 Low battery warning threshold

This control allows you to specify the logger battery voltage below which the bold low-battery warning indicator shows.

1.8.1.4 Radio strength warning threshold

This control allows you to specify the transceiver Rx radio signal strength below which the warning indicator will show.

1.8.1.5 Radio transmitter power setting.

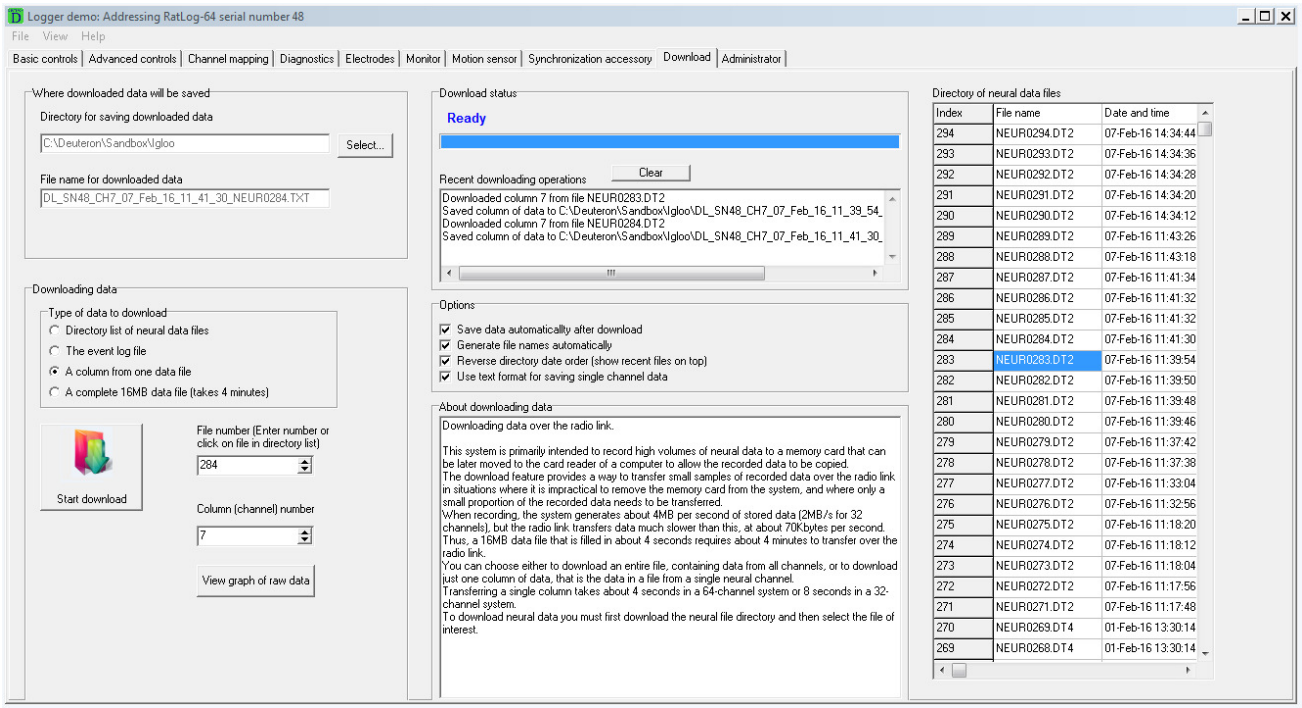
This setting can take values from 1 to 64 and has a non-linear relationship to the strength of the radio transmitter of the logger. In some circumstances, it is desirable to reduce the transmitted signal strength, especially if several loggers are used in adjacent laboratories at the same frequency.

1.8.1.6 Ambient radio frequency spectrum analyzer

The spectrum analyzer can be useful for detecting frequencies at which there is strong radio interference. Small peaks at frequencies that are multiples of 15MHz, like that shown, are normal, and come from the internal electronics of the system. Enter the start, step and end frequencies in the appropriate places. If you select more than one reading per point, the spectral sweep will proceed more slowly, which may help to catch occasional interfering radio bursts. If you are not sure how to interpret an ambient radio spectrum, copy the graphic by pressing the “copy graph to clipboard” and send it to Deuteron together with a description of the environment and the problems encountered.

1.9 Download Tab

The RatLog-64 neural logging system is primarily intended to record high volumes of neural data to a memory card that can be later moved to the card reader of a computer to allow the recorded data to be copied. The download feature provides a way to transfer small samples of recorded data over the radio link in situations where it is impractical to remove the memory card from the system, and where only a small proportion of the recorded data needs to be transferred.
When recording, the system generates about 4MB per second of stored data (2MB/s for 32 channels), but the radio link transfers data much slower than this, at about 70Kbytes per second. Thus, a 16MB data file that is filled in about 4 seconds requires about 4 minutes to transfer over the radio link.



There are four types data that can be downloaded.

- The directory list of stored neural files
- The event log file
- Data from one channel of one neural file
- A complete 16MB neural data file

You can only download data from neural files after downloading the directory list, so generally, when using the download feature, the first thing to do is to select “Directory list of neural files” from the “Downloading data” panel and then press the large “Start download” button. After a couple of seconds, the file directory will appear on the right side of the screen.

To download a complete 16MB data file select “A complete 16MB data file” in the “Downloading data” panel. Select the file of interest either by clicking on the appropriate line in the directory, or by selecting the number of the file under “File number”. Remember that the last file on the list will generally be only partially filled with recorded data, so if you want to see recent data, it is best to look at the second latest last file, not the very latest one. Again, press the larger “Start download” button to start the large data transfer. When the data is being transferred, you will not be able to select a different tab. When the download is complete, the 16MB binary file should be saved on the PC. If you have selected, under “Options” to “Save data automatically after Download”, the data will be saved using the file name and directory that you have specified in the top-left area of this sheet. Otherwise, you will be prompted to specify the directory and file names and then press “save” in the “Save-as” window.

It is much quicker to download the data from just one channel, in which case you should select “A column from one data file” in the Downloading data” panel, select the file number and the channel number, and press the large “Start Download” button.

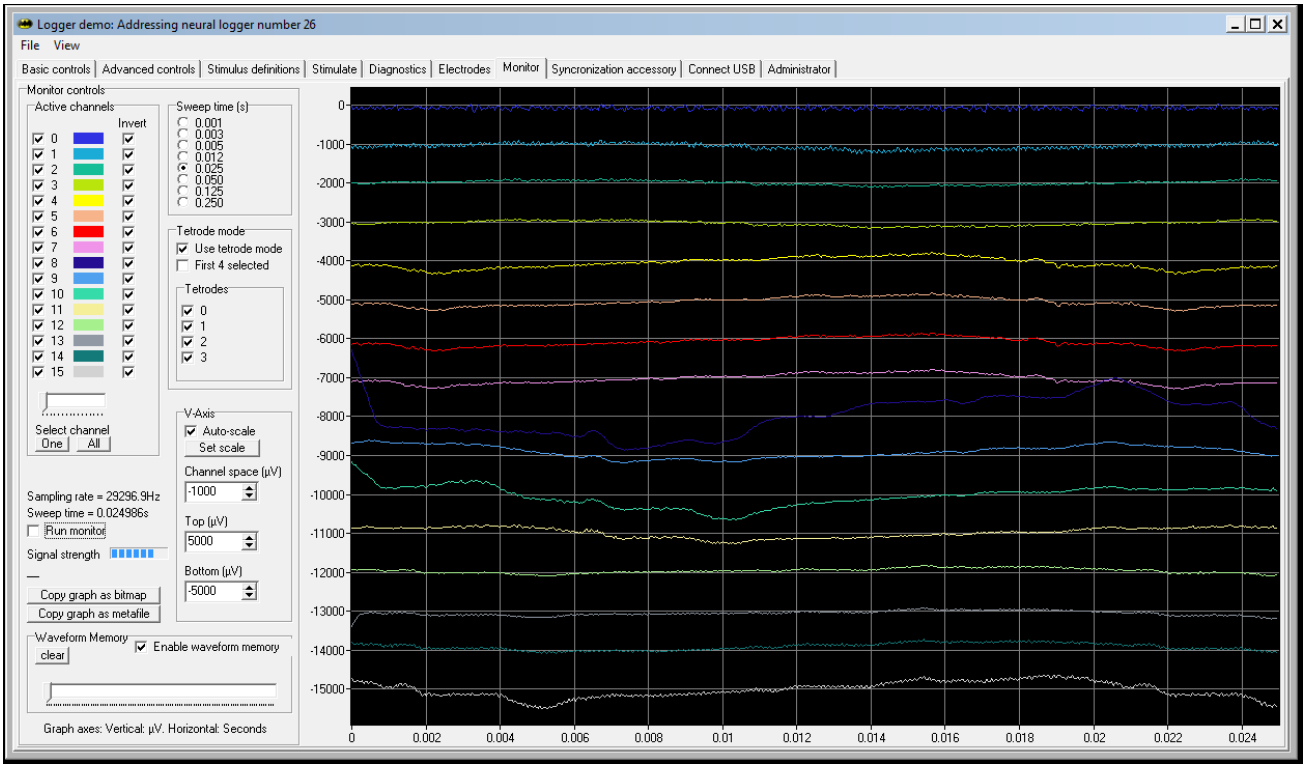
Although the Event Log File is also 16MB, it can be downloaded much faster than a neural data file because the file is generally only partially filled.

1.9.1 Tetrode groups of electrodes, control panel

Use this control to define groups of 4 neural electrodes that constitute a tetrode. These definitions are only used in monitor mode in situations where you wish to scan the signals from one or more tetrodes.

1.10 The Neural Monitor Tab and Audio Monitor tab

The monitor mode is a method of viewing live neural signals to ensure that the system is operating and connected correctly before starting to make a neural recording.



Before entering the monitor tab, ensure the system is synchronized by pressing the large “Synchronize” button under the Basic Controls tab. To start (or stop) the monitor, check (or uncheck) the “Run Monitor” check box. When the monitor is not running, you can change its settings, including:

- The sweep time
- The channels selected for monitoring
- The channels whose signals are to be inverted
- Whether tetrode or single channel mode is to be used

You can change the graph scaling at any time.

1.10.1 Zooming and panning the monitor display

If you stop the monitor, you can zoom into a part of the display by dragging a rectangle around the area to be enlarged using the left mouse button. To un-zoom, click anywhere on the graph. You can pan the enlarged area by pressing <Ctrl> and dragging using the mouse with the left button pressed.

1.10.2 Waveform memory

If you click the “Enable waveform memory” button, successive frames of recorded data will be kept in the computer’s memory. When the live monitoring is halted, you can review these frames by sliding the bar in the Waveform memory panel”. As you do so you will be able to see the timestamp for each frame, as well as the time difference between it and the last frame recorded. To clear the memory, press the “clear” button. If more than 50MB of computer memory has been allocated for waveform history, the computer will stop storing waveform frames.

1.10.3 Monitor Menu

If you right-click the mouse on the monitor display, you will get a pop-up menu that allows you the following functions:

- Monitor in a separate window. This allows you to move the monitor onto a separate window, which is especially useful if you have a second screen connected.
- Show or hide the monitor controls
- Copy the monitor display as a metafile (vectors) or a bitmap (pixels)
- Edit the palette of colors used for the monitor display

1.10.4 Monitor mode: some further details

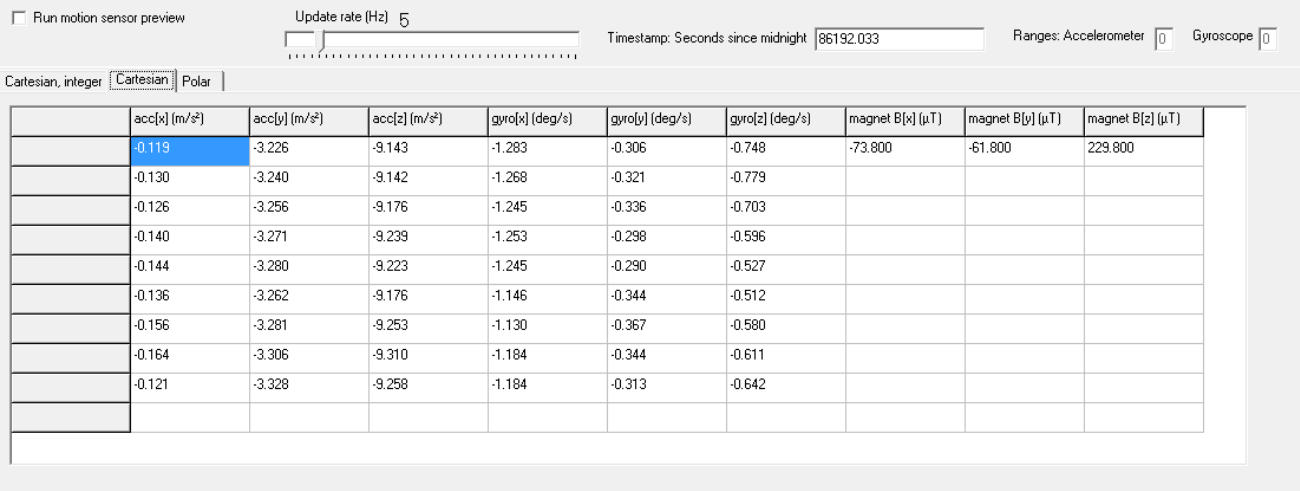
Since the system is not designed to be a full telemetry system, only a small subset of the live neural data stream can be viewed live.

There are two modes of operation: Single trace mode or tetrode mode. In the single trace mode, each channel is sampled for the sweep time and then displayed, then the next enabled channel is sampled and displayed. In tetrode mode, four channels are measured and displayed simultaneously. Tetrode mode sweeps are limited to sweeps of shorter duration than single trace sweeps.

When in monitor mode, the radio settings are different to those used during recording. The transmitter power is lower and the data bandwidth is higher. The signal strength is shown by the length of a bar marked “Signal strength”. If the strength becomes weak, the monitor activity will usually be temporarily suspended with a red indicator showing “Weak radio Signal”. In some circumstances, the monitor will switch itself off by un-checking its own run-monitor check-box.

In monitor mode, very full use is made of the radio link. This means that more than one device in the vicinity, using the same frequency, will not be able to communicate simultaneously, if one of them is in monitor mode. To resolve this, the devices must either use different frequencies or reduce their transmitter power.

1.11 The Motion Sensor Tab



	acc[x] (m/s²)	acc[y] (m/s²)	acc[z] (m/s²)	gyro[x] (deg/s)	gyro[y] (deg/s)	gyro[z] (deg/s)	magnet B[x] (µT)	magnet B[y] (µT)	magnet B[z] (µT)
	-0.119	-3.226	-9.143	-1.283	-0.306	-0.748	-73.800	-61.800	229.800
	-0.130	-3.240	-9.142	-1.268	-0.321	-0.779			
	-0.126	-3.256	-9.176	-1.245	-0.336	-0.703			
	-0.140	-3.271	-9.239	-1.253	-0.298	-0.596			
	-0.144	-3.280	-9.223	-1.245	-0.290	-0.527			
	-0.136	-3.262	-9.176	-1.146	-0.344	-0.512			
	-0.156	-3.281	-9.253	-1.130	-0.367	-0.580			
	-0.164	-3.306	-9.310	-1.184	-0.344	-0.611			
	-0.121	-3.328	-9.258	-1.184	-0.313	-0.642			

This tab is only displayed if the motion sensor is implemented.

The tab controls the motion sensor preview. As with the neural data monitor, not all data is displayed. The rate of update of the displayed data can be controlled with a sliding control both during and between previews. The timestamp displayed is read from the logger, and the displayed indices of the accelerometer and gyroscope ranges are described and controlled in the Advanced Controls tab.

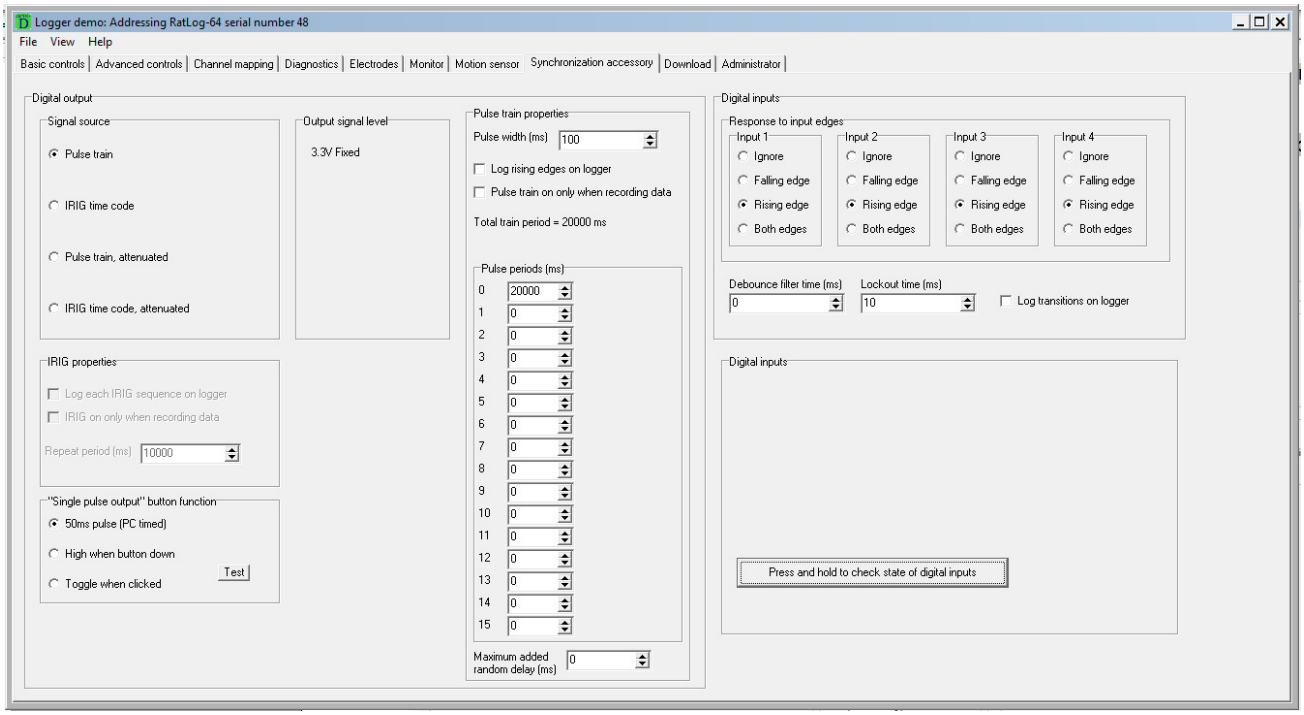
The data displayed consists of 8 or 9 rows of accelerometer and gyroscope data, measured at 1 ms intervals, and a single line of magnetometer data. This data can be displayed in any of three formats, “Cartesian, integer” which displays the raw data, “Cartesian” which presents the data in Cartesian coordinates in SI units, and “Polar” which presents the data in polar coordinates in SI units.

(On rare occasions there may be no magnetometer data for a single update. This is because the magnetometer data is measured every 9 ms and the update reflects slightly less than 9 ms of data).

The motion sensor preview is started by clicking on the “Run motion sensor preview” box. The preview can be stopped by clicking the box again or by exiting the Motion Sensor view (pressing another tab).

1.12 The Synchronization Accessory Tab

This tab is used to control the synchronization functions of the STX4 transceiver unit. This version of the synchronization accessory has four digital inputs and one digital output.



This tab is divided into two halves. The left panel controls the digital output while the right panel relates to the four digital inputs.

1.12.1 Digital output control

The left side of the tab contains all the controls for the digital output, except for the start and stop buttons, which are on the Basic Controls tab.

1.12.2 Signal source Selection

The digital output can either be a programmable pulse train or it can be an IRIG serial pulse time marker. In either case, the output can either be a TTL-compatible logic signal with 0 and 3.3V logic levels, or it can be an attenuated version of that signal, with a controllable signal level from 10mV to 2V in 8 steps. The attenuated digital signals can be useful when they are to be fed into analog data acquisition systems.

1.12.3 Pulse train properties panel

This panel allows you to define a repetitive digital output stream of up to 16 pulses. All pulses will have the same width, but you can define up to 16 different pulse periods. A pulse period is defined as the time difference between the rising edge of one pulse and the rising edge of the next pulse. Once the programmed pulse train has completed, it starts again from the beginning.

1.12.3.1 Randomized pulse periods

If you wish you can add a uniformly distributed random period to each pulse. The random part of each pulse will be randomly selected from any integer number of milliseconds up to the maximum specified.

For example if a programmed pulse train is set to have two defined periods of 1000ms and 2000ms, and the “maximum added random delay” is set to 100ms, then the first pulse will be randomly selected between 1000 and 1100ms and the second will vary between 2000 and 2100ms.

1.12.3.2 Log rising edges on logger

If this check-box is checked, then every rising edge of every pulse will result in a radio message going out to the logger and that event being logged on the logger. Note that pulse periods less than 500ms are not logged.

1.12.3.3 Pulse train on when recording data

There are two basic ways to control when the pulse train is generated. If the “Pulse train when recording data” box is checked, then the pulse train will be on automatically whenever neural data are being recorded. Otherwise, the pulse train is started or stopped by the two buttons on the “Event logging and Synchronization” panel in the Basic Controls tab. These are marked “Start pulse train” and “End pulse train”.

1.12.4 IRIG properties

The synchronization box generates serial time signals according to the IRIG-J2 specification. Unlike the original IRIG time codes IRIG-J2 is fully compatible with standard UART serial ports on a variety of instruments and computer systems. The code is transmitted at 2400 Baud, using 1 start bit, 7 data bits, one odd parity bit and one stop bit. The 17-character sequence, as defined by the IRIG-J2 standard has the format:

<SOH>DDD:HH:MM:SS<CR><LF>

where SOH is the ASCII "start of header" code, with hexadecimal value 0x01.
DDD is the day of year, from 1 to 365 (or 366 in leap years).
HH, MM and SS are decimal hours, minutes and seconds at the time of the start bit.
<CR> is the ASCII code for a carriage return, with hexadecimal value 0x0D
<LF> is the ASCII code for a linefeed, with hexadecimal value 0x0A

The IRIG properties frame allows you to choose whether to log the transmission of each IRIG sequence in the logger, and whether you wish the IRIG generation to occur only when recording, or as controlled by the Start-Pulse-train and stop-pulse-train buttons that are in the Event-logging frame of the Basic controls tab.

1.12.5 Digital Inputs

The DST4 synchronization accessory has four BNC connectors for digital inputs. Each of these inputs works independently and can be used for synchronization with other equipment. For each input, an “event” can be generated and logged. The event can be a rising edge, falling edge, or both. When used with mechanical switches, it is often useful to “de-bounce” the signal, since closing a simple mechanical switch often causes a rapid succession of logical transitions as its contacts bounce before stabilizing. You can set the “de-bounce time”, so that if multiple transitions occur within this period, they will be fused together and regarded as a single transition. The maximum de-bounce period is 31ms. You can also define a “lockout period” which defines a time after a switch transition during which transitions on all inputs will not generate a logged event.

1.13 Saving and loading settings

The logger system has very many settings as have been described. You can save all the settings for a particular kind of experiment using the “File” menu on the bar, at the top of the screen, above the tabs, which is always visible. Select “Save Settings…” to save all of the systems settings to a file on your computer, or “Load settings…” to load the system settings from a file on your computer.

When you load a set of settings, any settings in the logger that differ from the set that you load, will be automatically set in the logger by the program. You can see which settings are being changed, by observing the local log window. To view the local log in a separate window, click on the “View” menu on the bar at the top of the screen, and select “Local Log Window”. To return the local log to the Basic Controls screen, click on View, and again select “Local Log Window”.