MR Confon Starter f MKII+ User Guide

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Introduction

Thank you for purchasing the MR Confon *Starter f MKII+* MRI Audio System.

The equipment delivers high-fidelity acoustic stimuli for fMRI while also attenuating scanner noise. Electro-dynamic driver technology uses the magnetic field of the MRI scanner to drive the headphone membranes. This results in powerful speakers with an excellent frequency response across a wide dynamic range.

The package integrates perfectly with AudioFile[1], a novel USB sound processor with automated synchronous triggering capabilities, to give you the controls you need for rigorous multimodal EEG/fMRI studies.

Symbols

This manual contains international MR symbols as well as symbols to aide in general handling and installation of the equipment.

MR	MR SAFE: These items can go into the MRI room. No displacement with any field strength of any MRI scanner.
⚠ MR	MR-CONDITIONAL: These items must only go into the MRI room if specified installation and usage instructions are followed.
🚫MR	MR UNSAFE: Never take these items into the MRI room. SERIOUS DANGER FROM THE MAGNETIC FIELD EXISTS WITH THESE ITEMS.
⚠	WARNING: General warning regarding handling and installation.

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[1] Sold separately – see: http://www.crsltd.com/audiofile for more information

Starter f MKII+ Components

The Starter f MKII+ package is shipped with the following components:

[MR] Headphone(s) with integrated BNC cable

[MR] Memory foam cushions

[MR] RF Filter elements (BLP 1.9+)

[MR] BNC connectors

[MR] Amplifier and power supply

[MR] Technologist microphone

[MR] Desktop speakers

[MR] Stereo filter/Transformer box

[MR] Analogue to Digital Converter

[MR] 2x5m and 2.5m, red and white BNC cables (Nos. 1 - 3 / Nos. 3 - 6).

[MR] Stereo audio cable (No. 7)

[MR] Speaker cable (No. 8)

[MR] TOSLINK optical cable (No. 9)

[MR] XLR to BNC adapter [Headphone cable] (No. 10)

Headphones

 The Starter f MKII+ package includes one or more pairs of MR Safe headphones and/or earbuds.

Model HP PI US 03

The HP PI US headphone features an ultra-slim design that accommodates most adult participants in any head coil. They use piezoelectric technology, which allows them to work inside and outside the MRI room.

Figure 1 : Model HP PI US 03

MR Confon headphones and earbuds are available in a variety of sizes and cable routing arrangements to suit different head coil designs. Some designs only work inside the bore of the MRI scanner. Please refer to the table below for more information about other available headphones.

Table 1 : MR Confon Headphone List

Headphones	Features	Size	Headcoil
HP SI 01	Standard headphone with excellent passive gradient noise dampening and powerful electrodynamic speaker system.	32mm thick. Dimensions: outer 85x105mm, inner 45x65mm.	Available for Philips and GE scanners. Compatible with 8 and 12 channel head coils.
HP SC 01	Special version of HP SI 01 with additional compensation element optimized for use with Siemens scanners.	32mm thick	For Siemens scanners and larger volume head coils (i.e. not 32/64 channel).
HP SC 02	Same features as HP SC 01, but 6mm slimmer and with special foam cushion set.	26mm thick	Compatible with Siemens 8 and 12 channel head coils.
HP SIE 01	Special version of HP SI 01 with additional piezo drivers. Can be used inside or outside the scanner.	32mm thick	Available for Philips and GE scanners.
HP VS 01	Smaller version of HP SI 01.	20mm thick	Optimised for Philips and GE 32-channel head coils. Also for use with 8 channel head coil and thick foam cushion.
HP VS 02	Very small version of HP SI 01 with tilted cable management.	14mm thick	Optimised for Philips and GE head & neck coils.
HP PI US	Ultra small on-ear piezo headphone for use in modern multi-channel head coils with a diameter down to 190mm. Also consider alternate HP AT 01 insert earphone (earbud) design.	Dimensions: outer 80x105mm, inner 45x70mm.	Works with any head coil. Works inside and outside the scanner.
HP M 01	Same electrodynamic driver system as of HP SI 01 or HP SC 01. Small headphones, optimized for use with children and NHP. Special version for pure passive dampening or matched, non MRI-compatible (MR Unsafe) headphones are available.	Dimensions: outer 60mm, inner 25mm.	Available for Siemens, Philips and GE scanners.

Amplifier

 The Starter f MKII+ amplifier is MR Unsafe and should not be installed in the MRI room.

The Starter f MKII+ amplifier can drive headphones, external speakers, and supports an optional headcoil-mounted noise-cancelling microphone. It has a digital I/O interface for direct integration with the MRI scanner.

Figure 2 : Starter f MKII+ Amplifier

The amplifier is shipped with its own power supply and region-specific plug as shown in Figure 3. Plug the power cable into the rear of the amplifier. For the location of the *Power In* Port, see *The Amplifier* on page 26 of the *Starter f MKII+ Amplifier Quick Reference* Sheet.

Figure 4 : Power for Starter f MKII+ Amplifier

BNC Connectors

BNC connectors are MR-Conditional because they contain ferromagnetic material.

Connectors must be securely fastened, while any connectors not used should be removed from the MRI room.

As each MRI scanner installation is slightly different, the following BNC connectors are supplied to aide BNC cable connection in the MRI and Technologist rooms.
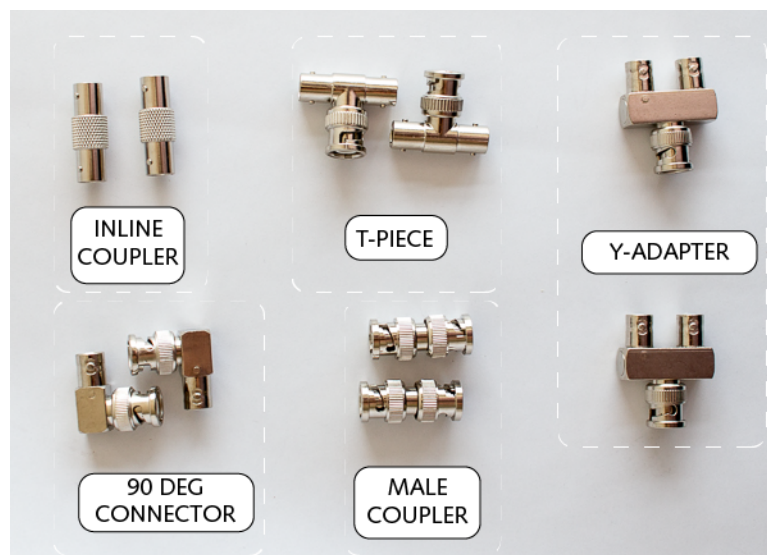

Figure 5 : BNC Connectors

In brief:

- Inline couplers connect two male BNC cables
- Male couplers connect two female BNC cables
- T-piece and Y connectors split the BNC cable signal
- 90 Degree connectors are used to rotate the filter setup

RF Filter Elements

The filter elements are MR-Conditional because they are made from BNC connectors which contain ferromagnetic material.

BNC connectors that do not make up the filter elements should be removed from the MRI room. All filter elements in the MRI room must be securely fastened. Please note that you may not need to use all the supplied BNC connectors that are included in the package. It is strongly advised that the filter elements are fitted with the least possible number of BNC connectors.

The left and right filter elements are mounted inside the MRI room, at the RF Filter Panel. The filter elements are supplied pre-assembled and connect to the headphone's left and right channel inputs.

Figure 6: Filter Elements

For more information about filter elements and how to connect them to your MR Confon headphones, see *Filter Elements* on page 24 of the *MRI Room Assembly.*

Technologist Microphone

The Technologist microphone is *MR Unsafe* and should not be installed inside the MRI room.

The Technologist microphone connects direct to the Starter f MKII+ amplifier and is used to inform and direct participants during a scanning session.

Figure 7 : Technologist Microphone

For more information on how to connect the Technologist microphone to the Starter f MKII+ amplifier, see *Connecting the Microphone* on page 20 of *Control Room Assembly*.

Filter Box

The Filter Box is *MR Unsafe* and should not be installed inside the MRI room.

The Filter Box should be installed in the control room, as close as possible to the RF Filter Panel. It can be mounted permanently on a wall, using the integrated wall bracket.

Figure 8 : Filter Box

For more information about connecting the Filter Box see *Connecting to the Filter Box* on page 17 of *Control Room Assembly.*

Desktop Speakers

The desktop speakers are MR Unsafe and should not be installed inside the MRI room.

A pair of high-quality desktop speakers are included with the package. They connect directly to the amplifier and allow the audio delivered to the headphones to be monitored by the Technologist.

Figure 9 : Desktop Speakers

For more information about connecting the desktop speakers to the amplifier, see *Connecting the Desktop* Monitor Speakers on page 18 of *Control Room Assembly.*

Analogue to Digital Converter

The Analogue to Digital Converter is *MR Unsafe* and should not be installed inside the MRI room.

The Analogue to Digital Converter takes analogue signals from audio sources such as computers, iPhones, iPads, CD, DVD and other media players, and turns them into digital/optical signals to send to the amplifier. If you are connecting to an audio source capable of producing S/PDIF digital audio (such as the AudioFile), this converter is not necessary.

Figure 10 : Analogue to Digital Converter

The Analogue to Digital Audio Converter is supplied with its own external PSU and TOSLINK (optical) cable. For more information about connecting the converter to the amplifier see *Analogue Audio Setup* on page 21 of *Control Room Assembly*.

Cables

BNC cables are colour coded using white connectors for the left audio channel and red for the right audio channel.

Cables 1-10 are MR Unsafe. They should not be installed inside the MRI room.

Cables 1-6 are interchangeable, as long the same length/colour is always used for the left (white) and right (red) channels.
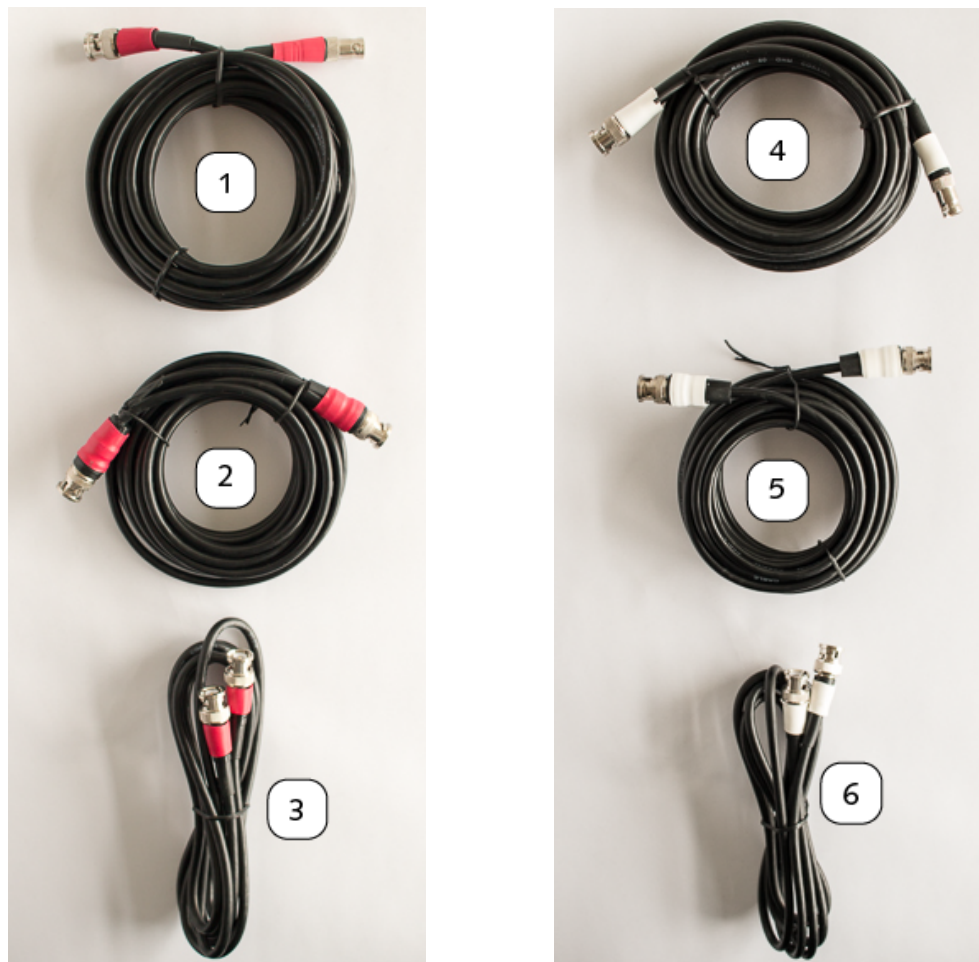

Figure 11 : Red and White Cables

Cables 1 and 2 are 5 meters (approx. 16.4 ft) long, while Cable 3 is 2.5 meters (approx. 8.2 ft) long. Cables 4 and 5 are 5 meters (approx. 16.4 ft) long, while Cable 3 is 2.5 meters (approx. 8.2 ft) long.

Cable 7 connects conventional analogue audio sources to the Analogue to Digital Converter (for example: computers, cell phones and media players).

Figure 12: Stereo Audio Cable

Cable 8 connects the desktop monitor speakers to the amplifier.

Figure 13 : Speaker Cable

Cable 9 is an optical cable that connects the Analogue to Digital Converter to the amplifier or, if a digital audio source is used, the audio source and the amplifier.

Figure 14 : Optical Cable

Cable 10 is the headphone cable and is the first part of the cable setup that connects the amplifier to the headphones.

Figure 15 : Headphone Cable

Memory Foam Cushions

 Memory foam cushions are MR Safe and are used inside the MRI room.

Where space permits, soft, memory foam cushions can be inserted between the head and contact points of the coil to provide even better isolation, reduce bone conduction and improve participant comfort

Figure 16 : Memory Foam Cushions

Control Room Assembly

Starter f MKII+ Amplifier Setup

The amplifier does not need any assembly and is ready to run. Set the amplifier at the desired location, connect the power cable and turn it on. When choosing a location for the amplifier, take into consideration:

- Distance from the RF Filter Panel is limited by the length of the BNC cables.
- Space should accommodate desktop monitor speakers and the Technologist microphone.

Figure 17 : Starter f MKII+ Amplifier

Connect Headphone Cable

Connect Cable 10, the headphone cable, to the PAT HP (Patient Headphone) port at the rear of the amplifier as shown in Figure 18.

Figure 18 : Connect Headphone Cable

Select Cables 1 and 4. Connect them to the headphone Cable 10 as shown in Figure 19.
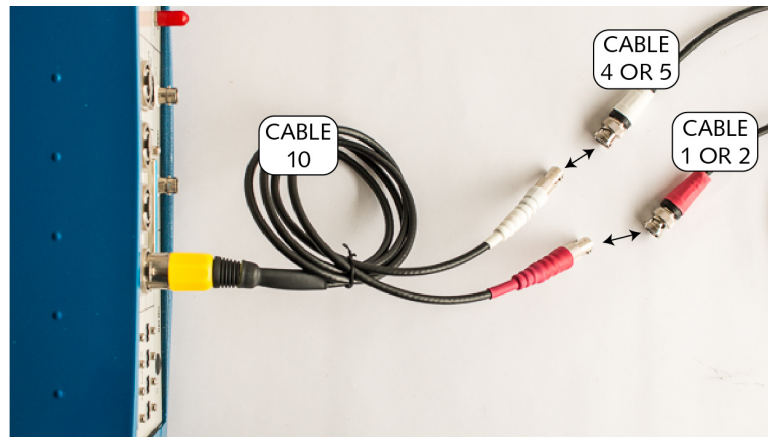

Figure 19 : Connecting to the amplifier

Connecting to the Filter Box

⚠️ Make sure you are connecting the Cables to the correct side of the Filter Box.

Connect a Cable 1 and 4 to the side of the Filter Box labelled "Isolated Input from Audio Amplifier" as shown in Figure 20.
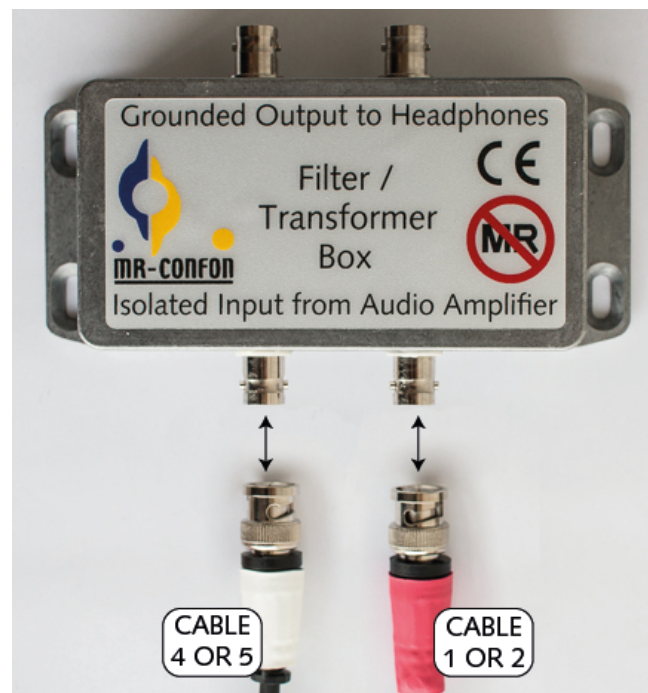

Figure 20 : Connecting to the Filter Box

Use Cables 3 and 6 to connect the Filter Box to the RF Filter Panel as shown in Figure 21. If the RF Filter Panel does not already have a pair of unused bulkhead BNC connectors installed, then arrange for the Panel to be modified with the set of BNC bulkhead connectors that are included in the package.
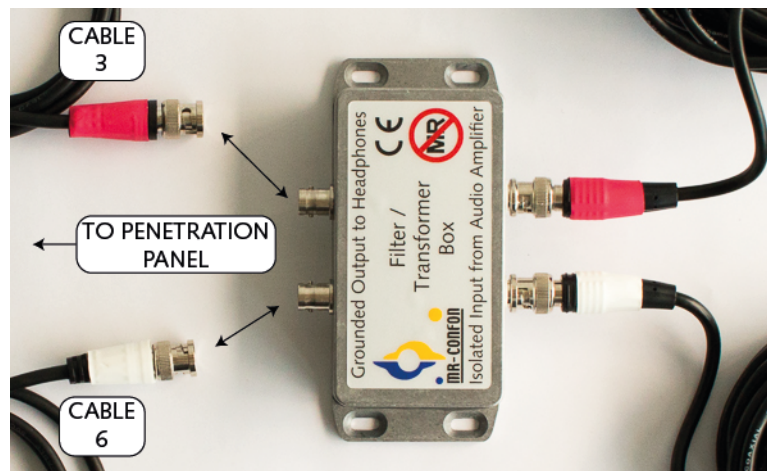

Figure 21: Connecting the Filter Box to the Penetration Panel

Connecting the Desktop Monitor Speakers

The Desktop Monitor Speakers are powered by the amplifier and do not require a separate power supply. Connect Cable 8, the speaker cable to the *Stim Mon* port of the amplifier. In Figure 22 notice that the Cable 8 has two types of wires to connect to the speakers - an insulated and a braided wire. The insulated wire is inside its own plastic housing while the braided wire is naked.
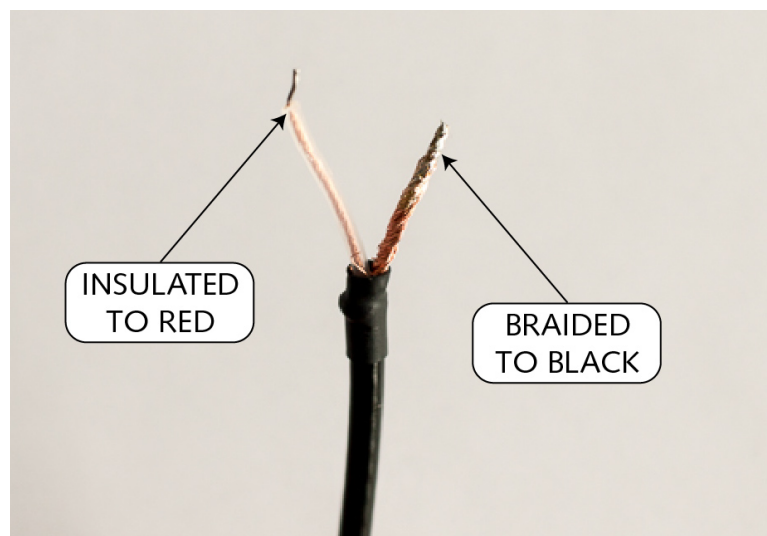

Figure 22 : Speaker Cable Detail

The insulated wire is inserted into the red input, and the braided wire into the black input. Push down on the plastic flaps to insert the wires into their respective connectors as shown in Figure 23.
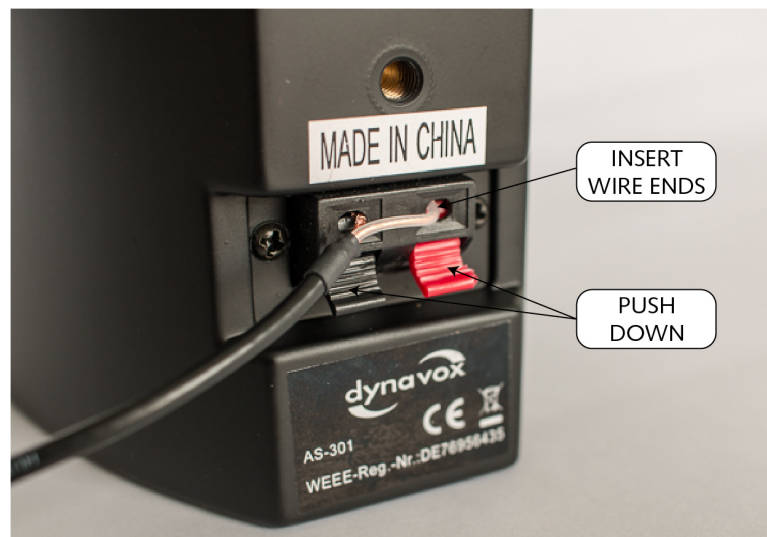

Figure 23 : Rear Speaker Detail

Figure 24 : Rear Speaker installed on the Starter f MKII+ amplifier

The final connection layout will look like Figure 24 (the second speaker not included for clarity).

Connecting the Microphone

The Technologist microphone connects to the amplifier's *Desk Mic* port.

Figure 25: Installing the Technologist microphone

Connecting Patient Microphone (optional)

If the optional bi-directional microphone has been ordered, it will connect to the input labelled IN 4.

Figure 26 : Installing Optional Feedback Microphone

Analogue Audio Setup

If you want to connect an analogue audio source to the Starter f MKII+ amplifier, you will need to use the supplied Analogue to Digital Converter.

Use the Cable 7 to connect your analogue audio source to the Analogue to Digital Converter and the Cable 9 to connect the Analogue to Digital Converter to the amplifier.
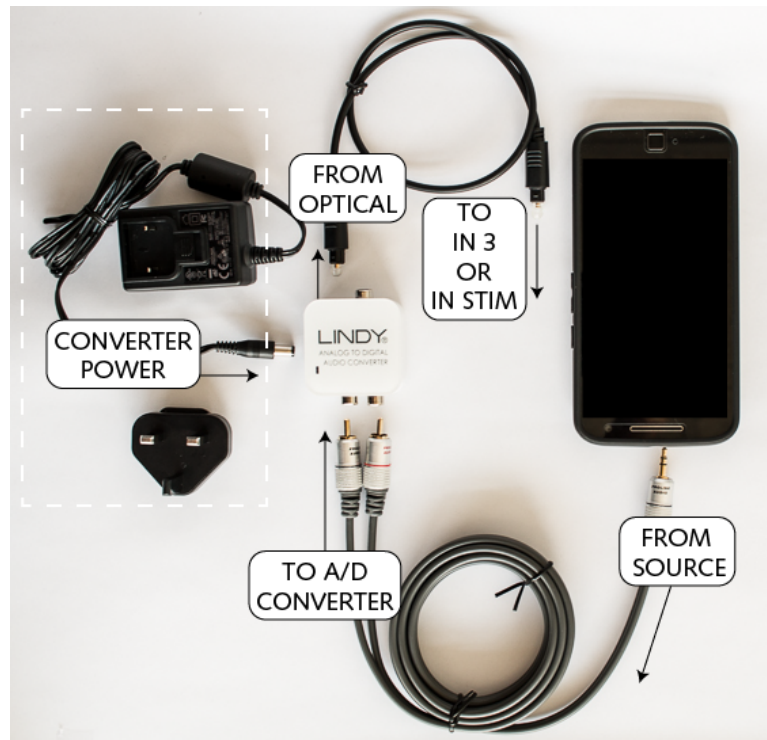

Figure 27 : Alternate Audio Setup

The output from Analogue to Digital Converter connects amplifier input IN 3 or IN STIM optical port, depending on the amplifier mode. For more information on the amplifier mode, see *Changing the Amplifier Mode* on page 29 of *Getting Started*.

AudioFile Setup

Should it be necessary to connect the AudioFile USB sound processor to your amplifier, you may do so at this point. If not, please skip this section.

Figure 28 : The AudioFile

AudioFile supports two different modes of operation.

- AudioFile Mode: Buffered playback of WAV encoded stereo audio files
- USB Audio Mode: Real time streaming of audio directly from a suitable host computer

AudioFile is shipped with *AudioFile mode* active. You can read more about *AudioFile mode* and its timing capabilities in the separate *AudioFile User Manual*.

AudioFile mode requires other specialised equipment to be installed which generates TTL-compatible triggers and track selection codes. As this manual only concerns the installation of AudioFile, it will simply be necessary to make sure that all the components have been successfully connected.

To test AudioFile without triggering equipment, it needs to be booted into *USB Audio mode*. In this mode, AudioFile is automatically recognized by your computer as USB sound card and can play an audio stored locally on the computer.

To boot AudioFile into *USB Audio* mode, insert the AudioFile SD card in your computer's SD slot and open the *Config.xml* file in the card's *Firmware* folder using the Windows Notepad utility. In the *Config.xml* file, locate the "Entry DeviceType" option. By default this is set to AUDIOFILE. Replace the "AUDIOFILE" option with "USB Audio" as indicated in the comment in the file.

```
#DeviceType Is Either "AUDIOFILE" Or "USB Audio"
<Entry DeviceType="AUDIOFILE"/>
```

Save the *Config.xml* file, then eject the SD card from the computer. Return the SD card to AudioFile and connect the device to your computer using the USB cable supplied the AudioFile package. The device will boot in USB Audio mode. Use the Cable 9 to connect AudioFile to the amplifier as shown in Figure 29.
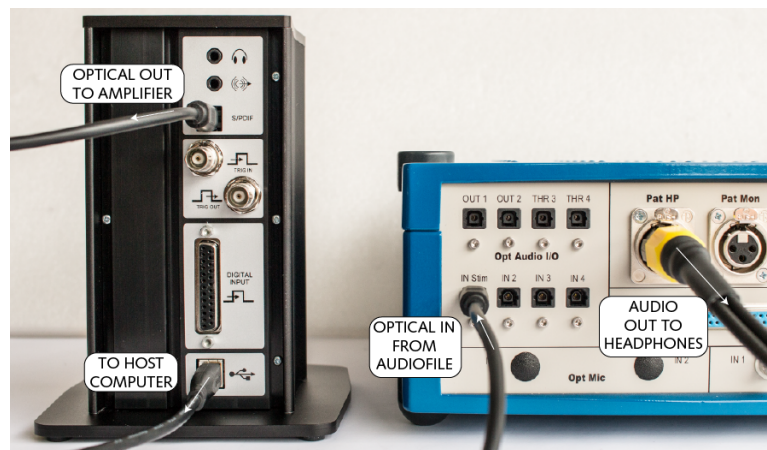

Figure 29 : Installing AudioFile

Note: Connect AudioFile to the *IN Stim* port or IN 3 port, depending on the amplifier operating mode. For more information on the amplifier mode, see *Changing the Amplifier Mode* on page 29 of *Getting Started*.

MRI Room Assembly

Follow the steps in this section to install the headphones.

⚠️ Use only MR Safe components in the MRI Room.

Headphones

⚠️ The red BNC connector corresponds to right audio channel, while the white BNC connector corresponds to the left audio channel.

Figure 30 : BNC Connectors

Filter Elements

🟧 MR Filter elements are MR-conditional, meaning that they are safe when installed properly in the MRI room. Make sure the filter elements are securely fastened amongst themselves and onto the bulkhead BNC connectors mounted on the RF Filter Panel.

Attach the headphone BNC connectors to the male coupler of the filter elements. If the filter elements have been disassembled, they can be reassembled as shown in Figure 31 or Figure 32:
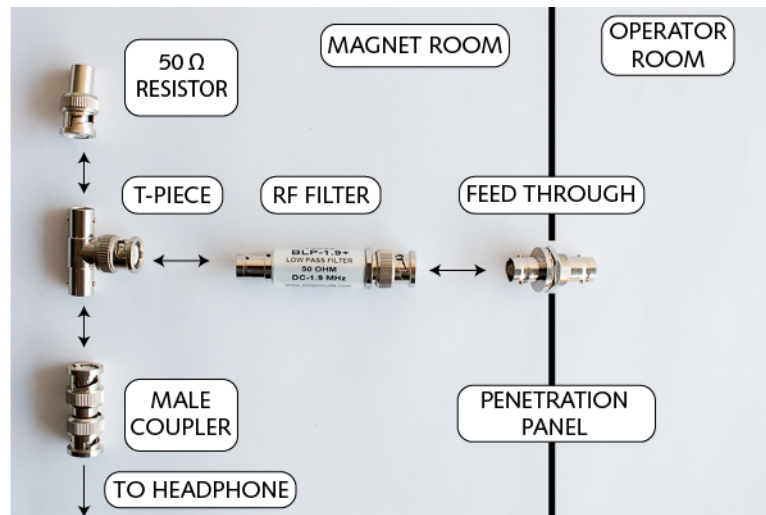
Figure 31 : Filter Elements (Disassembled)

Depending on the configuration of the MRI room, the Filter Elements can be rearranged with the help of extra BNC connectors. The RF filter is bi-directional, facilitating rearrangement of the filter element. For example, adding a 90 degree connector to the base filter element will create design shown in Figure 32.
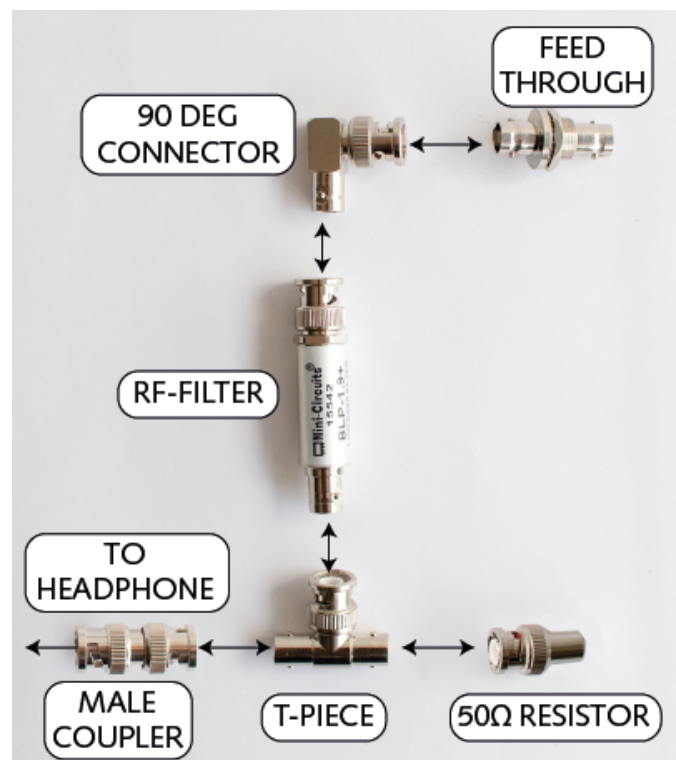

Figure 32 : Alternate Filter Element Assembly

These filter elements can now be attached to the RF Filter Panel at a 90 degree angle, allowing for a less obtrusive connection.

Starter f MKII+ Amplifier Quick Reference Sheet

The Amplifier
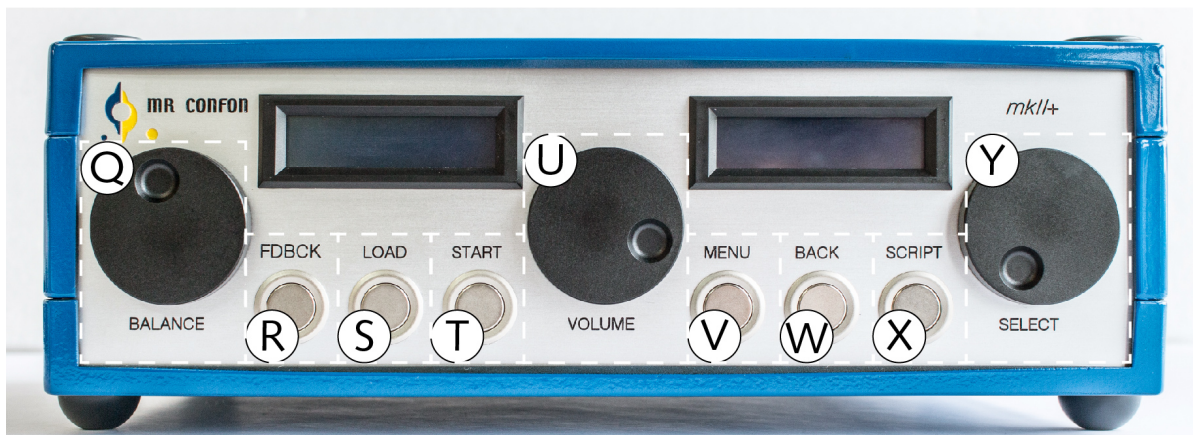

Figure 33 : The amplifier (rear panel)

Figure 34 : The amplifier (front panel)

The Starter f MKII+ amplifier features a variety of buttons, dials and connection ports. Two LCD displays provide report the current status of the device.

Rear panel interface:

A: Optical Outputs

B: fMRI mode In

C: Port not used.

D: Entertainment Mode In

E: Subject Microphone Input

F: Port not used

G: Subject Headphones

H: Patient Monitor Speaker (For use with subject feedback microphone)

I: Technologist Monitor Speaker

J: Port not used

K: Parallel Port (only used for firmware updates)

L: Technologist Microphone

M: Trigger Input/Output

N: Serial Input/Output

O: Power (ON/OFF)

P: Power (IN/OUT)

Front panel interface:

Q: Balance Dial (left/right audio channel)

R: Subject Feedback Microphone

S: Button not used

T: Switch between Entertainment and fMRI modes

U: Volume Dial

V: Button not used

W: Button not used

X: Button not used

Technologist Microphone

The Technologist microphone features two communications buttons – a *Talk* and a *Second Channel* button.

While the *Talk* button is pressed, the Technologist can communicate with the participant. During this time, all other audio sources are muted.

The *Second Channel* button is currently not used.

Figure 35 : The Technologist Microphone

Getting Started

Press the On/Off button at the rear of the amplifier to turn on the Amplifier and Technologist Microphone.

Changing the Amplifier Mode

The amplifier has two modes of operation:

Entertainment Mode: includes various features to enhance audio, like dynamic compression, remote volume control, priority input and trigger dependent functions. When in Entertainment mode, the right LCD indicates the source (SRC) as SPDIF 3. This corresponds to IN 3 on the rear of the amplifier.

Figure 36 : Entertainment Mode connection detail

fMRI Mode: In this mode, the Entertainment Mode features are disabled and the right LCD indicates the source (SRC) as IN STIM. This corresponds to the IN STIM on the rear of the amplifier.
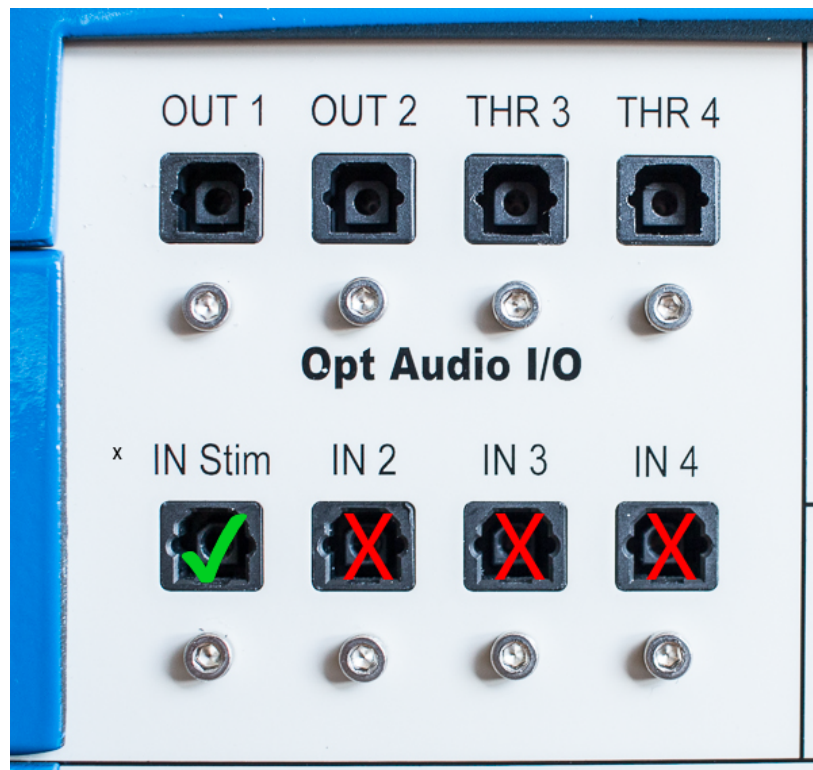

Figure 37 : fMRI Mode connection detail

To switch between these two modes, press the Start button. Don't forget to connect the optical cable to the correct optical input as indicated by each mode.

Adjusting the Volume on the Headphones

By default, the volume dial adjusts the sound on the patient headphones. While adjusting the volume dial, the "MUSIC-VOL" level displayed on the left LCD ranges from MUTE to +24.

Adjusting the Balance on the Headphones

By default, the balance dial adjusts the balance on the patient headphones. While adjusting the balance dial, the "MUSIC-VOL" level on the left-hand LCD ranges from MUTE L to MUTE R (*Mute Left to Mute Right*).

Adjusting the Volume of the Standard Microphone

The volume is adjusted by pressing down on the "Talk" button of the Technologist microphone while at the same time adjusting the volume dial.

The available volume level ranges from Mute to +24. Positive values (for example +12) indicate either very high volume or a low input level.

Adjusting the Volume of the optional Participant Microphone

Where applicable, the Participant Microphone levels are adjusted by pressing the FDBCK button. Notice that on the right LCD the SRC indication is now SPDIF 4L. This corresponds to the IN 4 in the optical input – make sure the optional Participant Microphone is connected to IN 4.

Adjusting the Desktop Speaker Volume

Push the volume dial once and the left LCD changes from "MUSIC-VOL" to "MUSIC-MONVL" on the first line and from "Balance" to "SUBJ-MONVL" on the second line.

MUSIC-MONVL is the Technologist speaker volume and can be adjusted by the volume dial.

SUBJ-MONVL is the Desktop Monitor speaker volume and can be adjusted by the Balance dial.

Adjusting the Balance of the Desktop Speakers

Adjusting the balance of the Desktop Monitor speakers in *Stim Mon* or *Pat Mon* ports is not currently supported.

Normal Operation Mode

After three seconds, the amplifier automatically reverts to its normal operation of adjusting the participant headphones when the volume dial used. To adjust the Technologist or Desktop Monitor speakers again, simply push the volume dial once and adjust volume/balance dials as required.

Safety Warnings

Life support applications

The Starter f MKII+ package should NOT be used in situations where failure of the device would constitute a hazard. It is designed for research applications only, and like any other regular electronic device could fail at any time, without warning.

Magnetic fields

Do not take MR Unsafe parts into the MRI room.

Servicing

DO NOT ATTEMPT TO DISMANTLE any part of the *Starter f MKII+* package. It contains no user serviceable components, refer all servicing to Cambridge Research Systems.

Cleaning

Clean external components with damp cloth only. Do NOT allow fluids to enter any of the components. Do not sterilise in an autoclave.

Dimensions

Starter f MKII+ Amplifier:

Width 32.5 cm (approx. 12.8 in)

Height: 11.4 cm (approx. 4.5 in)

Length: 27 cm (approx. 10.6 in)

Weight: 3.75 kg (approx. 8.27 lbs)

Safety Conformance

EN60601-1 Ed 3

Type B Equipment

Class 1

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