Technical Note ————————

Bitbrain Diadem EEG and The Observer XT

Noldus
Information Technology

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1 Introduction

The BitBrain Diadem is a 12-channel wearable and portable, dry EEG device designed for real-world applications that require easy set-up and high signal quality. The Diadem system is designed to address the pre-frontal, frontal, parietal and occipital brain areas to measure emotional and cognitive states such as cognitive workload.

The Diadem has been designed for adults. It can be used for children from the age of 10.

The sample frequency is 256 Hz and battery life is more than 8 hours.

Sensor layout

The headband includes 12 EEG sensors, plus ground (GND) and reference (REF). The sensors are placed at positions AF7, Fp1, Fp2, AF8, F3, F4, P3, P4, PO7, O1, O2 and PO8, according to the EEG 10/10 international standard. REF is located on the ear clip.

The correspondence between channel numbers and sensors is as follows:

Channel 1: AF7

Channel 2: Fp1

Channel 3: Fp2

Channel 4: AF8

Channel 5: F3

Channel 6: F4

Channel 7: P3

Channel 8: P4

Channel 9: PO7

Channel 10: O1

Channel 11: O2

Channel 12: PO8
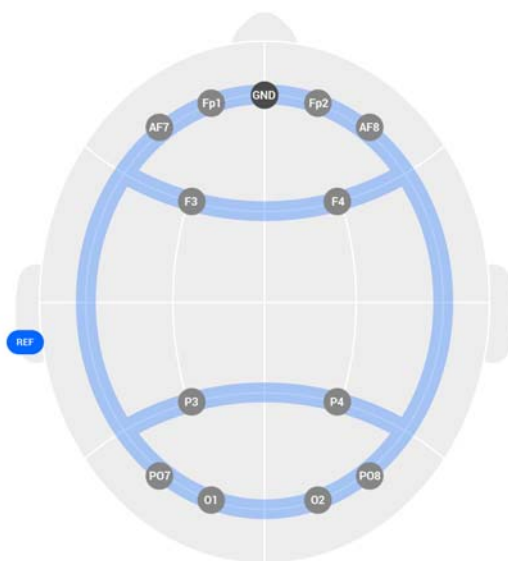
THIS TECHNICAL NOTE

This document describes how to achieve automatic synchronization between observational data in The Observer XT and EEG data acquired with and exported from a Bitbrain system. You can:

- Start and stop data acquisition in the Bitbrain Acquisition software from The Observer XT.
- Manually import Bitbrain EEG data into The Observer XT after the observation is ready.

SYSTEM TESTED

Processing unit

Dell Precision T3660

- Processor: Intel Core i7 12700K (12 Core), 3.6 GHz or better

- Internal memory: 16 GB

- Operating system: Windows 10 and Windows 11 Professional Edition

Software

- The Observer XT 16 or higher

- N-Linx Server 1.4 or higher

- N-Linx Agent 1.4 or higher

- BitBrainControl 1.0 software to control the EEG device

- Bitbrain Acquisition 0.3 software — The acquisition software for the Bitbrain device

NOTE

Tests were carried out with all the software on one PC. You can also use two PCs and set up a local network. In that case The Observer XT and N-Linx Server are installed on PC 1 and the BitBrain Acquisition software, the Bitbrain Control software and N-Linx Agent are installed on PC 2.

FOR FURTHER INFORMATION AND HELP

Other manuals

- User Guide - Diadem - Bitbrain

- The Observer XT Help

- The Observer XT Quick Start Guide

- N-Linx - Reference Manual

Customer Support

For technical support, please visit the MyNoldus portal (my.noldus.com). Log into your account or create a new one and submit a support case.

2 Software setup

If you purchased your PC from Noldus Information Technology, all the software is already installed and tested. If you purchased your own PC, please follow the instructions below.

INSTALL THE OBSERVER XT

1. Download the Observer XT installation file (The Observer XT Setup.exe) via your MyNoldus account (my.noldus.com, under Downloads > The Observer XT > Versions).

2. Double-click the installation file to run it and follow the instructions on the screen.

3. Activate or insert your license key:
   - If you have a software license —Activate your license.
   - If you have a hardware key - Insert the key into your computer.

INSTALL N-LINX SERVER

IMPORTANT If your set-up includes more than one PC — Install N-Linx Server on the Observer XT computer.

1. Download the N-Linx Server installation file (*N-Linx Server Setup.exe*) via your MyNoldus account (my.noldus.com, under Downloads > The Observer XT > Drivers & Tools).

2. Double-click the installation file to run it.

3. Next to **Installation type** choose **Standard**, unless you want to specify an installation folder other than the default one (C:\Program Files\Noldus\N-Linx Server 1).

4. Follow the instructions on your screen.

INSTALL AND CONNECT N-LINX AGENT

Install N-Linx Agent

**IMPORTANT** If you use a 2-PC set-up — Install N-Linx Agent on the Bitbrain computer.
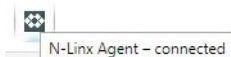
1. Download the N-Linx Agent installation file (*N-Linx Agent Setup.exe*) via your MyNoldus account (my.noldus.com, under Downloads > The Observer XT > Drivers & Tools).

2. Double-click the installation file to run it.

3. Next to **Installation type** choose **Standard**, unless you want to specify an installation folder other than the default one (C:\Program Files\Noldus\N-Linx Agent 1).

4. Agree with the license agreement, click **Install** and follow the instructions on your screen.

5. If the N-Linx Agent window does not open after installation, at the bottom-left corner of the screen, on the system tray, click the **Show hidden icons** icon and double-click the **N-Linx Agent** icon.
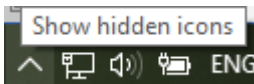
6. Next to **N-Linx Server Address**, enter the IP address of the computer where N-Linx Server is installed. This IP address must be *fixed*. If N-Linx Server and N-Linx Agent are installed on the same PC enter *localhost* as the N-Linx Server Address.

   TIP You can also enter the **Computer name** instead of the IP address. To find the **Computer name** of the computer where N-Linx Server is installed, on that computer open the **Control Panel** and choose **System**. Locate **Device name**.

7. Click **Connect**. If connection is established, the message at the bottom of the N-Linx window says **Connected**.

INSTALL BITBRAIN CONTROL SOFTWARE

1. Download the BitBrainControl installation file (BitBrainControl.Installer.exe) via your MyNoldus account (my.noldus.com, under Downloads > Versions).

2. Double-click the installation file to run it and follow the instructions on your screen.

3. Browse to C:\ProgramData\Noldus\BitBrain Control\1, copy the file with the name *Noldus.Proxy.BitBrain.config* and rename it to *Noldus.Proxy.BitBrain.config_old* to make sure that you have an original version of the file.

    The **ProgramData** folder is a hidden folder. To view this folder, browse to C:\ and on the **View** tab select **Hidden items**.

4. Open Notepad or another text editor and open the file with the name *Noldus.Proxy.BitBrain.config*.

5. Edit the file as follows:
    - <RabbitMQAddress>*IP address of the PC on which N-Linx Server is installed*<RabbitMQAddress>
    - <BitBrainAddress>*IP address of the PC on which Bitbrain software/N-Linx Agent is running*<BitBrain Address>
    - <BitBrainDeviceId>*shown on the amplifier device*<BitBrain DeviceId>
    - <BitBrainOutputFolder>*folder in which the data will be saved*<BitBrainOutputFolder>

    Notes:
    - Always use a forward slash (/) in the pathname, not a backward slash (\).
    - The RabbitMQAddress is *localhost* if N-Linx Server is installed on the same PC as the BitBrainControl software.
    - The BitBrainAddress is 127.0.0.1 if have a 1-PC set-up.

6. Save the config file with the same name.

7. Create the folder that you defined as the output folder in step 5.

To find an IP address:

1. Click the Windows button, type *cmd* and press **Enter**. A **Command Prompt** window will open.

2. Type *ipconfig* and press **Enter**.

3. The IP address you need is the IPv4 address.

INSTALL BITBRAIN ACQUISITION SOFTWARE AND PREPARE DATA ACQUISITION

1. Download the Bitbrain acquisition software (bitbrain-acquisition-0.3.zip) via your MyNoldus account (my.noldus.com).

2. Turn on the Bitbrain amplifier by pressing the power button. The LED on the amplifier will flash until a connection with the software is established, at which point the light will be steady.

3. Connect the Bitbrain Diadem via bluetooth:

   - Click the Windows button, type **Settings** and press **Enter**.

   - Click **Devices** and then click the plus (**Add Bluetooth or other device**) icon at the top of the screen. Click **Bluetooth** and wait till the Bitbrain device with the ID that you entered in step 5 in the procedure above appears.

4. Click the device name. The device will then start making connection with the PC. When the connection is established you will see a message that your device is ready to go. Click **Done**. The device ID will appear in the list with **Other devices** and will have the status **Paired**.

PREPARE THE OBSERVER XT

Connect The Observer XT to N-Linx Server

Follow this procedure just once. The settings are also valid for any new The Observer XT project that you create.

1. In The Observer XT, choose **File** > **Preferences**.

2. Click **N-Linx settings** on the left.

3. Select **Use N-Linx Server to connect with other applications**.

4. Next to **N-Linx Server address**, leave the default entry *localhost*.

5. Make sure the **N-Linx Server port** is *5672*.

   Ask your system administrator for assistance if this port is used by another program.

6. Click **Test connection**, and check that the message **Connected** appears.

If connection fails, it means that N-Linx Server is not installed properly. Reinstall N-Linx Server (page 7).

Project Setup

Follow these steps for each new Observer XT project you create to work together with the Bitbrain system.

1. Open the project and choose **Setup** > **Project Setup**.

2. Under **Observation Source**, select **Live Observation**.

3. In the **Devices** window, select *BitBrain Control*.

   If you do not see this item, it is likely that N-Linx Agent is not installed.

4. Double-click the **Status** cell next to *BitBrain Control* and check that the status is *Enabled, Running*.
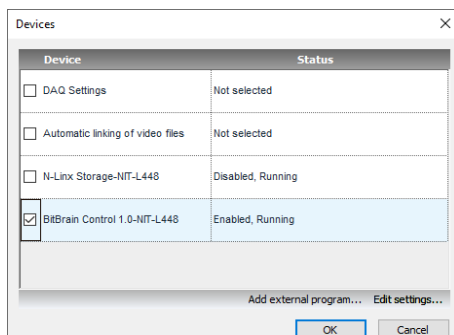
3 Carry out data acquisition

To carry out data acquisition:

1. Place the headset on the test participant's head following the instructions in the User Guide - Diadem - Bitbrain 2021.pdf.

2. Browse to the folder in which you installed the BitBrain Acquisition software and open the bin subfolder, for instance D:\BitBrain\bitbrain-acquisition-0.3\bitbrain-acquisition-0.3\bin.

3. Double-click the file with the name Bitbrain Acquisition.exe. A Console window will open.

4. In The Observer XT, create a new observation (**Alt+F6**).

5. To start data acquisition, click the **Start Observation** button.

   The Bitbrain window shows the channels in green (good connection), yellow (unstable connection) or red (bad or no connection).

6. If necessary, adjust the diadem, wait a few seconds (> 10) and then check whether the status of the channels has changed to green.

7. To stop data acquisition, click the **Stop Observation** button.

   The data are saved in the output folder that you defined in step 5 on page 9. Both raw data (*_eeg.csv) and derived data (alpha, beta, delta and theta rhythms) are saved. The latter are saved in the *eeg_power* subfolder.

8. Browse to the output folder and copy the data files from the BitBrain PC to The Observer PC in a 2-PC set-up.

4 Import the Bitbrain data into The Observer XT

The Observer XT 17 has a built-in import profile for Bitbrain data. In the Observer XT 16 this is not present yet. If you work with The Observer XT 16, follow steps 1-3 in the procedure below. If you use The Observer XT 17 you can skip these steps.

1. Make sure that The Observer XT is not running.

2. Download the zip file with the Bitbrain import profile (Profiles.zip) via your MyNoldus account (my.noldus.com) and copy it to The Observer PC.

3. Unzip the zip file and copy the import profile (BitBrain EEG.eip) and the folder with the data file (BitBrain EEG) to C:\ProgramData\ Noldus\Common\Profiles.

   The **ProgramData** folder is a hidden folder. To view this folder, browse to C:\ and on the **View** tab select **Hidden items**.

4. Start The Observer XT and from the **File** menu select **Import** and then **External Data**. The **Import External Data** window opens.

5. Select the *Bitbrain EEG (*.csv)* import profile from the **Files of type** drop-down list.

6. Select the observation that corresponds with the data file.

7. Browse to the output folder and select the appropriate data file, either a data file with the raw EEG data or a data file with pre-processed data (alpha, beta, theta and delta activity). You can use the import profile for both types of data files. Click **Open**. The EEG data for each channel are now imported. The data stream names will appear in the Project Explorer and in the Independent Variable list.
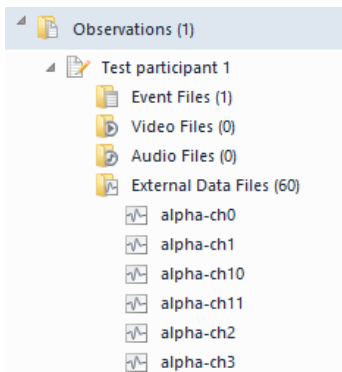
Optionally, in The Observer XT you can select data, visualize them, carry out further data analysis and export the synchronized observational and EEG data. For details, see The Observer XT Help. You can also further process your data in EEGLab, Matlab or Python.

HOW TO INTERPRET THE DATA

By measuring when and in what brain regions activity occurs you can get important insights in brain functions. It is key to take the context into account when trying to interpret EEG data. The Bitbrain system allows you to measure alpha, beta, theta and delta activity.

- Alpha —In healthy awake adults alpha waves occur while resting with the eyes closed. They disappear when people concentrate on a specific task. Relative asymmetry in alpha activity in the frontal cortex indicates positive affect and approach motivation (Paul *et al*., 2022).

- Beta —Beta waves are involved in conscious thought and logical thinking.

- Theta — Theta waves are relevant for cognition studies including learning, memory and spatial navigation. Recent research has

shown that theta activity in the frontal cortex is an index for cognitive workload (Chikhi *et al.*, 2022).

- Delta — Delta waves are the slowest brain waves in human subjects. They are related to sleep depth.