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# STIMULUS SYSTEM, USER'S MANUAL

## 1. General

This document applies to the following stimulus devices:

NM21711N	Audiovisual stimulus system
NM21709N	Electrical stimulator

Both devices have their own manuals that cover the use of the devices alone. This document contains important information on the installation and use of the stimulus devices together with the Elekta Neuromag MEG system.

## 2. List of symbols



Caution, consult accompanying documents. Parts of the system are marked with this symbol when it is necessary for the user to refer to important operating and maintenance instructions given in the manuals accompanying the system. In the manuals it also calls attention to specific instructions. These instructions may contain procedures, practices, conditions or the like which must be correctly performed or adhered to in order to ensure safe operation and to avoid damage to the patient, operator, or the system.

## 3. Installation



Improper installation of the stimulus equipment can result increase of the noise level of the MEG channels due to RF-leakage and/or unwanted ground loops.

### 3.1. Audiovisual stimulus system

Install the Stim2 system as described in the Stim2 manual with following additions (see figure 1):



The Stim to Scan cable (4) is connected to the trigger I/O box (EL20819N). The video signal is routed from the PC to the video distribution amplifier, which divides the signal to the PC display and Data projector. The audio signal is connected from the left and right audio outputs on the audio unit to the audio input of the Elekta Neuromag MEG-system. The audio signal

cables 8 and 9 are installed to filter cabinet at the factory; the shield clamp and the ferrites must be kept intact to retain the EMC-properties of the system.

The patient/subject headphones EL21103J are connected to the audio stim. out -connector under the gantry cover, as described in the Elekta Neuromag System, User's manual.

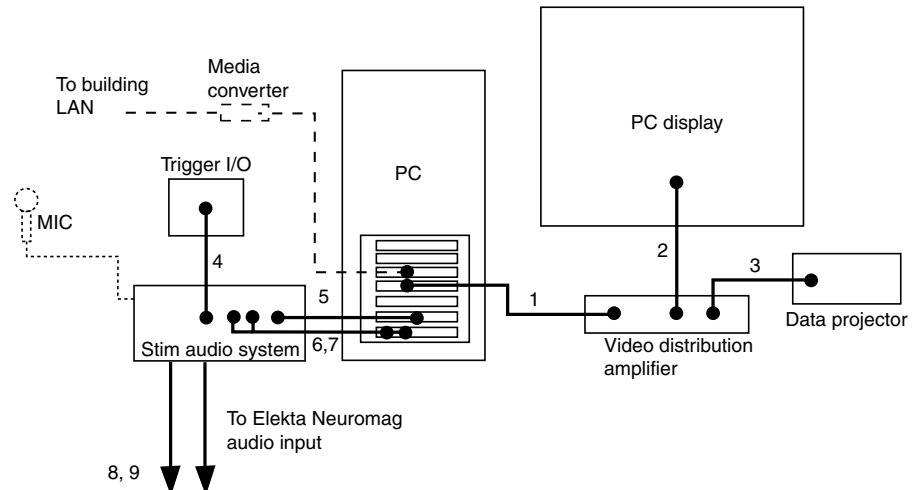


Figure 1. The signal connections of the Stim2 system. The connections between the Stim audio system and the PC (cables 5-7) are as shown in the Stim2 manual.



The response pad of the Stim2 system does not fulfill the EMC requirements of the Elekta Neuromag system and, therefore, cannot be used inside the Magnetically shielded room.



The Stim2 PC, the audio system, the PC monitor and the video distribution amplifier must be powered from the medical isolation transformer delivered with the Stim2 system. If the PC is connected to the building network, an optical LAN must be employed to keep the system electrically isolated from the network. The data projector is powered from the medical isolation transformer delivered with the data projector. For best picture quality, the phase of the mains should be the same for both medical isolation transformers.



All the equipment connected to the system must either be powered from a medical isolation transformer or they must fulfill the requirements of IEC 60601-1.

The trigger lines are connected to the trigger interface unit of the Elekta Neuromag MEG-system. The connections depend on the measurement setup. For more information, see the

Stim2 manual, Elekta Neuromag System User's manual and the Data Acquisition software manual.

### 3.2. Electrical stimulators



The electrical stimulators are installed inside the stimulus cabinet. The stimulators are powered from the mains outlets inside the cabinet. The cabinet doors should be kept closed during the measurement to avoid RF interference.

The electrode leads are connected to the units as instructed in the unit's own manual, and routed to the Magnetically shielded room via the stimulus cabinet feedthrough. The trigger inputs of the units are connected to the outputs of the trigger interface unit of the Elekta Neuromag MEG-system installed inside the stimulus cabinet. The exact connections depend on the experiment settings. For more information, see Elekta Neuromag System User's manual and the Data Acquisition software manual.

## 4. Notes on the use of the stimulators with the Elekta Neuromag system

### 4.1. General



- Always test the stimuli and the stimulus sequence without the subject before starting the measurement.
- Always double-check that the stimuli are applied to the correct sides of the subject (left to left, right to right).
- Check the stimulus timing (delay, jitter) before timing-critical measurements.
- To avoid infection, dispose the disposable and wash the non-disposable patient contact parts after each measurement.

### 4.2. Visual stimuli



- The trigger vs. stimulus onset delay depends on the projector model and the stimulus system setup. The delay should be measured and taken into account in timing-critical measurements.
- The trigger vs. stimulus onset jitter depends on the projector model, refresh frequency, and resolution. The jitter of the used setup must be checked before timing-critical measurements.
- Single-chip DLP projectors are known to create a "rainbow effect", caused by time-multiplexing of colours, which can cause unwanted brain responses in certain type of stimuli.



- The "black flash" due to non-symmetric black-to-white vs. white-to-black transition time of the pixels of the LCD-projectors can cause unwanted brain responses in certain type of stimuli.



- The brightness of the projector can harm the eyes of the subject if the beam is pointed directly to the eyes without the back-projection screen between the projector and the subject. Always have the back-projection screen between the subject and the projector before turning the projector on.



- The brightness of the projector can be reduced with neutral density filters. The filters absorb the infrared radiation generated by the projector and, thus, warm up. Always ensure that the selected filter does not get damaged or cause damage because of warming up.

### 4.3. Auditory stimuli



- Switch on the auditory system and test the stimulus before inserting the ear inserts to subject's ears.



- Sound pressure levels of about 80 dB SPL and higher can cause permanent damage to hearing.

- The audio feedthrough filter of the Elekta Neuromag system causes 6,5 dB attenuation to the audio signal. Thus the nominal sound pressure level at the subject headphones inside MSR is 6,5 dB SPL smaller than the nominal dB SPL level selected at the Stim2 program. If essential, the absolute sound pressure level of the given stimuli should be measured prior the measurement.

- The frequency response of the subject headphones is flat within approximately +/- 3 dB. Thus changing the frequency without changing the nominal dB SPL setting can change the actual dB SPL level up to 6 dB. If essential, the absolute sound pressure level of the given stimuli should be measured prior the measurement.



- Connecting headphones to the Neuroscan Audio System stereo headphone connector while having the unit connected to the subject headphones via the mono outputs and audio filter will reduce the sound pressure level at the subject headphones significantly. Connect the Stim Audio System only to one set of headphones at the time.



- The delay from the trigger onset to the tone onset at the subject headphones depends on the system setup. The delay should be measured and taken into account in timing-critical measurements.

- The foam ear inserts of the headphones are disposable. Use one pair for one subject only.

#### 4.4. Electric stimuli



- Always connect the electrode lead first to the stimulator, then to the subject
- Check that the stimulus amplitude is set to zero before switching on the stimulator
- The stimulus can cause a stimulus artefact (jump of MEG signals). The amplitude of the artefact depends on the stimulus setup.
- If EEG/EOG is used, to minimize the stimulus artefact, connect the EEG ground electrode close (<200 mm) to the electrical stimulus electrode to minimize the stimulus artefact. Ensure that the EEG ground electrode-to-skin impedance is best possible. The EEG ground electrode should be connected only to the EEG ground connector in the EEG interface panel under the gantry side panel. The EEG ground is floating (BF type) and fulfills the leakage current requirements of IEC60601-1.

Use of the stimulus electrodes:

- Soak the felt tips with physiological saline solution bath
- Insert 6 mm felt tips to the gold-plated electrode cups
- Press the soaked felt tips against the skin area to be stimulated
- When looking for the correct stimulus amplitude, always start from zero and go up with small increments
- Once the correct amplitude and location is found, secure the electrode with the velcro strap.
- The felt tips are disposable. Use one pair for only one subject and measurement.
- Wash the electrodes after use with water and ordinary soap or mild dish care detergent. Be careful not to let water into the connectors. Allow to dry. Pure alcohol can be used for disinfection.

## 5. System features

### 5.1. Audio filter (passive), technical properties

- Attenuation 6,5 dB +/- 0,5 dB @ 5 Hz - 15 kHz
- Input impedance 470  $\Omega$  - 1 k $\Omega$  @ 200 Hz - 15 kHz (with 300  $\Omega$  headphones connected).
- Max  $U_{in}$ : 10 Vrms @ 100 Hz - 20 kHz, 9 Vrms @ 70 Hz, 5 Vrms @ 40 Hz, 2 Vrms @ 20 Hz
- Common mode rejection ratio > 60 dB @ 3 kHz
- Channel separation > 80 dB @ 3 kHz

## 5.2. Typical delay and jitter values



The following values are measured with standard stimulus system and the premium projector. The values can depend on the system setup, used projector model, refresh rate, and resolution. Always measure the delay and jitter of the stimuli before timing-critical measurements.

### 5.2.1. Visual stimulus

Values measured with the Stim2 system, premium projector (Panasonic PT-D7700) at 60 Hz refresh rate and 1280 x 1024 resolution, and a video distribution amplifier (Extron SW2 VGA DA2A). The picture was set to non-scaling more (pixels shown 1:1).

- Delay from trigger onset to stimulus onset: 26,0 ms
- Jitter less than 40  $\mu$ s

### 5.2.2. Auditory stimulus

Values measured with the passive audio filter, Stim2 system, and Nicolet 300  $\Omega$  headphones connected to the audio stim. - connector under the gantry side cover.

- Delay from trigger onset to stimulus onset: 9,3 ms
- Jitter less than 100  $\mu$ s

### 5.2.3. Electric stimulus

Values measured with digitimer DS7A stimulator.

- Delay from trigger onset to stimulus onset: < 50  $\mu$ s
- Jitter less than 1  $\mu$ s