ThinkCap Instruction Manual

June 29, 2018

NeuroSky
Brain-Computer Interface Technologies

The NeuroSky® product families consist of hardware and software components for simple integration of this biosensor technology into consumer and industrial end-applications. All products are designed and manufactured to meet consumer thresholds for quality, pricing, and feature sets. NeuroSky sets itself apart by providing building block component solutions that offer friendly synergies with related and complementary technological solutions.

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Introduction to the ThinkCap

Congratulations on your purchase of a ThinkCap Development Kit! You should have everything you need here to develop exciting new products using the latest in EEG technology. Enjoy!

ThinkCap is a full EEG system integrated into a wearable cap. Everything needed to measure EEG signals is included on this mobile platform: sensors, amplifiers, filters, analog-to-digital conversion, and a wireless link. A computer can be used to capture the wireless data for recording and analysis. The system comes with 4 of NeuroSky's proprietary "non-contact" EEG sensors. These sensors are dry (meaning no gel or water is required), active (amplifiers are located on the sensors to reduce noise), and non-contact (they do not require direct contact with the skin). Typical dry EEG sensors need direct contact with the skin in order to measure the tiny voltages produced by the brain. NeuroSky's non-contact EEG sensors, on the other hand, can measure these signals with separation up to several millimeters. This breakthrough allows for dry sensing of EEG signals over hairy areas of the head. The system also has 4 "comb" EEG sensors. Rounded, spring-loaded bristles from the comb rest on the scalp. When your requirements call for a greater tolerance to movement, these sensors might be your best bet. Please try both styles of sensors and see which ones fit your needs.

Various software tools are included to make your evaluation and development easy. The place to start is with MindView. With this program you can get up and running quickly. After connecting the Bluetooth link to the PC, you will be able to see the EEG data in real time. A power spectrum is available for each channel, as well as the capability to record the raw EEG into a data file. If you are already familiar with EEG and BCI software, your next step may be to try our collection of drivers and scripts to third party software. You can connect the ThinkCap with FieldTrip, BCI2000, Matlab, and EEGLab. These are all very useful platforms for performing experiments and analyzing data. If you are ready to start building software applications for use with ThinkCap, your kit also includes tools to help with that. ThinkGear Connector is a signal server that takes care of all the dirty work of connecting with the hardware. All you have to do is access the signals that are served up for you on a TCP/IP socket. Or, if you are comfortable with C#, the MindView Core is a set of functions that help you easily build a full-function application from the ground up. Whatever your goal, there are plenty of tools here to help you achieve it.

ThinkCap Development Kit Contents

- ThinkCap headset
- ThinkCap SDK Disc, containing:
  - Bluetooth installation software
  - **PDF Instruction Manuals**:
    - ThinkCap Headset User Manual (this document)
    - Software Research and Development Tools Guide
    - ThinkCap Communications Protocol

  - **Applications** for PC:
    * MindView
  - **Research Tools** for PC:
    * Driver for FieldTrip
    * Driver for BCI2000
    * Scripts for Matlab
    * Scripts for EEGLab
  - **Software Development Tools** for PC:
    * ThinkGear Connector
    * MindView Core with example application
- USB cable, for charging the ThinkCap
- USB Bluetooth adapter

Setting Up Your ThinkCap

To get started with your ThinkCap:

1. Charge your ThinkCap using the USB cable
2. Install the MindView software application
3. Pair your ThinkCap to your computer
4. Fit the ThinkCap onto your head
5. Start the MindView program

Minimum System Requirements

- 2.0Ghz Processor or better
- One available USB port
- Windows 7 or Windows XP

Power Switch

Turn ThinkCap on: Press the power button firmly and hold for about 2 seconds.

Turn ThinkCap off: Press the power button firmly and hold for about 3 seconds.

Charging the ThinkCap

To charge the ThinkCap's lithium-ion battery, plug the supplied USB cable into the ThinkCap, and connect the other end to a powered USB port. The ThinkCap may take up to four hours to charge.

Important: Do not wear the ThinkCap while it is charging.

Software Installation

Important: Please install the Bluetooth software **before** inserting the Bluetooth adapter.

1. Insert the ThinkCap SDK Disc into your computer's DVD drive.

2. If autorun is enabled, start the ThinkCap SDK installer. Otherwise run NeuroSkyThinkCapSDK.exe on the disc.
3. After the ThinkCap SDK installer is complete, it will launch the Bluetooth software installer.
4. Insert the Bluetooth adapter when prompted.
5. If prompted, reboot your computer.

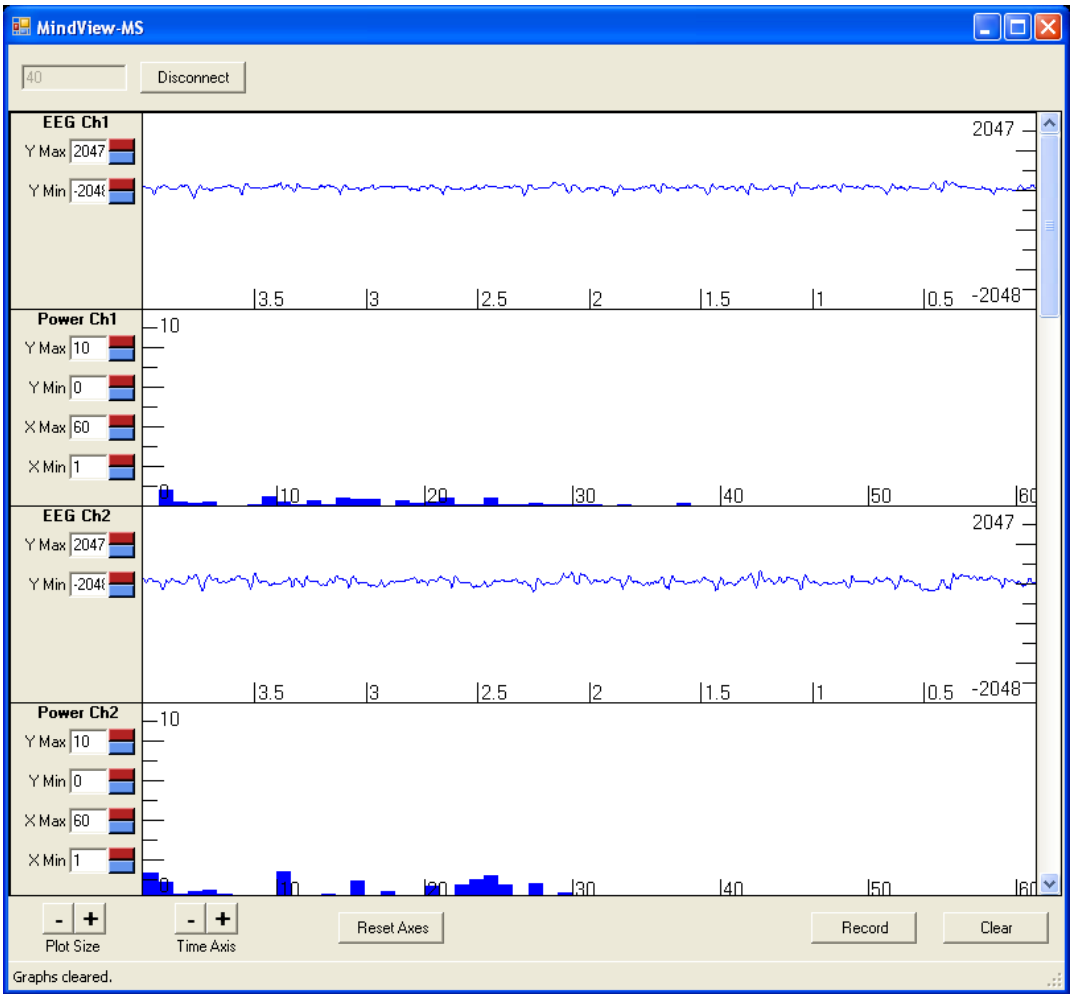
MindView

MindView is a Windows graphical interface to record and plot EEG data recorded using the ThinkCap headset.

What you can do with MindView:

- Record data directly from the headset and save it to disk
- Plot data and spectrum in real-time
- Export data into the EEGLAB free software for more advanced analysis

Press CONNECT on the start up screen and the program will load. In the top left corner, enter the COM port you are connected to (see the Serial Port Name section for more details) and press Connect. If you do not know the COM port, you may enter **Auto**.



To record data, select the Record button. Data will be saved to the current folder that the MindView program is located. To end data recording, press the Stop button. To change the axis, simply enter the desired upper or lower limit and press enter. Alternatively, you may press the red or green buttons to increase or decrease the limits, respectively. Data is saved in the DataLog format (see *ThinkGear Data File Formats* PDF for more details).

ThinkCap Bluetooth Pairing

1. Turn on the ThinkCap.
2. Double-click on the Bluetooth icon in the system tray. If the Bluetooth icon is not present, find **Bluetooth Settings** in your Start menu.
3. Click on *New Connection*.
4. Choose the Express Mode option and then click *Next*.

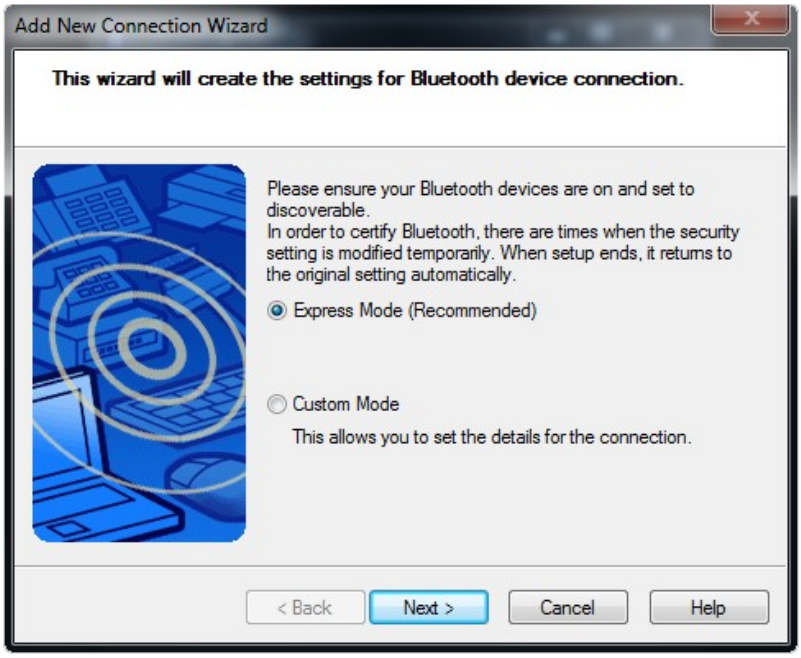


Figure 2.1: Mode Selection

5. If the wizard detects the ThinkCap, it will show up as **Serial Port Device**. Select **Serial PortDevice** and click *Next*.

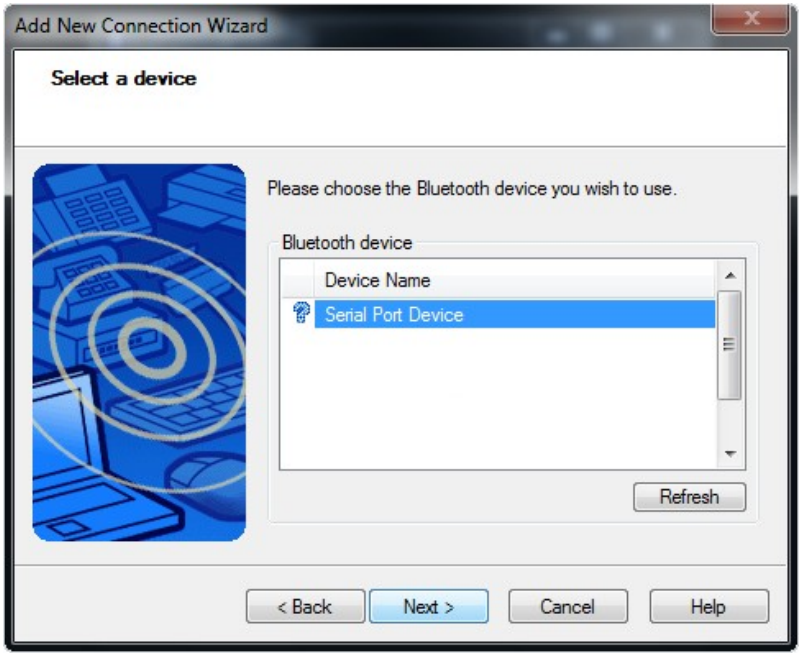


Figure 2.2: Device Selection

Note: If the ThinkCap does not appear on the list, verify that the ThinkCap is turned on

and click on *Refresh*.

6. Click *Next* to complete the pairing of the ThinkCap.
7. Double click on the ThinkCap icon to connect to the COM port. The Bluetooth manager will ask for a passkey (PIN) to connect to the ThinkCap. Enter in 0000 in the passkey box and click *OK*.

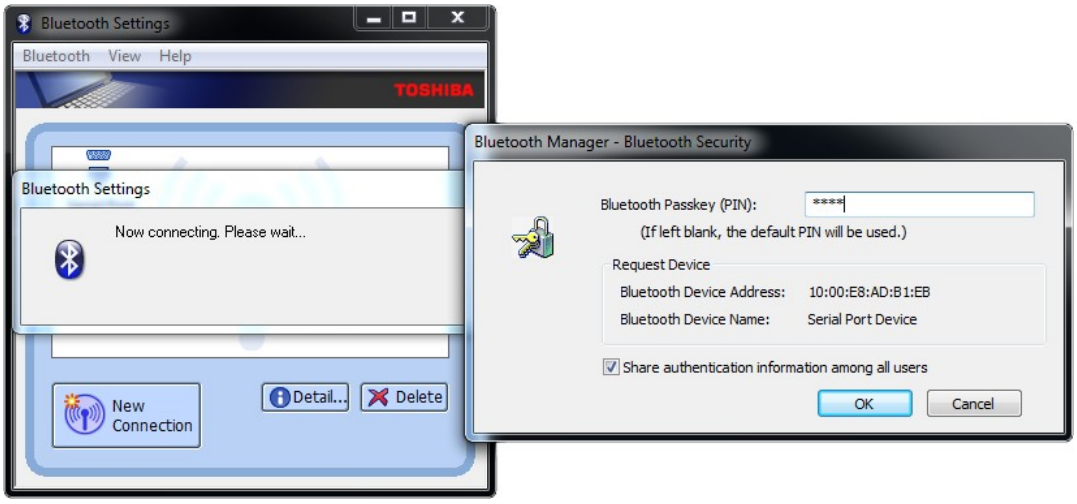


Figure 2.3: PIN code entry

8. Pairing is now complete.

Serial Port Name

To find the serial port that your ThinkCap is connected to, right-click on the **Serial Port Device** icon in the Bluetooth Settings window and select *Detail*…. The COM port will be listed in the *Setting* panel.

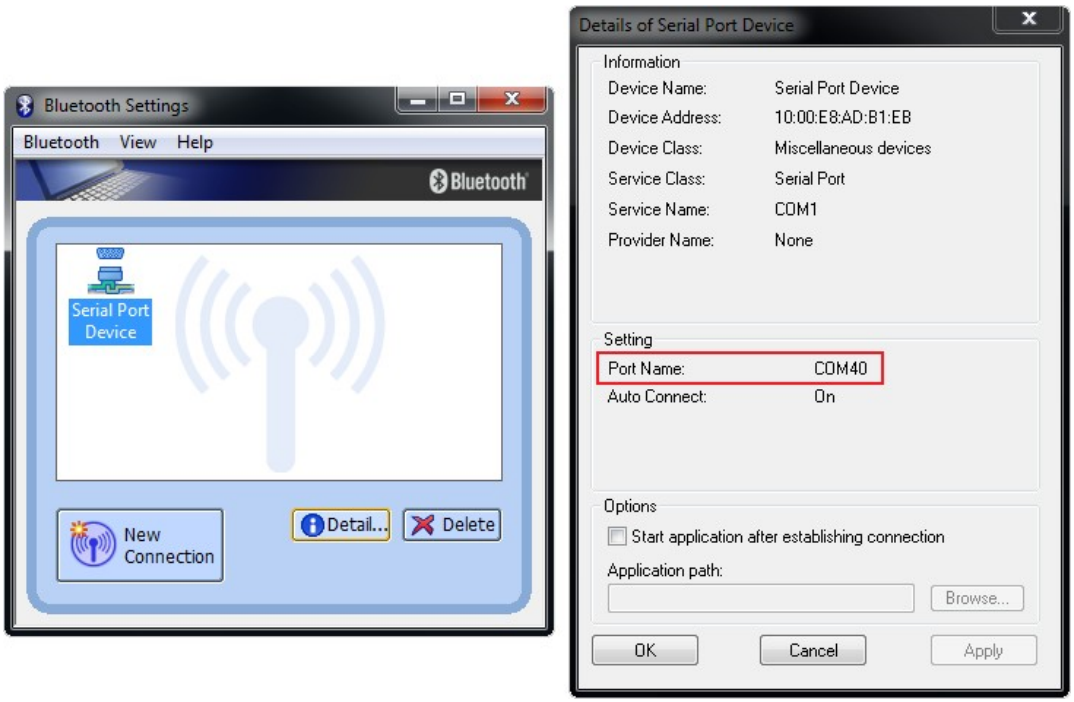


Figure 2.4: Serial port details

Using Your ThinkCap

This chapter walks you through fitting the ThinkCap and installation of the included ThinkCap software on your PC.

Fitting the ThinkCap

Important: In order to take full advantage of these functions and features of the ThinkCap, the ThinkCap must be properly worn.

1. Wear the ThinkCap such that the electronics case is located on the top or the back of the head. The cap should be snug on the head so that the sensors will be located as close as possible to the scalp. This also helps to avoid noise artifacts due to movement. An earclip is used for grounding purposes.

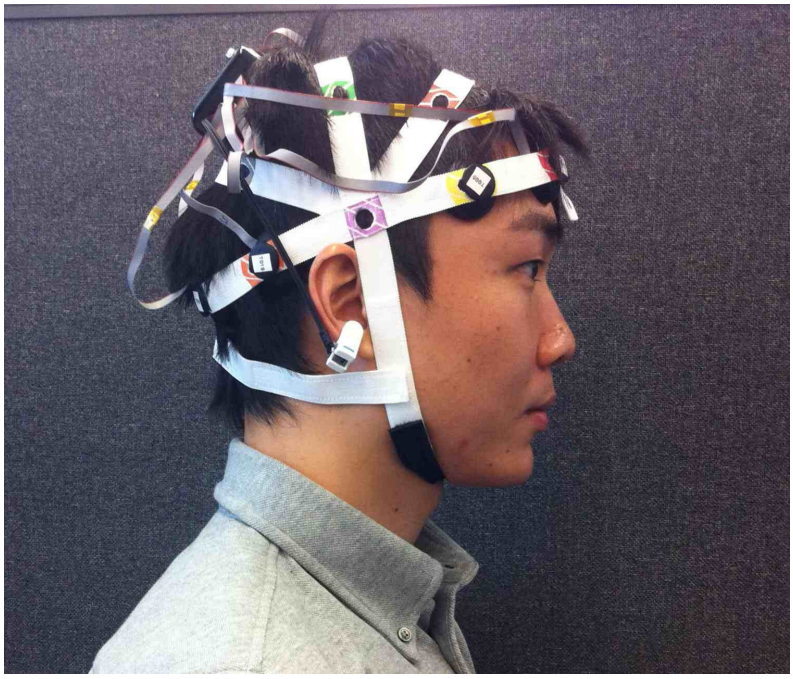


Figure 3.1: Wearing the ThinkCap, side view.

2. Cables connected to the sensors run above or below the straps, whichever is most convenient.
3. The sensor locations are adjustable. Mount the sensors into the appropriate hole in the cap.

4. The ThinkCap comes with two types of sensors. The Non-contact sensors are flat on the bottom and sit on top of the head. The Comb sensors have prongs that penetrate the hair and rest on the scalp.

Care and Maintenance

- Clean the ThinkCap's sensors and ear clip contacts with alcohol-wipes periodically to ensure the best signal quality. Use a soft cloth to clean the ThinkCap's electronics casing
- Occasionally you may want to wash the cap fabric. You must first remove all the electronics from the cap.
    1. Touch a grounded metal surface to avoid any static discharge.
    2. Gently remove all the sensors from the BraiNet harness and slide them out of the harness.
    3. Remove the electronics case from its mounting hole.
    4. Set aside all the electronics and cables.
    5. The cap may be washed in cold water on the gentle cycle.

ThinkCap Troubleshooting

Problem	Possible Cause	Solution
ThinkCap does not turn on	ThinkCap's battery may be low	Charge the ThinkCap
Pairing failed	Incorrect passkey	Use **0000** as the passkey while pairing.
Pairing failed	Low battery	Charge the ThinkCap completely before use.
Cannot see the ThinkCap while search-ing for Bluetooth devices	The ThinkCap is not turned on	Turn on the ThinkCap
Cannot add the SPP service during pairing	The ThinkCap's SPP service is not available.	Power cycle the ThinkCap and pair again.
Poor signal quality	Loose connection with earclip	Pinch earclip to ensure good contact

For further technical support, please contact NeuroSky Support at http://support.neurosky.com.

Cross Talk

When a sensor is attached to the ThinkCap system, but is not close enough to the head to pick up EEG signals, its output may oscillate. This large signal swing may create a small amount of noise on other active channels. It is recommended to (A) position all sensors close enough to the head to avoid oscillations, and, if necessary, (B) have a qualified NeuroSky representative remove sensors from the cap that are not integral to your experiment.

Important: There are no user serviceable parts inside the ThinkCap Support Module or inside the sensors. Attempts to service the ThinkCap components by untrained personnel can result in serious damage to the ThinkCap.

Technical Details

The ThinkCap is a specialized dry sensor multi-sensor system for use over hair. It measures through hair via one of two types of specialized electrodes unique to the ThinkCap: comb electrodes and non-contact electrodes. Through a system of elastic strips provided by BraiNet and plastic enclosures, the location of input from the 8 sensor channels is fully customizable. Everything needed to measure EEG signals is included on the mobile platform: sensors, amplifiers, filters, analog-to-digital conversion, and a wireless link. A computer can be used to capture the data through serial or wireless connection for the recording and analysis.

A full EEG system integrated into a wearable cap

- 2 types of sensors can be used, Comb Sensors or Non-Contact Sensors (both are dry and specialized for use over hair)
- 8 EEG channels
- Built into wearable cap (electronics can be removed to wash the cap)
- Plastic case containing electronics and battery
- Ear Clip (for reference and ground)
- Rechargeable lithium-ion battery charged from USB port on the support board case (up to 4 hours to charge)
- On/off switch
- Wireless Bluetooth pairing

ThinkCap Specs:

- Wireless Communications: Bluetooth with 115,200 baud rate
- ADC resolution: 12 bits
- Sampling rate 256Hz
- Lithium ion battery

Comb Sensors: The comb sensors have spring-loaded prongs that gently penetrate the hair. These prongs rest on the scalp and produce a low-noise EEG signal without the use of gel or water.

- Spring loaded prongs
- Excellent signal-to-noise ratio
- Dry electrodes

Non-Contact Sensors: Typical dry EEG sensors need direct contact with the skin in order to measure the tiny voltages produced by the brain. NeuroSky's non-contact EEG sensors, on the other hand, can measure these signals with separation up to several millimeters.

- Can measure signals up to several millimeters away
- High noise level produced by amplifier
- Moderate signal-to-noise ratio
- More susceptible to movement artifacts

Sensor Layout

The initial configuration of the sensor channels is shown in the layout above. The sensor locations can be changed by the user.

Warnings

- Batteries shall not be exposed to excessive heat.
- The ThinkCap is a sensitive piece of equipment, dropping or throwing the ThinkCap may cause damage to the ThinkCap.

Environmental requirements:

- Operating temperature: 0-35˚C
  - Do not expose the ThinkCap to temperatures above 140°F (60°C).
- Operating Voltage:
  - 5V (when recharging through the USB Port.
  - 4.3V (normal operation with battery)
- Current Rating: During battery recharging: 250 mA maximum
- Normal use under battery power: 120 mA maximum, (8 sensors).