

ABR SENSOR

Use **ActiView813** or higher to acquire ABR

Auditory Brainstem Response (ABR) measurements should be done with the ABR cord (3 electrodes) and a CMSDRL cord (2 electrodes). The ABR cord has 3 electrodes labeled: LA, Ref, RA.

The LA (Left ear) and RA (Right ear) are always FLAT electrodes.

The Ref can be FLAT or PIN according to user preference.

- Electrode position:
- LA (placed on the left Mastoid)
 - Ref (FLAT on the center of the forehead, PIN on Cz position)
 - RA (placed on the right Mastoid)
 - CMS (FLAT on the forehead, PIN in the headcap)
 - DRL (FLAT on the forehead, PIN in the headcap)



	Standard firmware ABR module in slot 225-232	HighSpeed firmware ABR module in slot 121-128 In .cfg file set: ABRlocation=0 ABR switch enabled in ActiView	HighSpeed firmware ABR module in slot R-P-T-D-C In .cfg file set: ABRlocation=1 ABR switch enabled in ActiView
Possible to do EEG and ABR simultaneous?	No	Yes	yes
Maximum number of EEG channels when measuring ABR:	0	64+8+sensors	128+8+Ergo
Daisy chain possible?	Yes	No	No
AIB mode possible?	Yes	No	No
Speedmode 0	Daisy chain mode	64+8+sensors @ 4 kHz	256+8+GSR+Ergo @ 4 kHz
Speedmode 1	Daisy chain mode	64+8+sensors @ 8 kHz	128+8+GSR+Ergo @ 8 kHz
Speedmode 2	Daisy chain mode	64+8+sensors @ 8 kHz	256+8+GSR+Ergo @ 8 kHz
Speedmode 3	Daisy chain mode	64+8 + ABR +sensors @ 16 kHz	128+8+ ABR +Ergo @ 16 kHz
Speedmode 4	160+8+sensors @ 2 kHz	64+8+sensors @ 2 kHz	256+8+GSR+Ergo @ 2 kHz
Speedmode 5	128+8+sensors @ 4 kHz	64+8+sensors @ 4 kHz	128+8+GSR+Ergo @ 4 kHz
Speedmode 6	64+8+sensors @ 8 kHz	64+8+sensors @ 8 kHz	64+8+GSR+Ergo @ 8 kHz
Speedmode 7	32+8+sensors @ 16 kHz	32+8+sensors @ 16 kHz	32+8+GSR+Ergo @ 16 kHz
Speedmode 8	AIB mode	-	-
Speedmode 9	ABR @ 16 kHz	-	-

AD-boxes with **Standard firmware** and with ABR module located in slot 225-232.

Simultaneous EEG+ABR not possible. ABR only available on speedmode 9 (16 kHz sample-rate).

Maximum number of channels that can be installed inside the AD-box is: 160+8+sensors.

All sensors available. Daisy-Chain and AIB. ABR location setting in CFG is ignored.

Speedmode 9:

- Acquire only ABR (and trigger/status channel, no other channels)

- BDF file contains 5+1 channels (Lmon, Ref, Rmon, Left, Right, Trigger/Status channel)

AD-boxes with **HighSpeed firmware** and with ABR module located in slot 121-128.

Simultaneous EEG+ABR possible for 64+8+sensors on speedmode 3 (ActiView shows Speedmode 13)

Maximum number of hardware channels that can be installed inside the AD-box is: 64+8+sensors.

All sensors available. Daisy-Chain and AIB not available.

Setting in .CFG file: ABRlocation=0

Speedmode 3: (Speedmode 13 in ActiView)	<ul style="list-style-type: none"> - Select the ABR tabpage and enable ABR with stopped acquisition. (can be saved in cfg) - Acquire ABR plus up to 64+8 channels EEG plus sensors plus Trigger/status channel. - .BDF file contains the saved EEG channels up to 64+8 channels, Lmon, Ref, Rmon, Left (referenced), Right (referenced), sensors, Trigger/Status channel.
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AD-boxes with **HighSpeed firmware** and with ABR module located in slot R-P-T-D-C.

Simultaneous EEG+ABR possible for 128+8+ERGO on speedmode 3 (ActiView shows Speedmode 13)

Maximum number of hardware channels that can be installed inside the AD-box is: 256+8+GSR+Ergo

On all speedmodes (except Speedmode 3), from the sensors, only GSR+ERGO are available, no other sensors.

On Speedmode 3, Ergo is available and GSR is available when ABR is disabled. With ABR enabled, only Ergo is available. Daisy-Chain and AIB not available.

Setting in CFG: ABRlocation=1

Speedmode 3: (Speedmode 13 in ActiView)	<ul style="list-style-type: none"> - Select the ABR tabpage and enable ABR with stopped acquisition. (can be saved in cfg) - Acquire ABR plus up to 128+8 channels EEG plus Ergo plus Trigger/status channel. - .BDF file contains the saved EEG channels up to 128+8 channels, Lmon, Ref, Rmon, Left (referenced), Right (referenced), Ergo, Trigger/Status channel.
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ABR signals are saved in both monopolar (unreferenced) and bipolar (referenced) form in a .BDF file. The monopolar channels are meant for offset checking and can be used as references for the standard monopolar headcap channels (for example: the average of Lmon and Rmon can be used as linked mastoid reference for the headcap electrodes). The monopolar ABR channels have the same properties (gain, noise, CMRR) as the standard EEG channels. The bipolar referenced channels are meant for ABR analysis. Only the bipolar channels have the improved specifications needed for ABR (lower high-frequency noise and increased common mode rejection). Note that no additional referencing should be performed on the Left and Right channels when analyzing ABR. The ABR channels are:

- Lmon monopolar unreferenced, 16 kHz sample rate, bandwidth DC to 3.3 kHz, LSB = 31.25 nV. (1/32 uV)
- Ref, monopolar unreferenced, 16 kHz sample rate, bandwidth DC to 3.3 kHz, LSB = 31.25 nV. (1/32 uV)
- Rmon, monopolar unreferenced, 16 kHz sample rate, bandwidth DC to 3.3 kHz, LSB = 31.25 nV. (1/32 uV)
- Left, bipolar with respect to Ref, 16 kHz sample rate, bandwidth 100 Hz to 3.3 kHz, LSB = 488 pV. (1/2048 uV)
- Right, bipolar with respect to Ref, 16 kHz sample rate, bandwidth 100 Hz to 3.3 kHz, LSB = 488 pV. (1/2048 uV)

For online/realtime electrode checking, ActiView displays the offsets of the 3 electrodes. Offset readings are only valid when CMS and DRL are properly connected, Blue LED continuously on. For valid ABR measurements, the 3 displayed offsets should all be stable and in the range of approx. +/- 50 mV.

The ABR tabpage in ActiView has 3 display modes:

1. **Raw Unreferenced:** Lmon, Ref and Rmon are displayed with respect to CMS. The bandwidth is 0 to 3,3 kHz. The bandwidth can be reduced with the filter selectors at the left side bar (this filter only affect the signals displayed in ActiView, not the signals which are saved to disk)
2. **LF Referenced:** Lmon and Rmon are displayed with respect to Ref. The bandwidth is 0 to 3,3 kHz. The bandwidth can be reduced with the filter selectors at the left side bar. (this filter only affect the signals displayed in ActiView, not the signals which are saved to disk)
3. **HF Referenced:** Left and Right are displayed with respect to Ref. The bandwidth is 100 Hz to 3,3 kHz. The filter selectors at the left side bar are disabled. These are the signals which are used for the online event related average.

The specifications of the Left and Right referenced ABR channels are:

- Bandwidth: 100 Hz to 3.3 kHz. (Highpass: first order 6dB/octave, Lowpass: 5th order CIC)
- Sampling-rate: 16 kHz
- AC input range: 8 mV peak-to-peak (AC amplification)
- DC input range: -250 mV to +250 mV
- Noise over the full bandwidth: 4 uV peak-to-peak
- CMRR: 150 dB
- LSB = 488 picoVolt. (1/2048 uV)



The ABR cord is available in 2 versions: (standard length of the ABR cord is 150 cm)

- Left electrode (FLAT), Reference electrode (FLAT) and Right electrode (FLAT).
- Left electrode (FLAT), Reference electrode (PIN) and Right electrode (FLAT).

How to know in which location your ABR module has been installed inside your AD-box?

With standard firmware:	The ABR module is always in slot 225-232. When an AD-box has high-speed firmware, then there will always be a label on the bottom of the AD-box saying “High Speed Firmware”
With HighSpeed firmware:	In Speedmode 3, run the AD-box with no electrodes connected, check the offsets. If channels 65 until 120 show zero offset then the ABR module is in slot 121-128. If all channels up to 128 show maximum negative offset then the ABR module is installed in slot R-P-T-D-C.

SUMMARY:

- Use ActiView813 or higher
- Edit the .cfg file according to the location of the ABR module.
- The Left and Right ABR signals are already referenced with respect to Ref in hardware before saving.
- The Left and Right ABR signals are already high-pass filtered in hardware before saving. (100 Hz to 3.3 kHz)
- The Lmon, Ref and Rmon ABR signals have the same properties as the standard EEG channels.