

NordicNeuroLab

# fMRI Hardware System

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## User Manual



NordicNeuroLab

# Introduction

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NordicNeuroLab's fMRI Hardware System is a complete, state-of-the-art solution designed specifically for fMRI. It incorporates sophisticated, high-precision hardware components for visual and auditory stimulus presentation, response collection, and paradigm synchronization for use in functional MR Imaging (fMRI) based on BOLD contrast.

The NNL fMRI Hardware system is fully CE certified (for more information, see section 7) and has FDA 510(k) clearance.

This manual is divided into two main sections, an Installation Guide to illustrate the set-up of each individual component of the fMRI Hardware System, and a "How to use...." section, providing a detailed description of how to operate the individual components.

We strongly suggest that you carefully read this manual to ensure safe operation of the equipment and to be able to take maximum advantage of the versatile features offered by the fMRI Hardware System.



The fMRI Hardware System complies with the EU regulations for active medical devices, Medical Device Directive 93/42/EEC, classified as a Medical Device Class I product.

Caution: Federal (US) law restricts this device to sale by or on the order of a licensed practitioner. (US only)



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# 1. Safety

## 1.1. General safety information



- This equipment must only be operated by personnel properly trained in identifying artifacts, streaks and distortions in image data and in validating the correctness of data retrieved from the SyncBox and the ResponseGrip.
- Make sure that all personnel handling the equipment are familiar with the safety instructions given in this manual and other documentation provided by NordicNeuroLab to ensure safe operation of the equipment.
- When connecting a PC to the system, verify that the PC complies with IEC/UL 60950-1 to ensure safe operation of the system. Most standard PCs sold by established vendors comply with this standard.






The fMRI Hardware System is tested for conformity with the most widely harmonized standards for medical electric device safety:

- IEC 60601-1 General Requirements for Safety
- IEC 60601-1-2 Electromagnetic Compatibility – Requirements and Tests










by an accredited test house and a CB Test Certificate, available upon request, have been issued.

National deviations to the IEC standard concerning the US (UL), Canada (CAN/CSA), Australia (AS/NZS), Denmark (EN), Israel (SI) and Korea have been amended to the test protocol.

	<p><b>Caution</b></p> <p>The&gt;NNL VisualSystem contains minor ferromagnetic components. These components cause local magnetic field distortions in the sub-ppm range over a range of about 30 mm. For the intended use (i.e., fMRI studies) these local magnetic field distortions are restricted to the eyeholes and do not affect the brain area.</p>
	<p><b>Caution</b></p> <p>Artifacts in the MR image (caused by the Headphones or the optical lenses in the VisualSystem)!</p> <p><b>Incorrect interpretation of image/data</b></p> <ul style="list-style-type: none"> <li>- check the MR image for bright spots, streaks and lines</li> <li>- test equipment regularly to identify any artifacts</li> <li>- if artifacts are observed, make sure that the supervising physician is properly trained to identify these artifacts</li> </ul>

	<p><b>Warning</b></p> <p>Self-heating of cables due to improper cable routing!</p> <p><b>Injury to subject and operating personnel</b></p> <ul style="list-style-type: none"> <li>- avoid looping of cables</li> <li>- make sure that all cables are in straight lines before starting an examination</li> <li>- make sure cables of the Headphones and Coil-mounted Display are not in direct contact with the patient</li> </ul>
	<p><b>Warning</b></p> <p>Parts of the fMRI Hardware System contain ferromagnetic materials which must be placed at a safe distance from the scanner as they could be dragged towards the magnet!</p> <p><b>Injury to subject and operating personnel</b></p> <ul style="list-style-type: none"> <li>- only parts of the system intended for use inside the scanner room can be taken inside. Refer to labeling on each unit and the corresponding sections in this user manual.</li> <li>- keep the Shielded Interface Unit (SIU) and ferrite beads cables and plugs at maximum distance from the scanner, at least outside the 200 Gauss (20 mT) line.</li> </ul>
	<p><b>Caution</b></p> <p>Light beam of the Fiber Transmitter and ResponseGrip Interface!</p> <p><b>Eye injury caused by light beam</b></p> <ul style="list-style-type: none"> <li>- never look directly into the optical connectors or fiber optic cables.</li> </ul>
	<p><b>Warning</b></p> <p>For a small percentage of the population, viewing certain types of video that contain flashing patterns of light might trigger an epileptic seizure!</p> <p><b>Injury to subject and/or damage to equipment</b></p> <p>The following users are cautioned to consult an physician before using the VisualSystem:</p> <ul style="list-style-type: none"> <li>- children under 5 years</li> <li>- anyone with a history of epilepsy, or a family history of epilepsy</li> <li>- anyone who has ever experienced epileptic seizures or sensory disturbances triggered by flashing light effects</li> </ul>
	<p><b>Warning</b></p> <p>Use of non specified power supply!</p> <p><b>Permanent damage to the equipment</b></p> <ul style="list-style-type: none"> <li>- only power supplies specified by NordicNeuroLab should be used with the equipment.</li> </ul>

## 1.2. Explanation of product marking and labeling

	<p><b>Consult accompanying documentation</b></p> <p>This is a general symbol used to encourage users to get familiar with the accompanying documentation and safety precautions before taking the system into use.</p>
	<p><b>Type BF applied part</b></p> <p>Indicates that all parts attached to the subject are insulated from the electronics inside to limit the magnitude of current running through the subject in the event of an unintended voltage originating from an external source connected to the subject.</p> <p>This applies to:</p> <ul style="list-style-type: none"> <li>- ResponseGrip</li> <li>- Headphones (AudioSystem)</li> <li>- Coil-mounted Display (VisualSystem)</li> </ul>
	<p><b>Attention</b></p> <p>Consult the manual for more information.</p>
 	<p><b>MR Safe</b></p> <p>An item that poses no known hazards in all MR environments.</p> <p>This marking applies to:</p> <ul style="list-style-type: none"> <li>- grips (ResponseGrip)</li> </ul>
 	<p><b>MR Conditional</b></p> <p>An item that has been demonstrated to pose no known hazards in a specified MR environment with specified conditions of use.</p> <p>This marking applies to:</p> <ul style="list-style-type: none"> <li>- Headphones (AudioSystem)</li> <li>- Coil-mounted Display (VisualSystem)</li> <li>- Shielded Interface Unit (SIU)</li> </ul> <p>(see installation guide for each product for safe operating conditions)</p>
 	<p><b>MR Unsafe</b></p> <p>An item that is known to pose hazards in all MR environments and must not be brought into the magnet room.</p> <p>This marking applies to:</p> <ul style="list-style-type: none"> <li>- SyncBox</li> <li>- ResponseGrip Interface (ResponseGrip)</li> <li>- Communication Console (AudioSystem)</li> <li>- Fiber Optic Transmitter</li> <li>- cables &amp; power supplies (except SIU power cable)</li> </ul>





## 2. System Overview and Installation Guide

## 2.1. System overview

The fMRI Hardware System consists of four components:

- **VisualSystem:** a powerful and flexible solution for presenting visual stimuli inside the MR scanner, which is based on OLED technology
- **AudioSystem:** high-precision electrostatic Headphones for auditory stimulus presentation inside the MR scanner; a user-friendly Communication Console for operator-subject communication and versatile control over audio settings
- **ResponseGrip:** a pair of hand-held grips for collecting subject feedback during the fMRI experiment
- **SyncBox:** for synchronization of stimulus presentation with MR image acquisition

Figure 1 gives an overview over the set-up of the fMRI Hardware System components. All signals entering or leaving the shielded magnet room are transmitted by use of fiber optics.

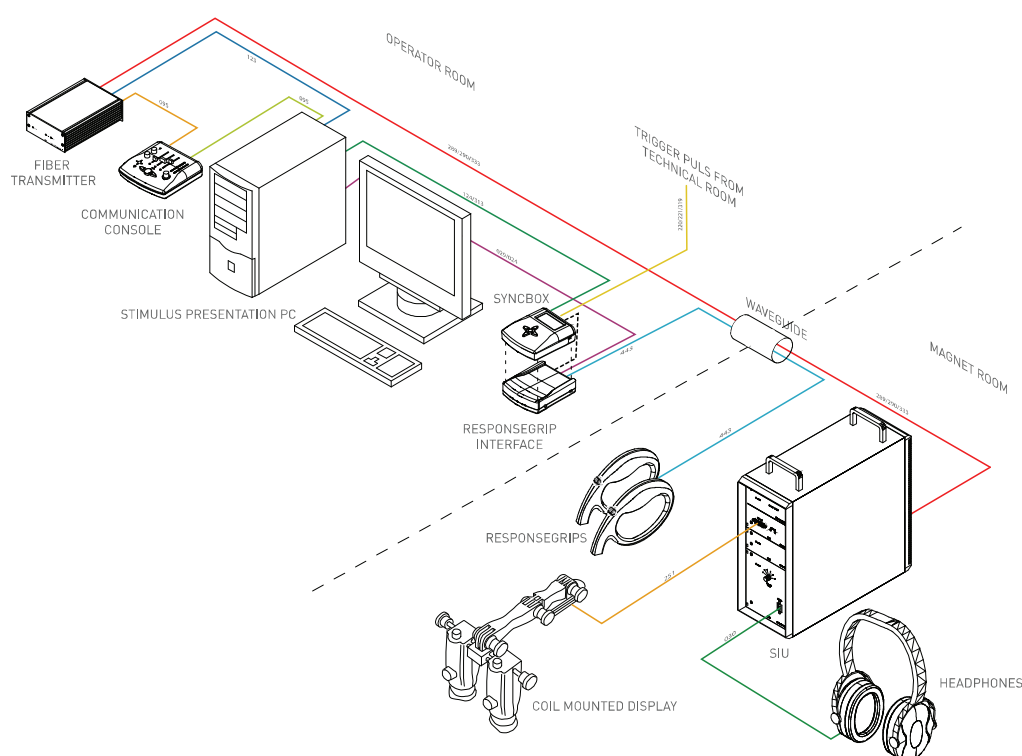
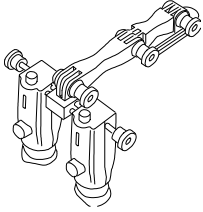

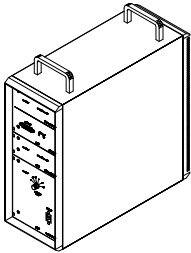

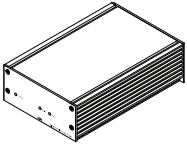

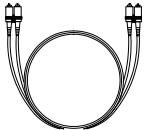

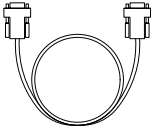

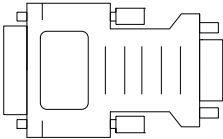

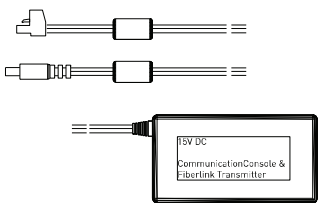

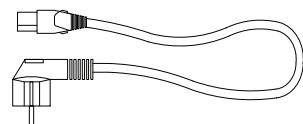



Figure 1. Schematic representation of the fMRI Hardware System set-up.

## 2.2. VisualSystem Installation

### 2.2.1. What's included ...

 <p>100497</p>	<p><b>Coil-mounted Display</b></p> <p>for presentation of visual stimuli and video materials inside the MR scanner.</p> <div>  <p>The signal cable attached to the Coil-mounted Display must be kept in straight lines to avoid self-heating. The cable connector contains ferromagnetic materials and must be kept at a safe distance from the MR scanner (outside the 20 mT line).</p> </div>
 <p>100208</p>	<p><b>Shielded Interface Unit (SIU)</b></p> <p>shielded enclosure for the Power Supply Unit, Electrostatic Energizer (audio amplifier), Optical Electrical Adapter Unit and OLED Interface Unit.</p> <div>  <p>The SIU contains ferromagnetic materials and must be kept at a safe distance from the MR scanner (outside the 20 mT line).</p> </div>
 <p>100527</p>	<p><b>Fiber Transmitter</b></p> <p>converts audio and video signals into an optical signal for transmission</p> <div>  <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p> </div>
 <p>100289/290/333</p>	<p><b>fiber cable</b></p> <p>for connection between the Fiber Transmitter and the SIU through an available waveguide</p> <div>  <p>This cable is fragile! Maximum bending radius: 10 cm</p> </div>
 <p>100123</p>	<p><b>VGA cable</b></p> <p>for connection of the Fiber Transmitter with the stimulus presentation PC</p> <div>  <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p> </div>
 <p>100314</p>	<p><b>DVI-to-VGA adapter</b></p> <p>adapts a DVI-A signal to a standard VGA signal; used if the stimulus presentation PC only has a DVI port available</p> <div>  <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p> </div>

 <p>100283</p>	<p><b>15V power supply</b></p> <p>15V power supply for both Communication Console and Fiber Transmitter. The power supply delivered with your system may vary depending on number and type of components.</p> <div>  </div> <p>Contains ferrormagnetic materials, keep out of the Magnet Room.</p>
 <p>100126/302/339/392/500</p>	<p><b>power cables</b></p> <p>for the SIU and the 15V power supply. The power cable delivered with your system may vary depending on your type of mains outlet and may come in dual configuration.</p> <div>  </div> <p>Power cables contain ferromagnetic materials, keep at safe distance from the MR scanner (outside the 20mT line).</p>

## 2.2.2. VisualSystem hardware installation instructions

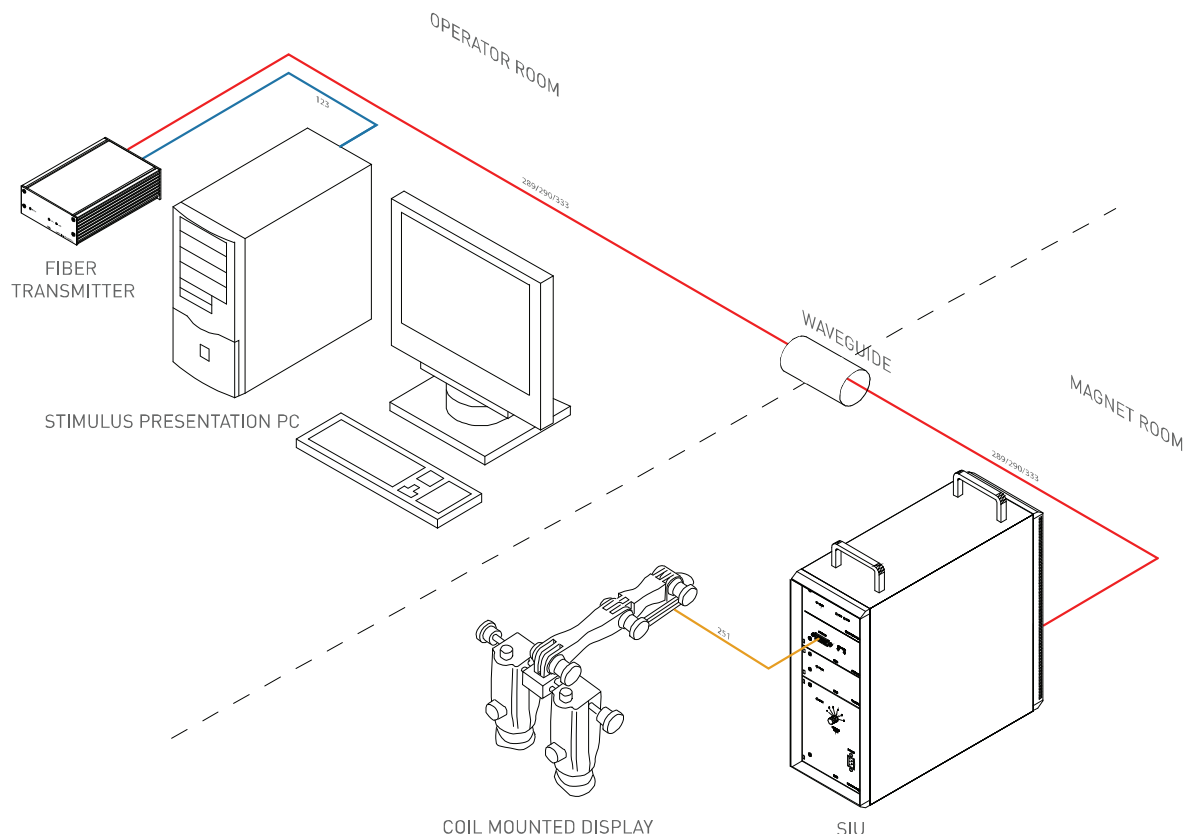


Figure 2. Schematic representation of the VisualSystem set-up.

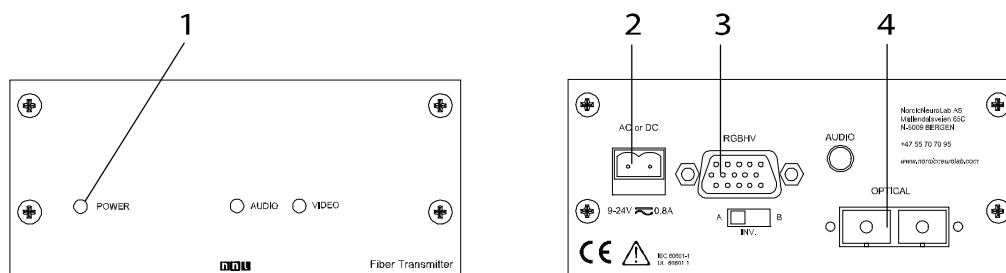


Figure 3. Front and back panel of the Fiber Transmitter.

### Operator room

- Connect the VGA cable between the stimulus presentation PC and Fiber Transmitter (3). For a PC with only a DVI output, use the DVI-to-VGA adapter that comes with the VisualSystem.
- Connect the fiber cable to the Fiber Transmitter (4) and feed the fiber cable through the waveguide into the magnet room.
- Connect the green connector of the 15V power supply to the Fiber Transmitter (2).
- Connect the power supply to your mains outlet. The light indicator (1) on the Fiber Transmitter should now be active.

## Magnet room

- Connect the fiber cable to the fiber input on the back panel of the SIU (8).
- Connect the Coil-mounted Display signal cable to the OLED Interface Unit at the front of the SIU (6).
- Connect the power cable to the SIU (9) and to your mains outlet. Switch on the SIU (7). The power indicator (5) should now be active.

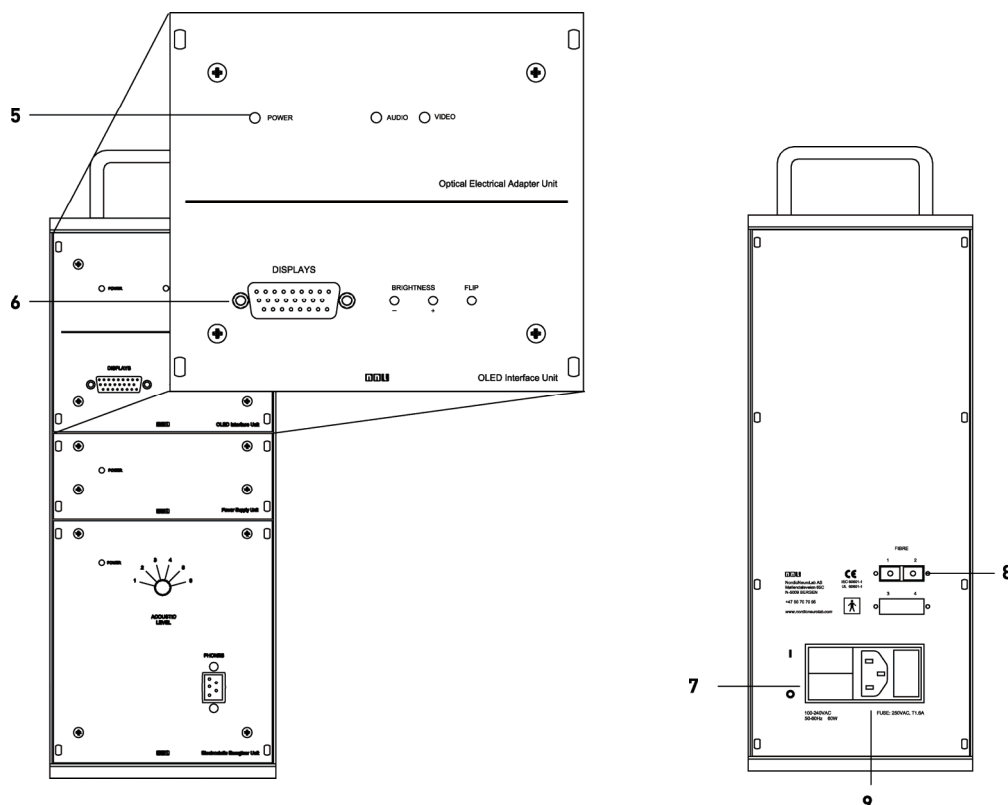


Figure 4. Front and back panel of the SIU.

### 2.2.3. Stimulus presentation PC configuration

The VisualSystem acts as a regular monitor and does not require any particular software installed to display standard SVGA video signal except for an additional VGA or DVI output from the PC.

For your image to display correctly the screen resolution for the VGA output on the PC connected to the VisualSystem must be set 800 x 600. Accepted refresh rates: 60-85 Hz. We recommend that the refresh rate is set to 85 Hz.



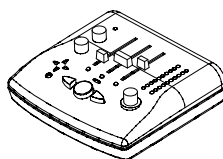

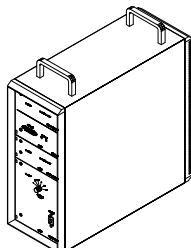

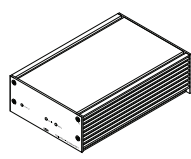



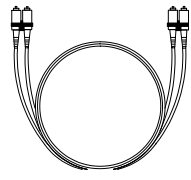

### 2.2.4. 3D and stereo vision

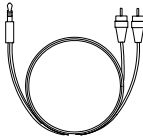

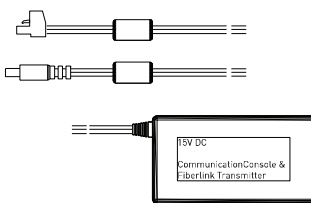

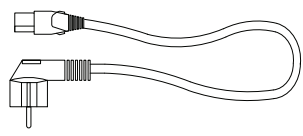

In order to display 3D and stereo materials, the stimulus presentation PC must be equipped with a graphics card supporting frame sequential presentation.

Please contact [support@nordicneurolab.com](mailto:support@nordicneurolab.com) for more information on suitable graphics cards and on how to enable and control the presentation of stereo stimuli on your VisualSystem.

## 2.3. AudioSystem Installation

### 2.3.1. What's Included...

 <p>100349</p>	<p><b>Headphones</b></p> <p>for presentation of auditory stimuli and audio materials inside the MR scanner</p> <div>  </div> <p>The headphone cable must be kept in straight lines to avoid self-heating. The cable connector to the SIU contains ferromagnetic materials and must be kept at a safe distance from the MR scanner (outside the 20 mT line).</p>
 <p>100041</p>	<p><b>Communication Console</b></p> <p>audio mixer for flexible control over audio settings</p> <div>  </div> <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100208</p>	<p><b>Shielded Interface Unit (SIU)</b></p> <p>shielded enclosure for the Power Supply Unit, Electrostatic Energizer (audio amplifier), Optical Electrical Adapter Unit and OLED Interface Unit</p> <div>  </div> <p>The SIU contains ferromagnetic materials and must be kept at a safe distance from the MR scanner (outside the 20 mT line).</p>
 <p>100527</p>	<p><b>Fiber Transmitter</b></p> <p>converts audio and video signals into an optical signal for transmission</p> <div>  </div> <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100049</p>	<p><b>Headphones extension cable</b></p> <p>additional extension cables to increase cable length of the Headphones</p> <div>  </div> <p>One of the extension cables contains a ferrite bead and must be kept at a safe distance from the MR scanner (outside the 20 mT line).</p>
 <p>100289/290/333</p>	<p><b>fiber cable</b></p> <p>for connection between the Fiber Transmitter and the SIU through an available waveguide</p> <div>  </div> <p>This cable is fragile! Maximum bending radius: 10 cm</p>

 <p>x 2 100095</p>	<p><b>audio cable</b></p> <p>cable for audio in/out signals to and from the Communication Console</p> <div>  </div> <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100283</p>	<p><b>15V power supply</b></p> <p>15V power supply for both Communication Console and Fiber Transmitter. The power supply delivered with your system may vary depending on number and type of components.</p> <div>  </div> <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100126/302/339/392/500</p>	<p><b>power cables</b></p> <p>for the SIU and the 15V power supply. The power cable delivered with your system may vary depending on your type of mains outlet and may come in dual configuration.</p> <div>  </div> <p>Power cables contain ferromagnetic materials, keep at safe distance from the MR scanner (outside the 20mT line).</p>



2.3.2. AudioSystem hardware installation instructions

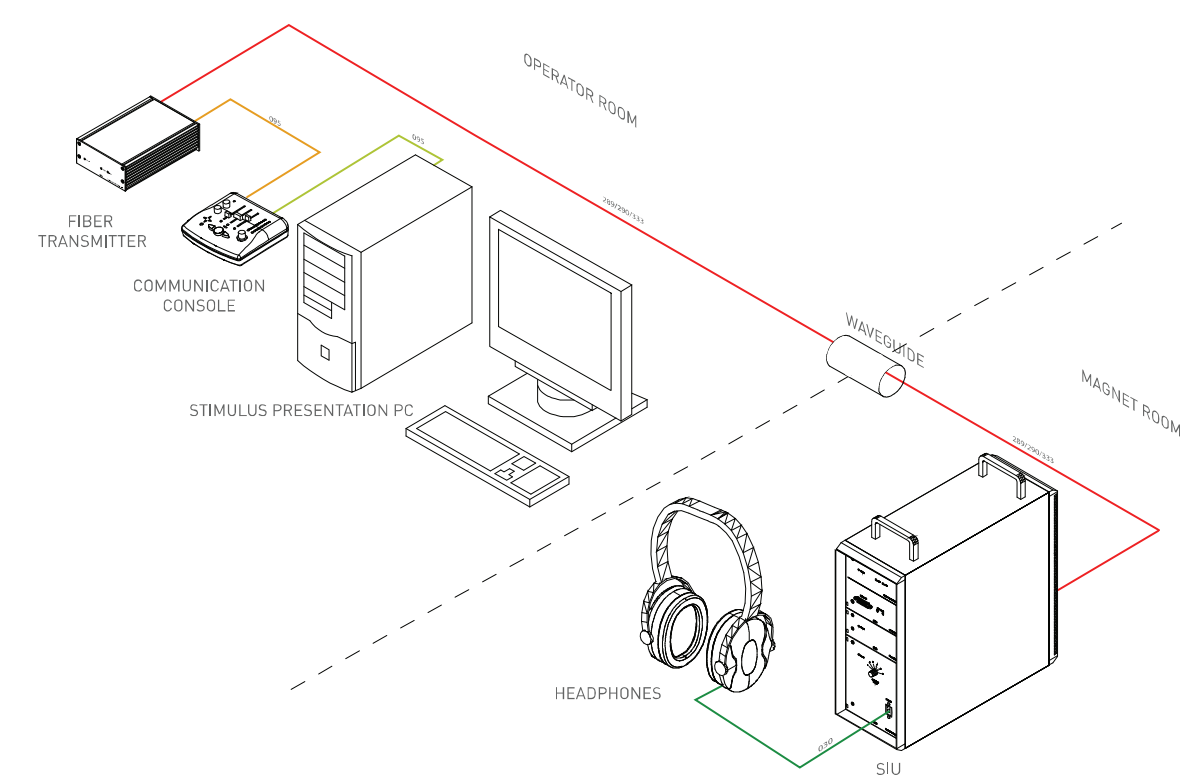


Figure 5. Schematic representation of the AudioSystem set-up.

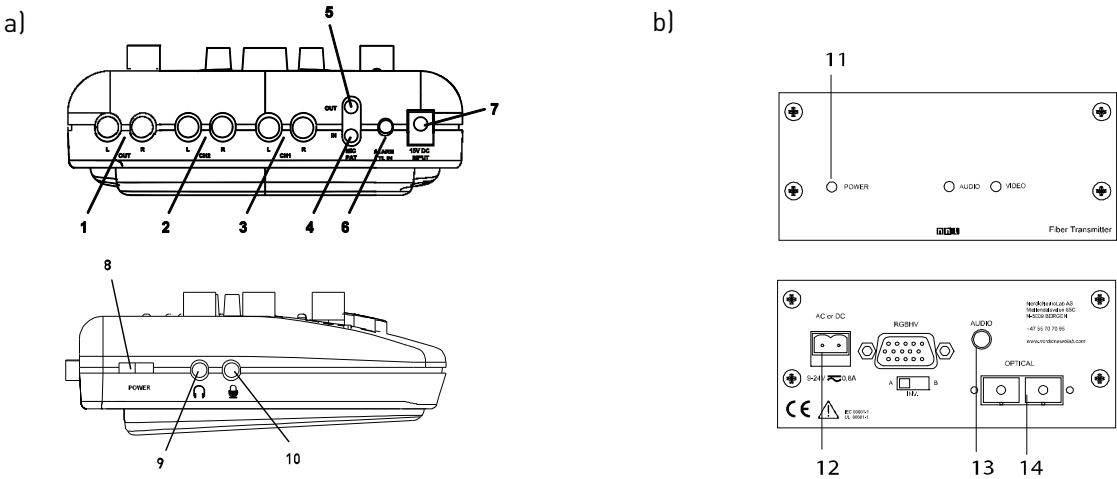


Figure 6. a) back and side view of the Communication Console; b) front and back panel of the Fiber Transmitter.

## Operator room

- Connect audio output of the stimulus presentation PC to CH1 or CH2 audio input on the Communication Console [2,3].
- Connect the OUT channel of the Communication Console (1) to the audio input on the Fiber Transmitter (13) with the other audio cable.
- Connect the fiber cable to the Fiber Transmitter (14) and feed the fiber cable through the waveguide into the magnet room.
- Connect the green connector of the 15 V power supply to the Fiber Transmitter (12) and the other connector to the Communication Console (7).
- Make sure the Communication Console is switched off (POWER, 8). Then connect the power cable to the 15 V power supply and your mains outlet. Turn on the Communication Console (POWER, 8). The yellow and green indicators on the Communication Console and Fiber Transmitter indicate that the units are turned on (11).
- Additional audio sources like a CD player, operator and/or subject microphone can be connected to the CH1 or CH2 audio input (2,3), the microphone input (10), and the MIC PAT IN input (4), respectively.
- The Communication Console can output the signal from a subject microphone via the MIC PAT OUT connector (5).
- Operator Headphones can be attached to output (9).

Refer to section 3.2.2 for more details on Communication Console configurations.

## Magnet room

- Connect the fiber cable to the fiber input on the back panel of the SIU (19).
- Connect the cable from the Headphones to the Electrostatic Energizer at the front of the SIU (16). Use the extension cable with the ferrite bead to connect to the SIU.
- Connect the power cable to the SIU (18) and to your mains outlet, switch on the SIU (17) and confirm that the power indicator (15) lights up.

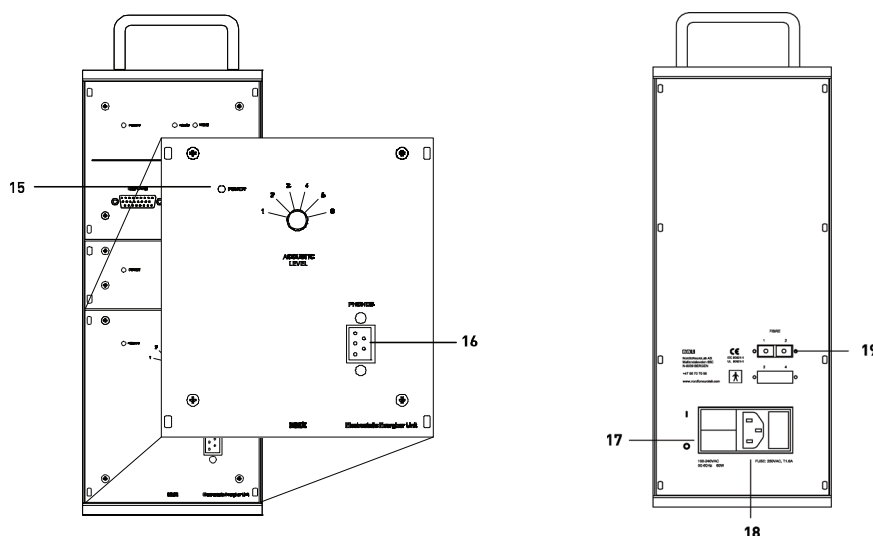
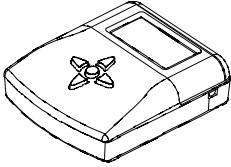

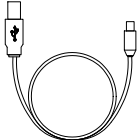

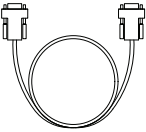

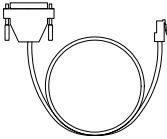

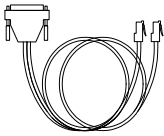

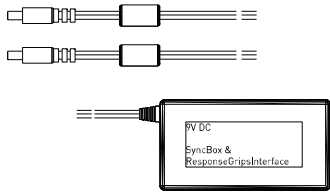

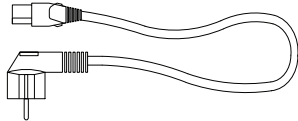



Figure 7. Front and back panel of the SIU.

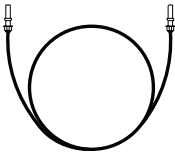
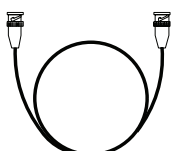
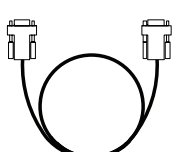
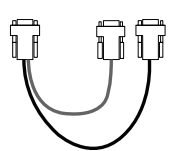
## 2.4. SyncBox Installation

### 2.4.1. What's included ...

 <p>100001</p>	<p><b>SyncBox</b></p> <p>SyncBox user interface</p> <div>  <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p> </div>
 <p>100026</p>	<p><b>USB cable</b></p> <p>for interfacing the SyncBox with a USB port on the stimulus presentation PC</p> <div>  <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p> </div>
 <p>100124</p>	<p><b>serial cable</b></p> <p>for interfacing the SyncBox with the serial port on the stimulus presentation PC</p> <div>  <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p> </div>
 <p>100543</p>	<p><b>Presentation® cable</b></p> <p>for interfacing the SyncBox with the parallel port on the stimulus presentation PC for use with the Presentation® software</p> <div>  <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p> </div>
 <p>100029</p>	<p><b>Presentation® cable (combined)</b></p> <p>for interfacing the SyncBox (and the ResponseGrip) with the parallel port on the stimulus presentation PC for use with the Presentation® software</p> <div>  <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p> </div>

 <p>100282</p>	<p><b>9V power supply</b></p> <p>for the SyncBox user interface and the ResponseGrip Interface. The power supply delivered with your system may vary depending on number and type of system components.</p> <p> Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100126/302/339/392/500</p>	<p><b>power cable</b></p> <p>for the 9V power supply. The power cable delivered with your system may vary depending on your type of mains outlet.</p> <p> Power cables contain ferromagnetic materials, keep at safe distance from the MR scanner (outside the 20mT line).</p>

Depending on your MR scanner, one of the following cables has been delivered with the SyncBox:

 <p>100220</p>	<p><b>Siemens MR trigger cable - optical signal</b></p> <p>trigger cable for use with Siemens MR scanners</p>
 <p>100221</p>	<p><b>Philips MR trigger cable - TTL signal</b></p> <p>trigger cable for use with Philips MR scanners</p>
 <p>100219</p>	<p><b>GE MR trigger cable - RS 485/422 signal</b></p> <p>trigger cable for use with GE MR scanners</p>
 <p>100313</p>	<p><b>GE MR adapter cable</b></p> <p>adapter cable for use with GE MR scanners when serial communication with the stimulus presentation PC is required</p>

### 2.4.2. SyncBox hardware installation instructions

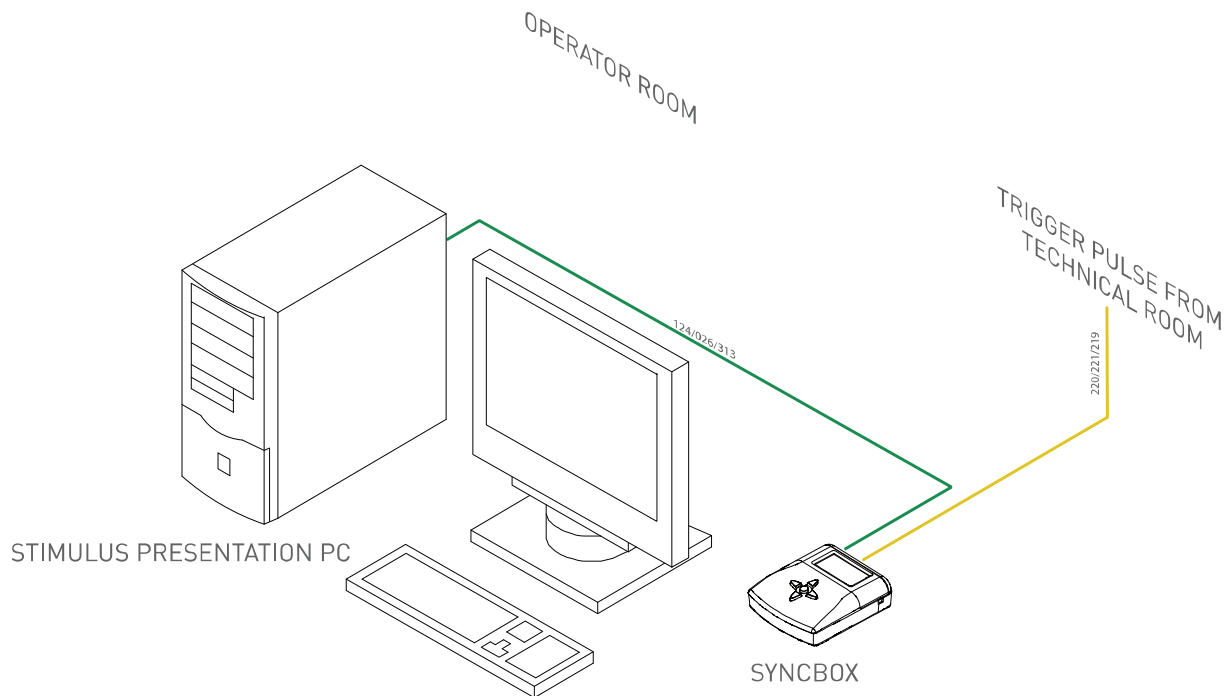


Figure 8. Schematic representation of the SyncBox set-up.

#### Connecting the MR trigger cable

Siemens MR scanner:

- The Siemens MR trigger cable must be connected to the scanner trigger output in the technical room by a Siemens technician or an on-site MR technician. For detailed information on the Siemens trigger output, contact [support@nordicneurolab.com](mailto:support@nordicneurolab.com). Ask your local Siemens organization for permission before connecting the SyncBox.

Philips MR scanner:

- The Philips MR trigger cable must be connected to the scanner trigger output by a Philips technician or an on-site MR technician. For detailed information on the Philips trigger output, contact [support@nordicneurolab.com](mailto:support@nordicneurolab.com). Ask your local Philips organization for permission before connecting the SyncBox.

GE MR scanner:

- The GE MR trigger cable must be connected to the scanner trigger output in the technical room by a GE technician or an on-site MR technician. For detailed information on the GE trigger output, contact [support@nordicneurolab.com](mailto:support@nordicneurolab.com). Ask your local GE organization for permission before connecting the SyncBox.

## Operator room

- Connect the trigger cable to the appropriate input on the SyncBox. For GE systems, use input (4), for Phillips systems use the BNC input (7), and for Siemens systems use the optical input (8).
- Connect the SyncBox to the stimulus presentation PC by using one of the PC interface cables that come with the SyncBox:
  - The USB cable is connected to the mini-USB port (6) on the side of the SyncBox and an available USB port on the stimulus presentation PC.
  - The serial cable is connected to connector (4) and a serial port on the stimulus presentation PC. If connected to a GE system, use the GE MR adapter cable.
  - The Presentation® cable is connected to the RJ-45 port (9) and to the parallel port on the stimulus presentation PC. This cable can also be connected to the ResponseGrip Interface to minimize cable usage.
- Connect the 9V power supply to the 9V DC input (5). Make sure the SyncBox is switched off and connect the power cable to the 9V power supply and your mains outlet. Turn on the SyncBox. The display should now be lit.

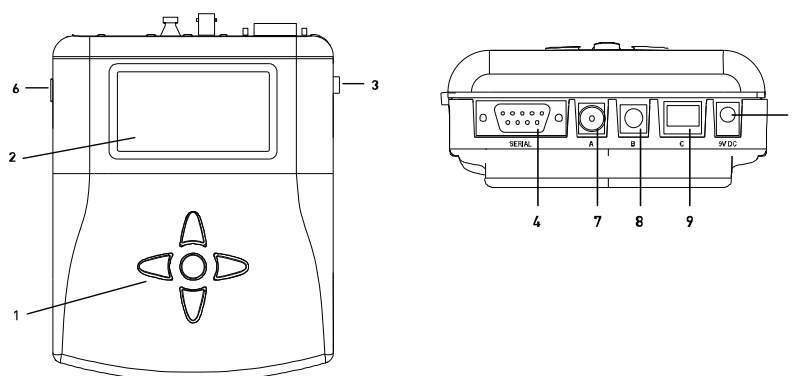


Figure 9. Top and back view of the SyncBox

### 2.4.3. Interfacing the SyncBox with the stimulus presentation PC

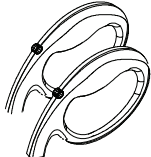

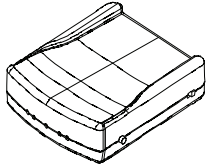

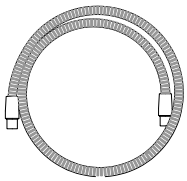

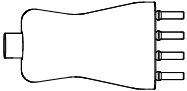

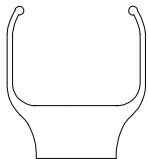

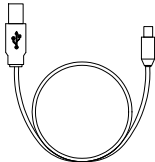

Due to the variety of stimulus presentation software packages and interfacing alternatives therein, the SyncBox is delivered with different interface cables for maximum user flexibility:



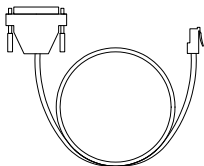

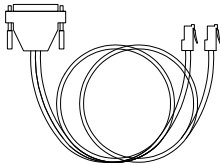

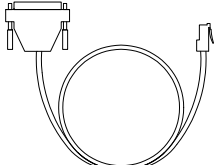

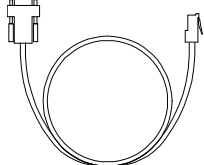

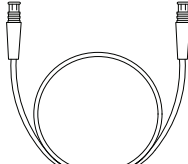

- **USB cable:** USB interfacing is supported by most stimulus presentation software packages. The SyncBox may be operated in two different USB modes, the Human interface Device (HID) mode and the serial mode (driver installation required; driver included on the User Manual CD). The USB mode is set in the SyncBox menu (see section 3.3.2).
- **Serial cable:** interfacing via the serial port of the PC is supported by most stimulus presentation software packages.
- **Presentation® cable/(combined):** For users of Presentation® we recommend using this cable with a parallel port PC interface. This cable also includes the option to connect to the ResponseGrip Interface to reduce the number of cables.

Refer to section 3.3 for more details on SyncBox interfacing options.

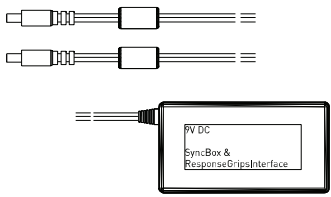

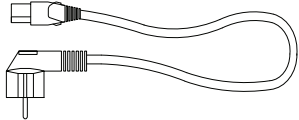

## 2.5. ResponseGrip Installation

### 2.5.1. What's included ...

 <p>100518</p>	<p><b>grips</b></p> <p>hand-held grips with 2 response buttons per grip</p> <div>  </div> <p>This device poses no known hazards in MR environments.</p>
 <p>100013</p>	<p><b>ResponseGrip Interface</b></p> <p>optic-electric interface unit between grips and stimulus presentation PC</p> <div>  </div> <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100443</p>	<p><b>ResponseGrip Bundle</b></p> <p>cable connecting the hand-held grips and the ResponseGrip Interface via the ResponseGrip Coupler</p> <div>  </div> <p>This device poses no known hazards in MR environments.</p>
 <p>100444</p>	<p><b>ResponseGrip Coupler</b></p> <p>coupler for connecting the ResponseGrip Bundle to the ResponseGrip Interface</p> <div>  </div> <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100444</p>	<p><b>ResponseGrip Coupler Support</b></p> <p>supporting foot for the ResponseGrip Coupler</p> <div>  </div> <p>This device poses no known hazards in MR environments.</p>
 <p>100026</p>	<p><b>USB cable</b></p> <p>for interfacing the ResponseGrip Interface with a USB port on the stimulus presentation PC</p> <div>  </div> <p>Contains ferromagnetic materials, keep out of the Magnet Room.</p>

 <p>100312</p>	<p><b>patch cable</b></p> <p>for connection between the ResponseGrip Interface and the SyncBox</p> <p> Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100025</p>	<p><b>Presentation® cable</b></p> <p>for interfacing the ResponseGrip Interface with the parallel port on the stimulus presentation PC for use with the Presentation® software</p> <p> Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100029</p>	<p><b>Presentation® cable (combined)</b></p> <p>for interfacing the ResponseGrip Interface (and the SyncBox) with the parallel port on the stimulus presentation PC for use with the Presentation® software</p> <p> Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100024</p>	<p><b>E-Prime cable</b></p> <p>for interfacing the ResponseGrip Interface with the parallel port on the stimulus presentation PC for use with the E-Prime software</p> <p> Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100310</p>	<p><b>serial cable</b></p> <p>for interfacing the ResponseGrip Interface with the serial port on the stimulus presentation PC</p> <p> Contains ferromagnetic materials, keep out of the Magnet Room.</p>
 <p>100341</p>	<p><b>operator notification cable</b></p> <p>for connection between the ResponseGrip Interface and Communication Console when operator notification is activated (for details, see section 3.4.3)</p> <p> Contains ferromagnetic materials, keep out of the Magnet Room.</p>



 <p>100282</p>	<p><b>9V power supply</b></p> <p>for the SyncBox user interface and the ResponseGrip Interface. The power supply delivered with your system may vary depending on number and type of system components.</p> <div><p>Contains ferromagnetic materials, keep out of the Magnet Room.</p></div>
 <p>100126/302/339/392/500</p>	<p><b>power cable</b></p> <p>for the 9V power supply. The power cable delivered with your system may vary depending on your type of mains outlet.</p> <div><p>Power cables contain ferromagnetic materials, keep at safe distance from the MR scanner (outside the 20mT line).</p></div>

### 2.5.2. ResponseGrip hardware installation instructions

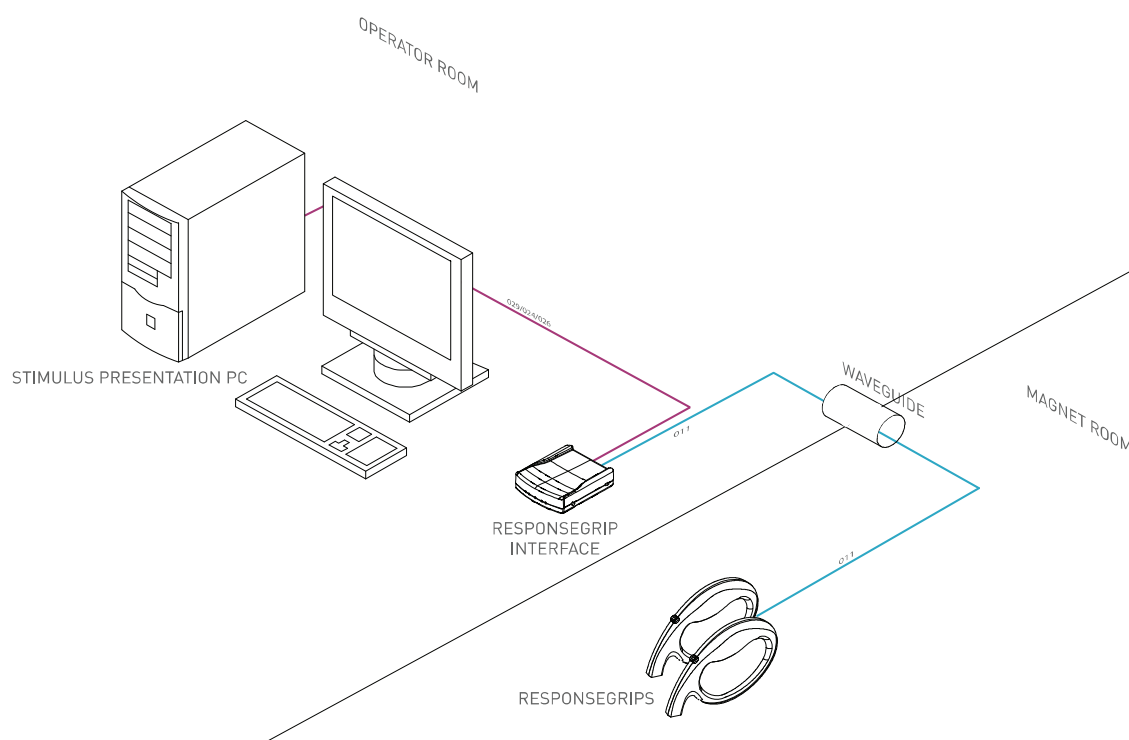


Figure 10. Schematic representation of the ResponseGrip set-up.

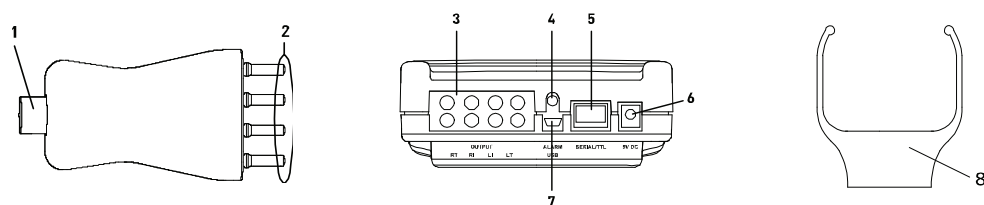


Figure 11. Back of the ResponseGrip Interface.

#### Magnet room

- Connect the grips and the ResponseGrip Bundle, and feed the cable trough the waveguide into the operator room.

#### Operator room

- Connect the ResponseGrip Bundle to the corresponding connector on the ResponseGrip Coupler (1)
- Connect the 8 pin fiber connector (2) of the ResponseGrip Coupler to the corresponding input on the ResponseGrip Interface (3).
- Attach the ResponsGrip Coupler Support (8) to the Coupler.

- Connect the ResponseGrip Interface to the stimulus presentation PC using one of the PC interface cables that come with the system:
  - The USB cable is connected to the mini-USB port (7) and to an available USB port on the stimulus presentation PC.
  - The serial cable is connected to the RJ-45 port (5) and a serial port on the stimulus presentation PC.
  - The Presentation® cable is connected to the RJ-45 port (5) and the parallel port on the stimulus presentation PC. This cable can also be connected to the SyncBox to reduce the number of cables.
  - The E-Prime cable is connected to the RJ-45 port (5) and the parallel port on the stimulus presentation PC.
- The patch cable is connected to the RJ-45 port (5) and to the matching port on the SyncBox.
- Connect the 9V power supply to the 9V DC input (6). Make sure the ResponseGrip Interface is switched off. Connect the power cable to the 9V power supply and your mains outlet. Turn on the ResponseGrip Interface. The light indicator on the ResponseGrip Interface should now be active.

### 2.5.3. Interfacing the ResponseGrip with the stimulus presentation PC

Due to the variety of stimulus presentation software packages and interfacing alternatives therein, the SyncBox is delivered with different interface cables for maximum user flexibility:

- **USB cable:** USB interfacing is supported by most stimulus presentation software packages.
- **patch cable:** The patch cable can be used to connect the ResponseGrip Interface via the SyncBox, which in turn is connected to the stimulus presentation PC via a USB cable to reduce the number of cables.
- **E-Prime cable:** For users of E-Prime we recommend using this cable with the parallel port PC interface.
- **Presentation® cable / (combined):** For users of Presentation® we recommend using this cable with the parallel port PC interface. This cable can also be connected to the SyncBox to reduce the number of cables.

Refer to section 3.4 for more details on ResponseGrip interfacing options.

## 3. How to use the ...

### 3.1. ... VisualSystem

The VisualSystem has been designed for presenting high-quality graphics and text to the subject. It features an optical design that enlarges images generated by OLED (Organic Light Emitting Diode) displays. OLEDs emit light themselves, do not require a backlight and, thus, generate brilliant colors and truly black pixels without the risk of dead or grey pixels. Additionally, the VisualSystem offers integrated diopter and pupil distance adjustment.

The VisualSystem consists of 3 main components: the Coil-mounted Display, the OLED Interface Unit integrated in the SIU, and the Fiber Transmitter.

#### 3.1.1. Coil-mounted Display

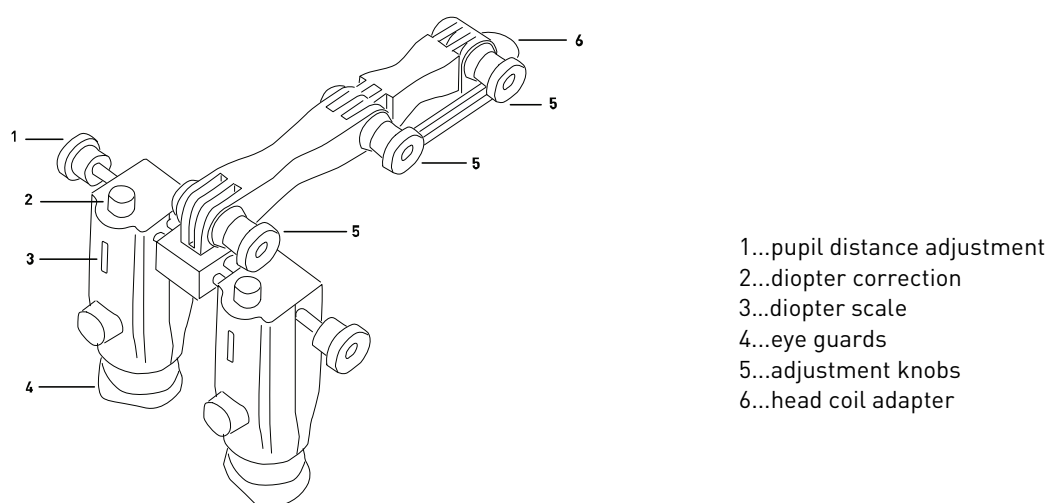


Figure 12. The Coil-mounted Display.



#### Caution

The Coil-mounted Display of the NNL VisualSystem contains minor ferromagnetic components. These components cause local magnetic field distortions in the sub-ppm range over a range of about 30 mm. For the intended use (i.e., fMRI studies) these local magnetic field distortions are restricted to the eyeholes and do not affect the brain area.

The Coil-mounted Display is effortlessly adjusted to fit onto the subject's eyes by using the adjustment knobs (5) on the flexible arm.

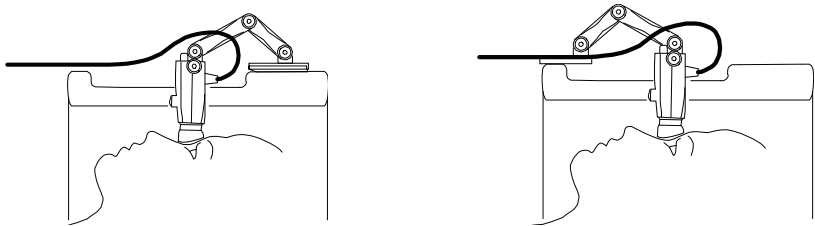


Figure 13. The Coil-mounted Display attached to two different types of head coils and fitted onto the subject's eyes.

Position the cable of the Coil-mounted Display so that it forms a small loop on top of the coil (as shown in Fig. 13). Make sure that the cable does not run around the entire coil.



**Caution**

Make sure there is enough space between the Coil-mounted Display and the MR bore before operating the subject table.

Pupil distance and diopter correction can be adjusted using knobs (1) and (2), respectively, as shown in the diagram below. The diopter scale indicates the applied diopter correction (range: -5 to +2 dpt) for each eye.

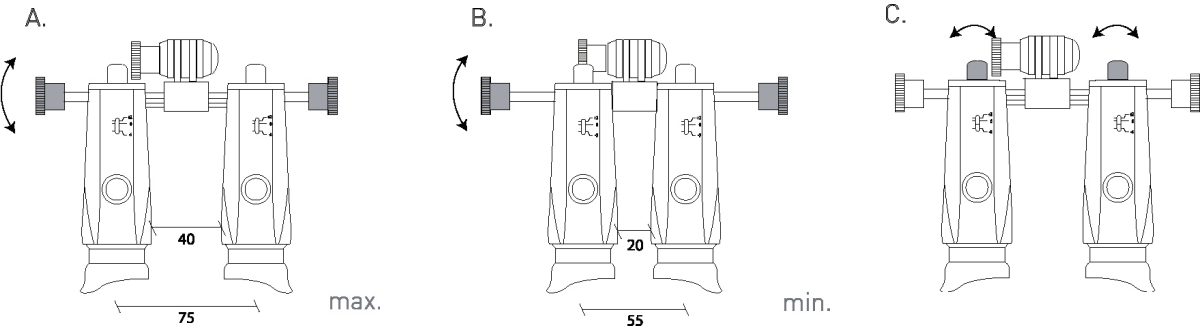


Figure 14. Pupil distance adjustment: maximum (a) and minimum (b) distance positions [mm]; (c) diopter correction for each eye.

It is important that the image can be perceived clearly on both eyes. Adjust the diopter correction individually so that both images are in focus. Further adjust the pupil distance between the eyes. Both settings are essential for the fusion of the two images.



**Caution**

Do not force the diopter correction beyond the end of its scale (indicated in red) as this might irreversibly damage the mechanism and the system.

### 3.1.2. OLED Interface Unit

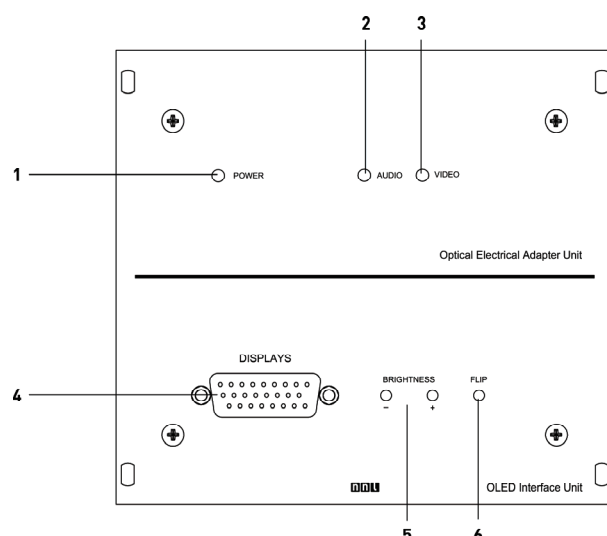


Figure 16. OLED Interface Unit, front panel of the SIU.

- Turn on the equipment by using the ON/OFF switch at the back of the SIU (as described in section 2.2.2). The power indicator (1) is now lit.
- Make sure that the resolution of the video signal from the computer is set to 800x600. A green light will flash if sound signal is transmitted (2) and a stable green light is on when video signal is transmitted (3).
- If properly connected, video from the computer is now visible in the Coil-mounted Display.
- Brightness can be adjusted by operating two small push-buttons at the front of the OLED Interface Unit (5).
- Using the FLIP button (6), the image displayed in the Coil-mounted Display can be flipped by 180°, mirrored, or both.

### 3.1.3. Fiber Transmitter

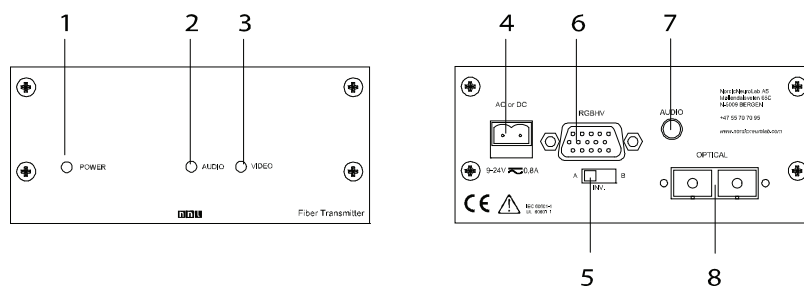


Figure 17. Front and back of the Fiber Transmitter.

- After installation, the Fiber Transmitter is automatically powered on with the system. A green light will flash if an audio signal is transmitted (2) and a stable green light is active when a video signal is transmitted (3).
- There is a small switch marked "INV" below the VGA input for inverting the 3D signal. It can be used to direct the left-eye image to the right display and vice versa, the right-eye image to the left display. After installation these settings are usually not changed.

## 3.2. ... AudioSystem

Designed specifically for fMRI, the AudioSystem offers flexible solutions for auditory stimulus presentation, hearing protection, and operator-subject communication.

The electrostatic Headphones ensure high-precision presentation of audio materials even in the MR environment, with a flat frequency response from 8Hz to 35kHz.

The AudioSystem consists of four main components: the Headphones, the Communication Console, the Electrostatic Energizer integrated in the SIU, and the Fiber Transmitter.

### 3.2.1. Headphones

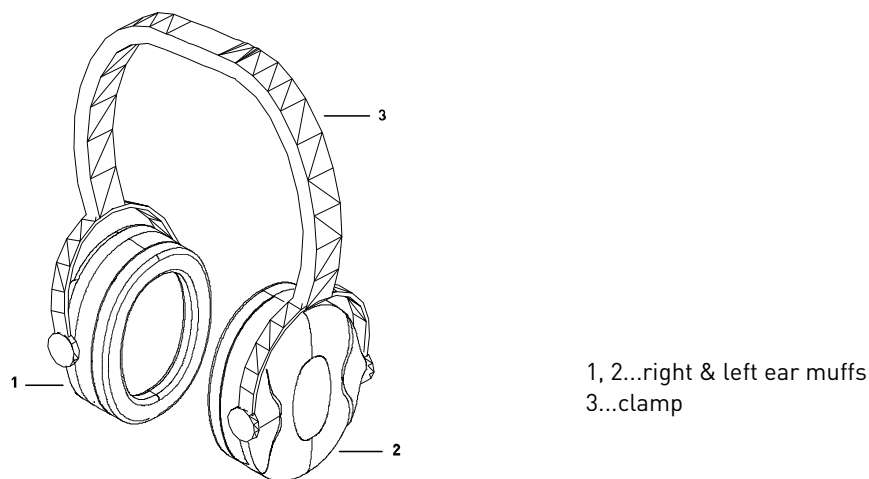


Figure 18. Electrostatic Headphones.

The Headphones consist of the right and left ear muffs, and the clamp. Always make sure that the ear muffs are tightly fit over the subject's entire ear to ensure maximum noise protection.

Keep in mind that the end of one of the extension cables contains a ferrite bead and would be dragged towards the magnet if taken inside the 20mT line.

### 3.2.2. Communication Console

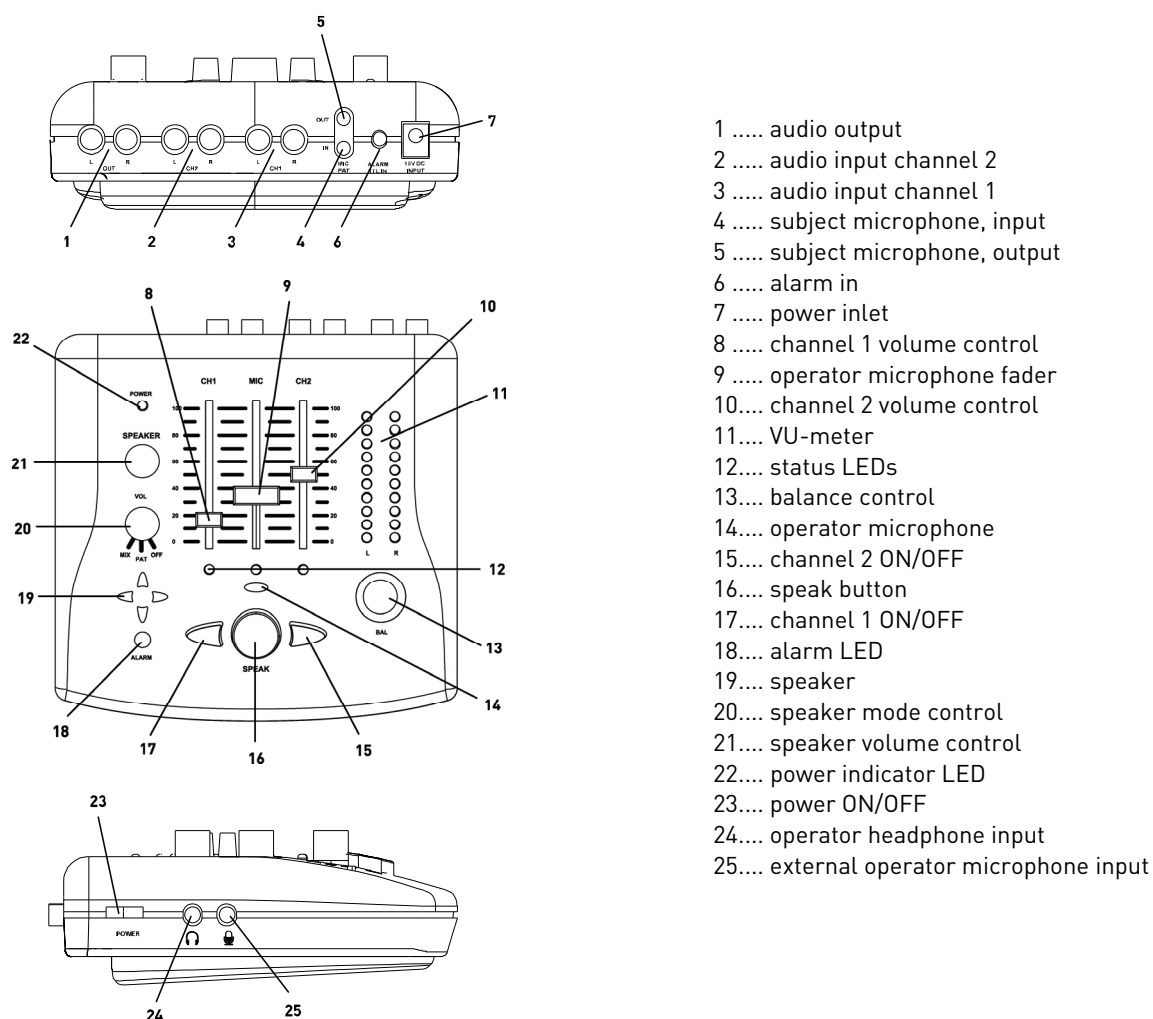


Figure 19. Top, back, and side view of the Communication Console.

- The Communication Console gives the operator flexible control over audio materials presented to the subject from two external sources, channel 1 and channel 2 (3,2). Each channel has its own volume control and ON/OFF button (8,10,17,15). LEDs (12) indicate which channel is active.
- The Communication Console also allows the operator to directly communicate with the subject via an operator microphone (14), which has a “push to talk” feature. The speak button [16] must be held down to activate the microphone. Channels 1 and 2 will then be inactive. Alternatively, an external operator microphone can be used, which plugs into (25). The internal operator microphone will then be inactive.
- The balance control (13) adjusts the left/right balance on the audio output to the subject. The output is visualized by the VU-meter (11).
- The Communication Console also has a built-in speaker (19) with its own volume control (21). This speaker is used for subject feedback or output feedback from the Communication Console. These functions can be set with the speaker mode control (20), which has three positions: OFF, PAT and MIX.



- When the speaker mode control is in the OFF position, the speaker is inactive. In PAT position signal from a subject microphone is audible. The subject microphone must be connected to the subject microphone input (4). The subject microphone output can also be re-directed to another device via the subject microphone output (59). In MIX position the speaker presents the audio output from Communication Console. As an alternative to the built-in speaker, operator headphones can be connected to the Communication Console (24).

### Operator notification

The Communication Console has a built-in operator notification function, which sets off a visual (flashing indicator) and auditory (repeated beeping sound) alarm when the subject sets off operator notification via the ResponseGrip.

Make sure that the ResponseGrip Interface has been configured with operator notification enabled (as described in section 3.4.3) and the alarm output on the ResponseGrip Interface is connected to the alarm input on the Communication Console (6) via the alarm cable that comes with the ResponseGrip (see section 2.5.1).



Remember that the Communication Console needs a warm-up time of 10 seconds after power up.

### 3.2.3. Electrostatic Energizer

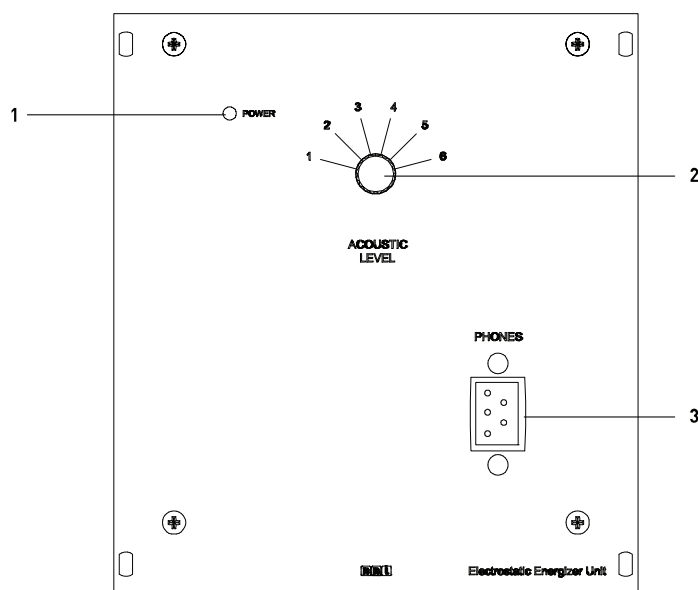


Figure 20. Electrostatic Energizer Unit front panel, SIU.

The Electrostatic Energizer amplifies the incoming signal and transforms it to a high-voltage signal for input to the electrostatic Headphones. It is mounted inside the SIU and has three key elements:

- power indicator LED (1) is active when the unit is turned on
- acoustic level control (2) (6 fixed positions)
- Headphones connector (3), for connection of the electrostatic Headphones (see section 2.3.2)

### 3.2.4. Fiber Transmitter

See section 3.1.3.



Make sure that the ACOUSTIC LEVEL (2) is initially set to the minimum to avoid hearing damage

### 3.3. ...SyncBox

The SyncBox is designed for synchronization of stimulus presentation and MR image acquisition in fMRI experiments. The SyncBox receives the trigger signals coming from the MR scanner during image acquisition and forwards the trigger signal to the PC presenting the stimuli, giving the user full flexibility with respect to how the trigger signal from the MR scanner is transmitted to the PC. User settings can be entered manually through the user interface on the SyncBox unit, or automatically via the stimulus presentation program.

The SyncBox can also be operated in simulation mode. This is useful for the development and testing of experimental paradigms outside the MR environment. By simulating the trigger signals coming from the MR scanner during image acquisition, paradigms can be developed and tested in the office, minimizing the need for expensive MR scanner time.

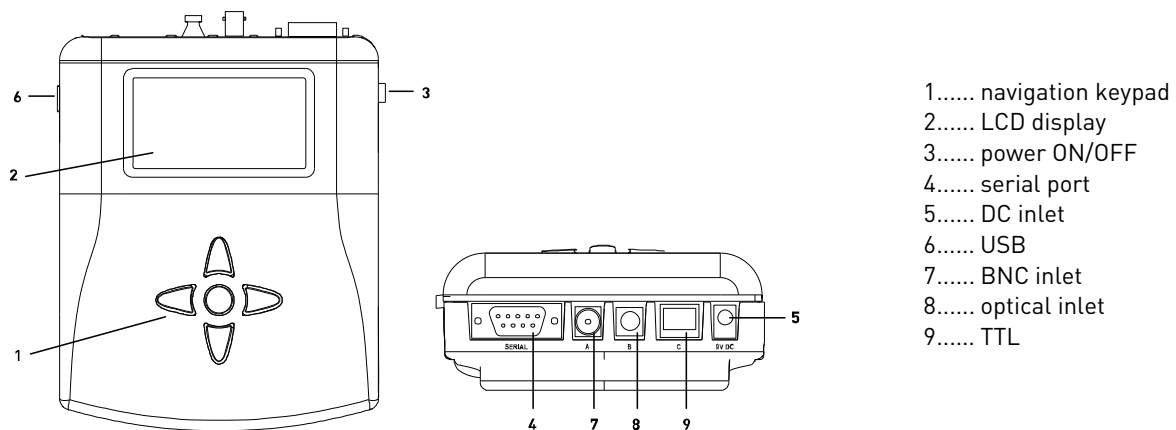


Figure 21. Top and back view of the SyncBox.

Turn on the SyncBox using the power ON/OFF [3] switch on the right side of the SyncBox unit. The 5-button navigation keypad [1] allows for easy navigation through the menu. Use the up and down, right and left arrows to navigate through the menu. The round button in the middle is used as “enter” or “confirm”.

#### 3.3.1. Interfacing the SyncBox with the stimulus presentation PC

##### USB Interface

When connected to the stimulus presentation PC via USB, the SyncBox can be recognized by the PC as a Human Interface Device (HID) or as a serial port. The two different modes - HID or serial interface - are chosen in the Options menu (for more details, refer to section 4.3.2).

##### HID mode

When connected via USB, the SyncBox will be recognized by the PC as a Human Interface Device (HID)/keyboard. No drivers are needed. The letter “s” will be sent to the stimulus presentation PC when a trigger signal is received from the MR scanner (for more details on specifying the signal sent to the stimulus presentation PC, refer to section 3.3.2).

For OS language settings other than English, the trigger signal from the SyncBox may correspond to a different letter. You can check this by opening a text editor (e.g., Notepad) and operating the SyncBox in Simulation mode. The letter corresponding to the trigger signal will appear in your document.

### Serial mode

To operate the SyncBox in serial mode via USB a driver is required. This driver is included on the User Manual CD. Operating the SyncBox in serial mode allows for two-way communication between the SyncBox and the PC, which is required for operating the SyncBox in Computer mode (for more details on operating the SyncBox in Computer mode, refer to section 3.3.2).

When operated in serial mode, the ASCII code for the character “s” will be sent to the stimulus presentation PC when a trigger signal is received from the MR scanner. Note that the SyncBox needs to be running (either in Simulation or Synchronization Mode). For more details on specifying the signal sent to the stimulus presentation PC, refer to section 3.3.2.

The settings for the serial port are listed below:

serial interface parameter	setting
bits per second	57600
data bits	8
parity	none
stop bits	1
flow control	none

### Parallel Interface

The SyncBox has a standard TTL output for the synchronization signal. The output is “active high”. The signal has a duration of 10 ms and is available on output C. The synchronization signal is located on pin 10 of the Presentation parallel interface cable (100026, 100029) provided with the system.

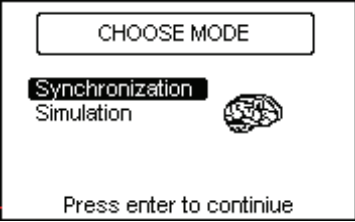
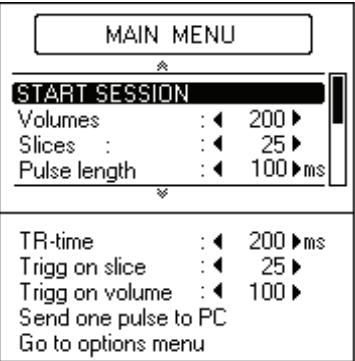
### Serial Interface

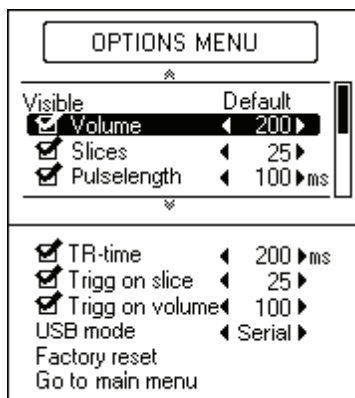
See USB Interface – Serial mode; no additional driver required.

For E-Prime and Presentation sample paradigms using the different interfacing options, please contact [support@nordicneurolab.com](mailto:support@nordicneurolab.com).

### 3.3.2. SyncBox Operation Modes

#### Manual Mode

	<p><b>CHOOSE MODE:</b></p> <p>Choosing “Synchronization” will turn the SyncBox into Synchronization mode. The SyncBox will wait for trigger pulses from the scanner. The SyncBox will send trigger pulses to the PC according to your settings in the main menu (see below).</p> <p>Choosing “Simulation” will turn the SyncBox into Simulation mode. The SyncBox will simulate trigger signals according to the specified settings.</p>
	<p><b>MAIN MENU:</b></p> <p>In accordance with your MR acquisition settings, enter the following details:</p> <p><b>Volumes:</b> the number of volumes the SyncBox should expect during one session</p> <p><b>Slices:</b> the number of slices that one volume consists of  <b>If your MR scanner only sends a trigger signal on each volume, always set this value to 1.</b></p> <p><b>Pulse length:</b> the time the scanner takes to acquire one slice  The value can only be set in Simulation mode. The parameter is removed from the menu in Synchronization mode.</p> <p><b>TR-time:</b> the time from the beginning of acquisition of one volume to beginning of acquisition of the next volume  The value can only be set during Simulation mode.</p> <p><b>Trigg on slice:</b> SyncBox sends a signal to the PC on specified slices  Pressing the right button when the value is set to 1 you can specify on which slice the SyncBox sends a signal to the PC.  Pressing the left button when the value is set to 1 you will find two more options, “each” and “rand”. By selecting “each” the SyncBox will send a signal to the PC on each slice in the selected volumes.  By selecting “rand” the SyncBox will send a signal on an occasional slice in the selected volumes.  If your MR scanner only sends a trigger signal on each volume, always set this value to 1.</p> <p><b>Trigg on volume:</b> SyncBox sends a signal to the PC on specified volumes  The SyncBox will send a pulse on the first slice of each volume.  Pressing the right button when the value is set to 1 you can specify on which volume the SyncBox sends a signal to the PC.  Pressing the left button when the value is set to 1 you will find two more options, “each” and “rand”. By selecting “each” the SyncBox will send a signal to the PC on each volume. By selecting “rand” the SyncBox will send a signal on an occasional volume.</p> <p>Press START SESSION to start synchronization/simulation.  Press ‘Send one pulse to PC’ to check communication with the PC.  Press ‘Go to options menu’ to open the OPTIONS MENU.</p>

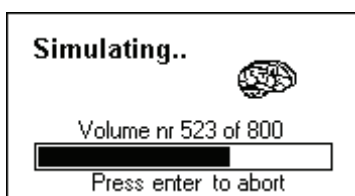


#### OPTIONS MENU:

In the OPTIONS MENU you can enter the same settings as in the MAIN MENU, with the difference that in the OPTIONS MENU the entered values will be stored as default values. If you want to remove a parameter from the MAIN MENU, you can do this simply by pressing ENTER on it in the OPTIONS MENU.

The SyncBox can be operated in two different USB modes – HID and serial. This mode is chosen in OPTIONS MENU (for more details on SyncBox USB Interfacing, refer to section 3.3.1).

If you are completely lost press ENTER on the 'Factory reset' line. All values will now be set back to standard factory values. Press 'Go to main menu' to return to the MAIN MENU.

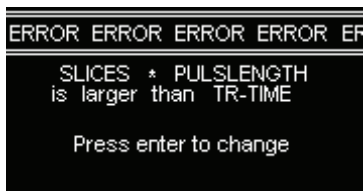


Press START SESSION to start simulation/synchronization.

The chosen mode (synchronization, simulation) will be indicated in the upper left corner of the display.

During the session the letters R and S will be displayed in the upper right corner of the display. R indicates that a pulse has been received from the scanner, S indicates that a pulse has been sent to the PC.

Press ENTER to abort the simulation/synchronization session.



If this text appears some of your settings are out of range. The text depends on the inaccurate value. Press ENTER to return to the MAIN MENU, where you can change your settings.

**Example: SyncBox in Synchronization mode**

Volumes: 200

Slices: 25

Trigg on slice: 1

Trigg on volume: 5

The SyncBox will send a trigger signal to the PC on the first slice of volumes 1, 6, 11, 16, 21,...,191, 196.

**Example: SyncBox in Simulation mode**

Volumes: 200

Slices: 25

Pulse length: 100

TR-time: 3000

Trigg on slice: 1

Trigg on volume: 5

The SyncBox will send a trigger signal to the PC on the first slice of volumes 1, 6, 11, 16, 21,..., 191, 196. Each slice will last for 100 ms and the time between acquisition of the first slice of each volume will be 3000 ms.

**Computer Mode**

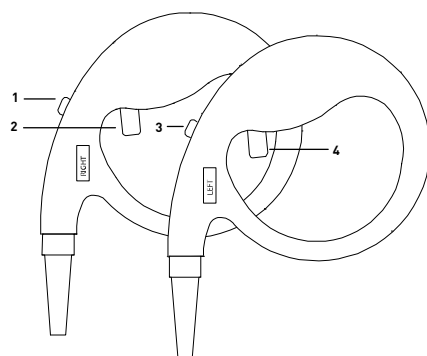
The SyncBox can be completely controlled by the PC. By using a Serial Interface all settings, start, and stop can be executed from your stimulus presentation program. Sample codes for E-prime and Presentation® are available on request. Please contact [support@nordicneurolab.com](mailto:support@nordicneurolab.com).

### 3.4. ...ResponseGrip

Ergonomically designed for the use in either hand, the ResponseGrip is suitable for a wide range of experimental paradigms and is compatible with all leading stimulus presentation software packages. The ResponseGrip consists of the hand-held grips and the ResponseGrip Interface.

The ResponseGrip Interface provides real-time feedback of subject responses via LED indicators and optional sound signaling to allow the operator to monitor the subject's response.

#### 3.4.1. Grips

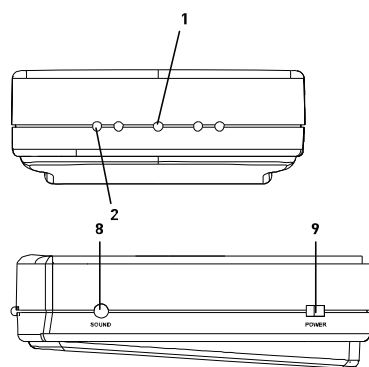


- 1..... RIGHT THUMB button
- 2..... RIGHT INDEX button
- 3..... LEFT THUMB button
- 4..... LEFT INDEX button

Figure 22. Hand-held grips with 2 response buttons per hand.

The grips are intuitive in their operation, allow for natural and relaxed positioning of hands and arms and are, therefore, also ideally suited for pediatric subjects and patients.

#### 3.4.2. ResponseGrip Interface



- 1..... power LED
- 2..... status LEDs  
(LT, LI, RI, RT; from left to right)
- 3..... optical connections  
(top row: transmitters;  
bottom row: receivers)
- 4..... alarm outlet
- 5..... TTL/serial port
- 6..... power inlet
- 7..... USB

Figure 23. Front, back, and side view of the ResponseGrip Interface.

The ResponseGrip Interface is easy to operate and there are only two control switches, the POWER ON/OFF switch and the SOUND ON/OFF switch, both located on the side of the unit. When switched on, the system is immediately ready for use. A green power indicator shows that the system is turned on (1) and the status LEDs (2) indicate which button is being pressed.

The sound switch (8) turns ON/OFF the sound signal when a button is pressed. A high tone is generated when a left-hand button is pressed and a lower tone is generated when a right-hand button is pressed.





Like regular light bulbs, the light sources have limited lifetime.  
Always turn the system off when not in use.

3.4.3. Interfacing the ResponseGrip Interface with the stimulus presentation PC

USB Interface

When connected via USB, the ResponseGrip will be recognized by the PC as a Human Interface Device (HID)/keyboard. No drivers are needed. The following letters are sent when response buttons on the grips are pressed:

response button	corresponding letter
left thumb	a
left index	b
right index	c
right thumb	d

For OS language settings other than English, the response buttons may correspond to different letters. You can check this by opening a text editor (e.g., Notepad) and pressing each response button. The corresponding letters will appear in your document.

Parallel Interface

For highest timing accuracy parallel interfacing should be chosen. The ResponseGrip Interface has separate standard TTL outputs for each button. The outputs are “active high”, which means that when a button is pressed the output goes from 0V to 5V. When released, the output returns back from 5V to 0V. Since different stimulus presentation programs require input on different pins, the ResponseGrip comes with two parallel port cables to be used with Presentation® and E-Prime. The pins used in each cable are listed below:

response button	corresponding Presentation® pin (cable 100025, 100029)	corresponding E-Prime pin (cable 100024)
left thumb	13	15
left index	15	13
right index	12	12
right thumb	11	10
(SyncBox trigger signal)	{10}	

Serial Interface

To allow for two-way communication between stimulus presentation PC and the ResponseGrip Interface, a serial interface is available. The settings for the serial port are listed below.

serial interface parameter	setting
bits per second	9600
data bits	8
parity	none
stop bits	1
flow control	none

If the ResponseGrips are connected to the SyncBox via the patch cable and operated in serial/USB serial mode, the following serial port settings are required:

serial interface parameter	setting
bits per second	57600
data bits	8
parity	none
stop bits	1
flow control	none

The pre-programmed setup sends the ASCII codes for the following characters over the serial port:

response button	corresponding letter
left thumb	a
left index	b
right index	c
right thumb	d

If the ResponseGrip is connected to the stimulus presentation PC via the SyncBox (with patch cable), please note that the SyncBox needs to be running (either in Simulation or Synchronization Mode) for this to work.

For E-Prime and Presentation® sample paradigms using the different interfacing options, please contact [support@nordicneurolab.com](mailto:support@nordicneurolab.com).

### Changing the pre-programmed settings:

Note that ResponseGrip settings can only be changed if the ResponseGrip Interface is directly connected to the stimulus presentation PC via serial cable (not possible to change settings if connected with patch cable via the SyncBox).

Connect to the ResponsGrip trough a Terminal application, like HyperTerminal with the same settings listed under the "Serial Interface" section.

Note that all characters written in the communication window must be lower case.

The following commands may be used to change the settings of the ResponseGrip Interface:

- **a** – Operator notification. The buttons on each grip may be configured to notify the operator when pressed individually or simultaneously. A time delay between button-press and operator notification can be specified.  
 "Alarm LT" (Left Thumb) will appear in the communication window.
  1. If you want the left-thumb response button to act as operator notification when pressed, type "y" (yes). Type "n" (no) if you do not want the operator notification function on this button.
  2. LI, RI and RT will be displayed. Make your selection as in step 1.
  3. "T=" is the time delay between button-press and operator notification.
  4. If you do not want to set a delay, press "00". If you want to set a 5-second delay, press "05". Two digits are required.
  5. Finally, "M="(Mode) will be displayed. Type "s" (single) for single button operator notification.
  6. Type "a" (all) if you want all buttons specified in steps 1 and 2 pressed simultaneously for operator notification (see example below).

**Example: Operator Notification**

Buttons to act as operator notification:

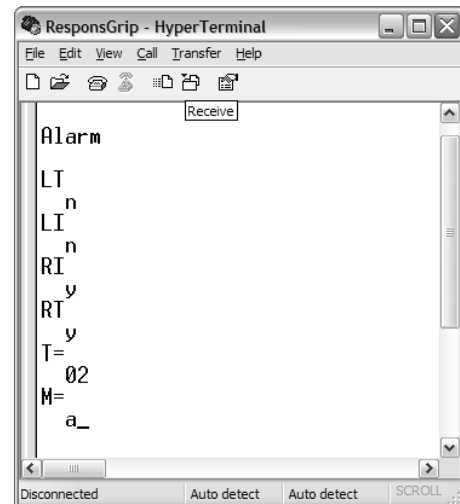
- RI (right index finger)
- RT (right thumb)

Time delay:

- 2 seconds

Mode:

- All selected buttons (i.e., RI and RT) must be pressed simultaneously to notify the operator

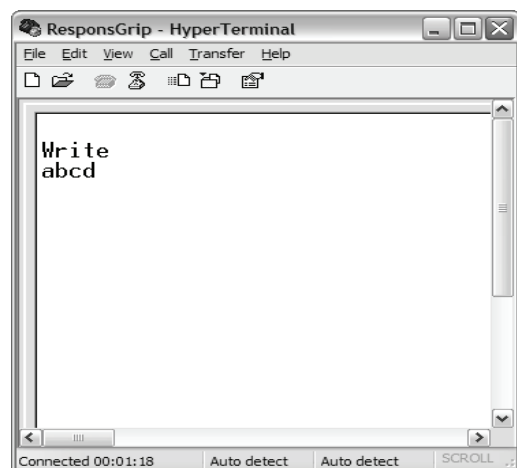


- **w** – Choose ASCII code for ResponseGrip buttons. This function gives the operator the possibility to change the letters sent from the ResponseGrip Interface to the computer. The communication window will display “Write”: The ResponseGrip is waiting for you to type four letters - one to identify each button - in the following order: LT, LI, RI, RT.

**Example: Choose ASCII code**

Letters to send when button is pressed:

- LT -> a
- LI -> b
- RI -> c
- RT -> d



- **r** – Read settings from the ResponseGrip. Settings are displayed in the communication window.

**Example:**

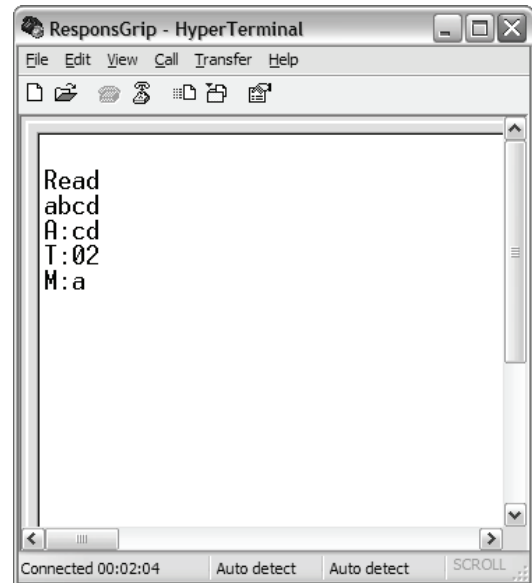
**Read** indicates that you selected the read function.

**abcd** indicates the selected ASCII characters for each button in the following order: LT, LI, RI and RT.

**A:cd** means that RI and RT have been chosen as operator notification buttons.

**T:02** indicates a 2-second time delay between button-press and operator notification

**M:a** indicates operator notification mode “all”. RI and RT must be pressed simultaneously to notify the operator.



## 4. Cleaning & Equipment Disposal



### Caution, do not open any parts or units!

The fMRI Hardware System contains no user serviceable parts inside. Electric shock or permanent damage to the equipment may occur if touching the electronics.

All servicing of the equipment should be performed by servicing personnel approved by NordicNeuroLab. Please contact your local distributor or NordicNeuroLab with your service request when needed.

**Not following these instructions will violate the terms of the Limited Warranty.**

### 4.1. Cleaning of Equipment

Make sure all units are switched OFF and disconnect from their respective power supplies. Gently clean the surface of the optics (Coil-mounted Display) and the units with a slightly damp, soft cloth. Allow any moisture to completely evaporate before re-connecting and operating the system.

Check the optics for residues or dirt which may reduce visibility on a regular basis.

All parts in contact with subjects should be cleaned daily, and between every examination when deemed necessary. All other parts should be cleaned weekly or more frequently if needed.

Anti-fog solution has been applied to the surface of the optics to avoid blurring during extended use. It needs to be re-applied after each cleaning.

#### 4.1.1. Disinfection

If disinfection of any parts of the system is deemed necessary due to contamination, use a clean cloth with the detergent Virkon®. Please follow the instructions provided by the manufacturer on the use of Virkon®. Wipe the treated area afterwards by using a damp cloth to remove any residues of the detergent.

**Do not use the following cleaning or care products:** Spray or bath, ethanol, ether.

Cleaners and disinfectants other than Virkon® have not been tested by NordicNeuroLab and are, therefore, not recommended for use.

Please contact NordicNeuroLab for additional information on correct handling of the equipment. Contact information can be found in section 9.

### 4.2. Correct Disposal of this Product (Waste Electrical & Electronic Equipment)

To prevent possible harm to the environment or human health from uncontrolled waste disposal, please separate this product from other types of waste and recycle it responsibly at the end of its working life.

Users should contact their local government office for details of where and how they can take this product for environmentally safe recycling.

Alternatively, the product can be returned to NordicNeuroLab for appropriate disposal.

NordicNeuroLab AS  
Møllendalsveien 65 C  
5009 Bergen  
Norway

## 5. Troubleshooting & Support



### General note

When reconnecting cables and checking power supplies, make sure all units are turned OFF and mains supply connections are disconnected.

### 5.1. General problems

This section covers problems that may occur on all units of the fMRI Hardware System.

**Problem: The power indicator does not light up when the unit is turned on.**

#### Possible cause(s):

1. The mains supply connector is not properly connected.
2. The power supply is not connected or wrong power supply is being used.

#### Solution(s):

1. Check that the mains supply connector is properly connected and that the mains supply outlet is turned on.
2. Check the label on the power supply used and make sure it is the correct one. Also check that it is connected properly.

### 5.2. Shielded Interface Unit / Fiberlink

**Problem: The power indicators do not light up when the SIU is turned on.**

#### Possible cause(s):

1. The fuse may be blown.

#### Solution(s):

1. Open the fuse holder underneath the mains supply inlet at the back of the SIU. If the fuse is broken replace it with the spare fuse. If this is a problem that occurs frequently, contact [support@nordicneurolab.com](mailto:support@nordicneurolab.com).

**Problem: The video or audio status light on the Optic Electric Interface Unit in the SIU is off even if the SIU is turned on and signals are sent to the Fiber Transmitter.**

#### Possible Cause(s):

1. The Fiber Transmitter is not powered on.
2. The fiber cable is broken.

#### Solution(s):

1. Make sure the Fiber Transmitter is connected to the power supply and that the status lights are on.
2. Change the fiber cable.

**Problem: There is a general problem with signal transmission.**

**Possible Cause(s):**

1. One or both of the fibers in the fiber cable may be broken.

**Solution(s):**

1. One fiber is used for transmitting signals for both the AudioSystem and the VisualSystem. The other fiber is used for the 3D signal. This means that if the AudioSystem is working and there is a problem with the VisualSystem then the fiber cable is ok. This is also true vice versa. If this is the case check the relevant product trouble shooting section.

### 5.3. VisualSystem

**Problem: No image in the Coil-mounted Display.**

**Possible Cause(s):**

1. One (or more) of the units in the VisualSystem are not turned ON.
2. The connector to the Coil-Mounted Display is not properly inserted.
3. Incorrect screen resolution on stimulus presentation PC.
4. The screen saver on the stimulus presentation PC may be active.
5. The brightness is adjusted to a minimum.
6. Something is wrong with the Fiberlink.

**Solution(s):**

1. Make sure that all units of the VisualSystem are turned on.
2. Check the connector at the front of the SIU (OLED Interface Module).
3. Set the resolution to 800x600 and select a refresh rate between 60 and 85Hz.
4. Disable the screen saver.
5. Increase brightness by using the "+" switch at the front of the OLED Interface Module.
6. Refer to Fiberlink troubleshooting.

**Problem: Pixel rows and/or columns are missing on the edges of the image displayed in the Coil-mounted Display**

**Possible Cause(s):**

1. The resolution and refresh rate on the video output port of the stimulus presentation PC connected to the VisualSystem is configured incorrectly.

**Solution(s):**

1. Make sure that the resolution and refresh rate on the video output of the stimulus presentation PC are configured to 800 x 600 pixels and 85 Hz, respectively.

**Problem: Image cannot be fused by the viewer. The subject sees two images.**

**Possible Causes(s):**

1. The distance between of the VisualSystem oculars (pupil distance) is not adjusted correctly.
2. The image is not focused on both displays of the Visualsystem.

**Solution(s):**

1. Adjust the pupil distance of the VisualSystem.
2. Adjust the diopter correction for each eye separately so that both images are focused.

## 5.4. AudioSystem

**Problem: There is no sound in the Headphones.**

**Possible Cause(s):**

1. The "ACOUSTIC LEVEL" control on the Electrostatic Energizer is adjusted to a minimum.
2. The sound source used does not transmit any sound to the AudioSystem.
3. The channel used is not activated on the Communication Console.
4. The volume control for the channel used has been turned down.

**Solution(s):**

1. Turn the "ACOUSTIC LEVEL" control on the Electrostatic Energizer clockwise to the desired listening level.
2. Make sure that sound is transmitted.
3. Press the channel activation button on the Communication Console.
4. Increase the volume for the channel used on the Communication Console.

**Problem: Sound from only one channel or different volume levels in Headphones.**

**Possible Cause(s):**

1. The "BAL" control on the Communication Console is not in neutral position.
2. Poor connections.
3. Sound source is supplying different levels of volume in left/right channel.

**Solution(s):**

1. Make sure the "BAL" control on the Communication Console is in neutral position.
2. Reconnect all cables.
3. Check the User Manual for the sound source.

## 5.5. SyncBox

**Problem: Stimulus presentation program does not receive trigger pulses from the SyncBox.**

**Possible Cause(s):**

1. The cable between the SyncBox and your PC is not connected properly.
2. The settings in your stimulus presentation program are wrong.
3. The MR does not send trigger signals to the SyncBox.
4. The settings on the SyncBox are wrong.

**Solution(s):**

1. Check the cable used between SyncBox and PC.
2. Use this manual as reference and check all settings in your paradigm.
3. Check the settings in the sequence used on the MR console and make sure it sends trigger signals.
4. Make sure the settings on the SyncBox match the settings in the MR sequence (refer to section 3.3.2) and that trigger pulses are sent at the desired time.



## 5.6. ResponseGrip

**Problem: The button indicators are always lit.**

**Possible Cause(s):**

1. The grips are not connected properly.

**Solution(s):**

1. Reconnect all connections, three in total, from the grips to the ResponseGrip Interface.

**Problem: Stimulus presentation program does not collect responses.**

**Possible Cause(s):**

1. The cable between the ResponseGrip Interface and your PC is not connected properly.
2. The settings in your stimulus presentation program are wrong.

**Solution(s):**

1. Check the cable used between ResponseGrip Interface and stimulus presentation PC.
2. Use this manual as reference and check all settings in your stimulus presentation software.

**Problem: There is no sound signal when pressing buttons on the ResponseGrips.**

**Possible Cause(s):**

1. The ResponseGrip Interface is not turned ON.
2. The sound switch on the right side of the ResponseGrip Interface unit is turned off.

**Solution(s):**

1. Turn on the ResponseGrip Interface.
2. Turn on the speaker by switching the toggle on the right side.

## 5.7. Unsolved problems?

If you are still experiencing problems, abnormal operation or system failure, or if the fMRI Hardware System is not performing up to your expectations, please report this to NNL at [support@nordicneurolab.com](mailto:support@nordicneurolab.com) or contact your local distributor.

## 6. Technical Specifications

### VisualSystem

#### Coil-mounted Displays

Physical	dimensions	Housing (W, H, D): 85mm x 50mm x 130mm suspension arm (H, L): 40mm x 117mm
	weight	540 g (19 oz)
	cable	5,4 meters (16.4 feet)
	connector	26 pin HDDSUB, male
Electric	supply voltage	max 4.5 V
	power consumption	790 mW peak (25°C, 60Hz, All pixels on), Typical <400 mW
Optics	pupil distance adjustment	55 – 75mm
	diopter correction	-5 dpt to +2 dpt
OLED Displays	input signal (R,G,B)	0 – 0.7 V
	frame rate	60-85 Hz (min-max)
	format	800 x 600 pixels
	field of view	30° horizontal, 23° vertical
	aspect ratio	4:3
	colors	16.7 million colors
	video signal bandwidth	maximum 56 MHz (VESA SVGA 85 Hz mode)
	3D vision	VESA frame sequential stereovision supported
	color pixel	aspect ratio: square pitch: 15 µm arrangement: R, G, B vertical stripe
	color gamut:	> 75% of NTSC gamut
	gray levels	256
	uniformity	85% (area uniformity as per VESA FPDM standard)
	contrast ratio	> 100:1 intrinsic (dark ambient)

#### OLED Interface Unit (Note! Mounted in the Shielded Interface Unit (SIU). See specifications for the SIU unit, for more details)

Electric	power consumption	max 7.7 W
Physical	connector	26 pin HDDSUB, Female
	push buttons	brightness control (+/-) flip button (rotate/mirror image)

### AudioSystem

#### HeadPhones

Physical	dimensions (W, H, D)	85 mm x 45mm x 105 mm (semi-elliptical shape)
	weight	351 g (12.4 oz)
	connector	custom 5 pin, male connector
Acoustic	attenuation of external noise	30 dB
	frequency response	flat range: 8 – 35 000 Hz

#### Communication Console

Physical	dimensions (W, H, D)	140mm x 55mm x 135mm
	weight	324 g (11.4 oz)
Connectors	input	power: 2.1mm DC-jack, + on centre pin audio in: 4 x RCA, channel 1 & 2, separate R/L microphone input: 1 x mini-jack patient microphone input: 1 x mini-jack alarm input: MCX (mini-coax)
	output	audio out: 2 x RCA, separate R/L headphones output: 1 x mini-jack patient microphone output: 1 x mini-jack
Electric	supply voltage	15 VDC, + on centre pin
	power consumption	max 2.25 W
Audio	input impedance	15 kΩ
	maximum input level	2,8 V
	maximum output level	2.8 V
	frequency response	flat range: 5 – 35 000 Hz, -3dB, 1 V <sub>rms</sub> output
	signal-to-noise ratio	< 80 dB

### Electrostatic Energizer (Note! The Electrostatic Energizer is mounted in the SIU unit. See specifications for the SIU unit, for more details.)

Physical	connector	custom 5 pin, female. Output for the HeadPhones
Electric	power consumption	max 2,9 W
	audio output voltage	800 V <sub>rms</sub> differential
Acoustic	frequency response	1,6 – 50 000 Hz [-3dB, measured at 100 V <sub>rms</sub> differential output]
	harmonic distortion	0,001% maximum at 1 kHz
	signal-to-noise ratio	10V <sub>rms</sub> differential output 100 dB (measured at 100 V <sub>rms</sub> differential output)
	channel separation	80 dB at 1 kHz (measured at 100 V <sub>rms</sub> differential output)

### Shared Components

#### Fiber Transmitter

Physical	dimensions (W, H, D)	110mm x 50mm x 170mm
	weight	580 g (1,27 lb)
Connectors	input	power: custom 2 pins connector audio in: 3,5 mm stereo jack video in: HD15-DSUB
	output	fiber: Dual SC connector, Class 3B laser
Electric	supply voltage	15 VDC
	power consumption	max 5 W
Video	input signal	standard VGA
	frame rate	60Hz to 85 Hz
	format	800 x 600 pixels
	RGB processing	24 bits, no compression or scaling
Audio	number of channels	2, unbalanced
	frequency response	+0/-0,5 dB in frequency range 20 – 20 000 Hz
	input impedance	> 24 kOhm
	output impedance	< 1 Ohm
	maximum audio level	+10 dBu
	signal-to-noise ratio	95 dB (A-weighted)
	channel phase differential	+/- 0,1°
	crosstalk attenuation	minimum 95 dB measured at 1 kHz

#### Shielded Interface Unit (SIU)

Physical	dimensions (W, H, D)	mini: 133mm 260mm x 315mm standard: 133mm 348mm x 316mm maxi: 133mm 450mm x 375mm
	weight	6,2 kg (13,7 lb) varies for maxi and mini depending on configuration
Connectors	input	power: IEC C14 fiber: dual SC connector
	output	Coil-mounted displays 26 pins HD-DSUB HeadPhones: custom 5 pin, female connector
Electric	supply voltage	100 – 240 VAC
	line frequency	50 - 60 Hz
	fuse	T 1.6 A
	power consumption	max 60 W

### SyncBox

#### General Specifications

Physical	Dimension (W, H, D)	105mm x 43.9mm x 130mm
	weight	240 g (8.5 oz)
Connectors	input	power: 2.1mm DC-jack,+ on centre pin Philips-Trigger: BNC, female, TTL level Siemens-Trigger: HFBR-female, optical GE-Trigger: 9 pin DSUB, RS-485/422
	output	serial Port: 9 pin DSUB, RS-232 USB: mini-B USB. For emulated keyboard (HID) or serial port RJ-45: for parallel port adapter cable
Electric	supply voltage	9 VDC
	power consumption	max 2.4W
Timing	accuracy internal clock	±0.5 ms

### Specifications for Input Trigger Signals

TR time	minimum	1 ms
	maximum	9999 ms
Slice time (pulse length)	minimum	1 ms
	maximum	9999 ms

### Setup for Serial communication with PC

transfer rate	57600 Baud(bit/s)
data bits	8 Bit
stop bits	1 Bit
parity bits	0 Bit
hardware control	No

### ResponseGrip

#### ResponseGrips (handles)

Physical	dimensions (W, H, D)	43.9mm x 130mm x 105mm (circle shaped)
	weight	160 g (5.6 oz)
	buttons	2 x 2
Connector	input / output	fiber: custom 8 pins connector
Cable	signal type	fiber optic ,polymere
	maximum lenght	40 meters (43,7 yd)

#### ResponseGrip Interface

Physical	dimensions (W, H, D)	120mm x 47mm x 130mm
	weight	204 g (7,2 oz)
Electric	supply voltage	9 VDC
	power consumption	max 2,1 W
Connectors	input	power: 2.1mm DC-jack,+ on centre pin fiber: 4 x HFBR, female
	output	fiber: 4 x HFBR, female USB: mini-B USB. Emulated keyboard (HID) RJ-45: for parallel port or serial adapter cable alarm output: MCX (mini-coax)

### Setup for Serial communication with PC

transfer rate	9600 Baud(bit/s)
data bits	8 Bit
stop bits	1 Bit
parity bits	0 Bit
hardware control	No



## 7. Declaration of Conformity

We, NordicNeuroLab AS declare under our sole responsibility that the products to which this declaration relates is designed and constructed to comply with the essential requirements of the EC Medical Device Directive.

**Manufacturer:** NordicNeuroLab AS  
Møllendalsveien 65C  
N-5009 Bergen  
Norway

**Products:** fMRI Hardware System  
VisualSystem  
AudioSystem  
SyncBox  
ResponseGrip

**Applicable EU Directive:** 93/42/EEC Medical Device Directive

**Product Class:** I

**Applied Standards:** IEC 60601-1:1988 + A1:1991 + A2:1995  
IEC 60601-1-2:2001  
ISO 13485:2003  
ISO 14971:2000



Tormod Thomsen  
CEO  
NordicNeuroLab AS



(Date)

## 8. Limited Warranty

NordicNeuroLab AS warrants to the original consumer or other end user that the **fMRI Hardware System** (VisualSystem, AudioSystem, SyncBox, ResponseGrip) is free of defects in materials and workmanship for a period of two years from the date of purchase. During the limited warranty period this product will be repaired or replaced at our option, without charge.

This warranty shall be voided if the product is modified, tampered with, misused, or subjected to abnormal working conditions. This warranty does not cover physical damage to the surface of this product. This warranty does not apply when the malfunction results from the use of this product in conjunction with accessories, other products, or peripheral equipment.

Repair or replacement as provided under this warranty is the exclusive remedy of the purchaser. This warranty is in lieu of all other warranties, express or implied, including any implied warranty of fitness or suitability for a particular use or purpose, and NordicNeuroLab AS shall in no event be liable to the purchaser for indirect or consequential damages of any kind or character.

## 9. Contact

If you have any questions or problems, please contact us through any of the following routes.

If you purchased your system through one of our international distributors, please contact the distributor first, especially if your system is under warranty.

In all other cases, please contact [info@nordicneurolab.com](mailto:info@nordicneurolab.com) if you have any questions or [support@nordicneurolab.com](mailto:support@nordicneurolab.com) to get assistance with technical problems.

Alternatively, you can call us on +47 55 70 70 95 during office hours.

For sales related questions, please contact your local distributor, or contact us at [sales@nordicneurolab.com](mailto:sales@nordicneurolab.com).

NordicNeuroLab AS  
Møllendalsveien 65 C  
5009 Bergen  
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„making functional MRI easy“

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