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ERPmini

A low cost one channel EEG machine built for teaching and learning

The ERPmini

The ERPmini is a low cost, 1 channel EEG machine that is well suited for …

The ERPmini can operate in either continuous mode or single trial mode. In continuous mode, data are streamed continuously to the host PC at 512 Hz (see Continuous Mode below). In single trial mode, the ERP mini waits for input on the trigger (TRIG) port and collects a single trial of data if any of the first three bytes of the trigger value are asserted. This allows for distinguishing between 3 different trial types, making the ERPmini suitable for demonstrated basic evoked potential paradigms (e.g. frequent versus rate stimuli in a P300 task).

The ERPmini always boots into continuous mode (I know this is ironic given the name).

# Quick Start

## Continuous Mode

1. Connect the ERPMini to the the USB port on your host computer.
2. Establish a 57600 BAUD serial connection between the host computer and the ERPmini.
3. \*Send a command string to the ERPmini to place it in continuous mode (see configuring the ERPmini). This step is optional
4. Start reading data (see the section below describing the data packet structure)

\*This step is optional if the ERPmini just powered up because it defaults to continuous mode. However, it will be necessary if the ERPmini was previously put into single trial mode.

## Single Trial Mode

1. Connect the ERPMini to the USB port on your host computer.
2. Connect the stimulus computer to the USB C TRIG input on the ERPmini
3. Establish a 57600 BAUD serial connection between the host computer and ERPmini.
4. Establish a 9600 BAUD serial connection between the stimulus computer\* and the ERPMini.
5. Send a command string to the ERPmini to place it in single trial mode (see configuring the ERPmini)
6. Write a digital 1, 2 or 3 to the serial port of your stimulus computer.
7. Read the data packet from the serial buffer on the host computer (see section below describing the single trail packet stucture.

\*The same computer can act as both the host and the stimulus computer.

Configuring ERPmini

ERPmini can be configured by sending command strings from the serial port of the host PC. The following table describes the commands and their effect.

|  |  |  |
| --- | --- | --- |
| Command | Effect | Description |
| cm0 | Enables continuous mode | Immediately places ERPmini in continuous mode. |
| cm1 | Enables single trial mode | Immediately places ERPmini in single trial mode. |

# Continuous Mode

In continuous mode, raw values are streamed to the host PC at 512 Hz. Each raw value is represented as two consecutive unsigned 8-bit integers. Details of the data packet are provided in the Continuous Mode section of The ERPmini Data Packet portion of this document.

When it is first powered on, ERPmini will start in continuous mode. Successfully configuring ERPmini in continuous mode will cause the yellow LED on ERPmini to flash briefly. Attempting to place ERPmini in continuous mode when it is already in continuous mode will have no effect but will generate an error signal (flashing red LED).

# Single Trial Mode

In single trial mode, ERPmini collects and transmits a single trial of data when it receives a trigger signal over the trigger input port (TRIG). By default, the trial contains a 125 ms (64 data points) pre-trigger period and a 750 ms (384 data points) post-trigger period. The pre-trigger period contains the raw EEG values from the 125 ms prior to receiving the trigger and the post trigger period contains the raw EEG values from the 750 ms after receiving of the trigger. Deails of the single trial data packet are provided in the Single Trial Mode section of The ERPmini Data Packet portion of this document.

When it is first powered on, ERPmini will start in continuous mode and must be configured to single trial mode. Successfully configuring ERPmini in single trial mode will cause the green LED on ERPmini to flash briefly. Attempting to place ERPmini in single trial mode when it is already in single trial mode will have no effect but will generate an error signal (flashing red LED).

The ERPmini LED output

The following table provides a reference for interpreting the signals from the colored LEDs on the top of the ERPmini

|  |  |  |
| --- | --- | --- |
| Color | Behavior | Meaning |
| White | Solid | Waiting to establish a valid serial connection the host computer |
| Red | Solid | Electrodes are not connected to a participant or not plugged into the ERPmini |
| Yellow | Solid | Poor electrode connection |
| Green | Solid | Good electrode connection |
| Yellow | Flashing | ERPmini was successfully placed into continuous mode |
| Green | Flashing | ERPmini was successfully placed into single trial mode |
| Red flashing | Flashing | An unrecognized or unsupported command was received. |

The ERPmini Data Packet

# Continuous Mode

When in continuous mode, data are streamed to the host PC at 512 Hz. The EEG is collected with 12-bit resolution in the range -2048 to 2047. Before transmitting, 2048 is added to the value to ensure it is it positive. It is then split across two bytes which are transmitted sequentially. The first byte contains the higher 5 bits, and the second byte contains the lower 7 bits. To distinguish the two bytes, the most significant bite (MSB) on the first byte will always be 1, and the MSB on the second byte will always be zero.

The example shows how a raw value of 643 would be represented across the bytes. The value 2048 has been added to the raw value to eliminate signed integers so the value below is a decimal 2961 (12-bit binary: 1010 1000 0011).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| High Byte | | | | | | | | Low Byte | | | | | | | |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| signals high byte | unused | unused | Highest 5 bits | | | | | unused | Lowest 7 bits | | | | | | |

To combine the bytes into a 16-bit integer, use a bit mask to select the first 5 bits of the high byte (0x1F or 31) and the first 7 bits of the lower byte (0x7F or 127), shift the bits of the high byte to the left by 1 bit and combining them with the low byte. Subtract 2048 to put the data back into the original range.

raw\_sample = ((byte1 & 0x1F) >> 1 | (byte2 & 0x7F) -2048

According to Neurosky, the following is used to covert raw data samples to volts.

v = raw\_sample \* (1.8/4096) / 2000;

The input voltage to the TGAM1 is apparently 1.8, the 12 bit data range of 4096 and a gain of 2000 is applied. Multiply this value by 1 million to convert to microvolts (which is probably a more appropriate scale).

# Single trial mode

When in single trial mode, data is transferred in individual packets that includes a header that describes the data, and a data payload that contains the raw data bytes.

The header bytes are described in the following table. Literal characters are enclosed by quotations. Underscores represent the space character (ascii character 32). Italic characters are place holder for single or multiple 8 bit values.

|  |  |  |  |
| --- | --- | --- | --- |
| Bytes | Content | Data type | Description |
| 1-11 | “trial\_onset” | *char* | Marks the onset of a data packet for a single trial |
| 12 | *evt* | *uint8* | *evt* is an 8-bit integer in the range 1 to 3 representing the state of the two lowest bits read on the trigger input cable. |
| 13-14 | *sr* | *uint16* | *sr* is 2 consecutive unsigned 8 -bit integers that give the sampling rate when combined into an unsigned 16-bit integer. Should always be 512. |
| 15-16 | *preBytes* | *uint16* | *two consecutive (high, low) unsigned 8-bit integers that, when combined into a*n unsigned 16-bit integer give the total number of bytes in the pre-trigger period. The total number of data points in the pre-trigger period will be *preBytes* / 2. |
| 17-18 | *pstBytes*\_ | *uint16* | *two consecutive (high, low) unsigned 8-bit integers that, when combined into a*n unsigned 16-bit integer give the total number of bytes in the post-trigger period. The total number of data points in the post-trigger period will be *pstBytes* / 2. |

The data payload begins at byte 19. The number of bytes in the payload is equal to *preBytes + pstBytes.* Raw values are stored in the payload as 2-byte pairs and are the high and low (respectively) bytes of a signed (two’s complement) 16-bit integer in the range -2048 to 2047. The packet is terminated with a CR/LF which allows convenient reading of the entire packet without having to know its length ahead of time.

The entire packet length is the header length plus the data payload length or,

*19 + preBytes + pstBytes + 2*