Somatosensory Stimulus System Operator's Guide

June 2004

CE CONFORMITY MARK

CE 0197

The Somatosensory Stimulus System has been developed and manufactured in accordance with the requirements of the following European directive: 65/65/CE

Technical Standards: IEC 60601-1, IEC 60601-1-2, EN 55011

PN 9037-832 Rev. B

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Description

Overview

The somatosensory stimulus system uses gentle puffs of air to stimulate various parts of the patient's body in order to evoke a response signal in the brain that can be measured by a Magnes system or another recording device. Small flexible plastic attachments (sensory output devices) are placed, for example, on the thumb, index finger, little finger, and lip. Gentle air pressure is delivered to the attachments, displacing the skin surface. The stimulus is usually sent to one sensory output device at a time in a repetitive pattern of multiple stimulations.

Intended Use

The Somatosensory Stimulus System is intended for use as an accessory to the Magnes System to evoke responses from the brain of a subject. It may also be used in conjunction with other detector systems for which tactile stimulation of the somatosensory system is required.

System Components

Control/Driver Electronics

The control/driver electronics provide a digital logic interface to the data acquisition system such as the Magnes DAS. Triggers generated by the Magnes DAS or other data acquisition system control the system to deliver air pulses to the stimulators.

Pneumatic Delivery System

Pneumatic circuitry regulates the delivery of compressed air to the output connectors 1 through 4 on the back of the somatosensory stimulus system. The nominal drive pressure of the stimulators is 5 to 25 PSIG.

Sensory Output Devices

These small, flexible, plastic clamps deliver the air pulse to the patient. These are covered later in this section.

Controls and Connectors: Front Panel

(Refer to Figure 1).

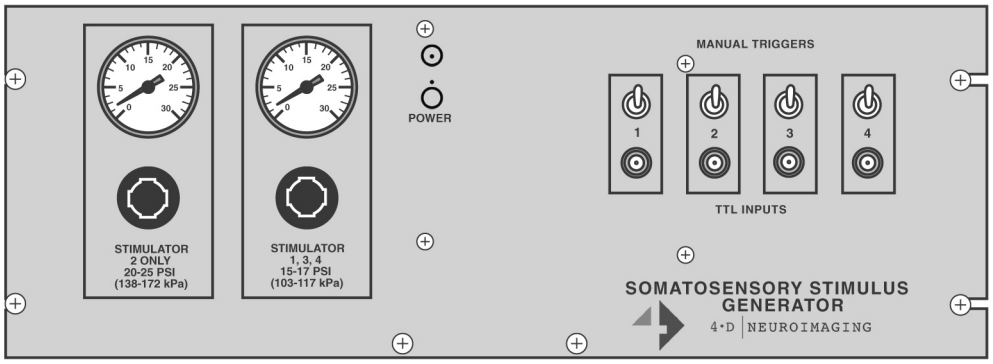

Figure 1. Front Panel of the Somatosensory Stimulus System

Stimulator 2 Only and **Stimulator 1, 3, 4**

These two knobs control the pressure of the air delivered to the four stimulator channels (located on the back panel), and the gauges display the chosen pressure. Two control knobs are provided so that different pressures can be used at different stimulator sites, if desired. For example, if a particular site is more sensitive to the pressure pulse than another site, a stronger pulse can be sent to that site. The pressure valves for each gauge are only recommendations; the two regulators are identical and can be adjusted from 0-30 psi.

Power

This switch controls power to the unit.

Manual Triggers

These momentary switches allow you to manually trigger each sensory output device independently. The switch numbering corresponds to that of the connectors on the back panel. These switches are provided for testing the output devices and their connections; they may also be used for special stimulation protocols.

TTL Inputs

These BNC connectors are TTL (5V logic) compatible inputs that are used to individually control each sensory output device. If only one sensory output device need be activated in a given run, it is easier to use the Stimulator Control Selection Box.

Controls and Connectors: Rear Panel

(Refer to Figure 2.)

DAS Trigger Input and DAS Trigger Output

Currently not used.

DAS Inputs

Currently not used.

Hand Controller Output and Hand Controller Input

Currently not used.

Parallel Port and Stimulator Channel Selector Box

This 25-pin connector is used for multichannel trigger inputs from the external channel selector box. The channel selector box enables you to manually indicate which of the four sensory output device channels is to be activated. When used with a Magnes system, the channel selector box is driven by one of the trigger outputs on the DAS user interface panel. Via this output, the Magnes DAS sends a trigger pulse to the channel selector, which routes the trigger to the control/driver electronics for the selected stimulator. If multiple stimulators must be activated within a given run, use the front panel TTL inputs.

Stimulator Supply

This feature is not currently supported.

Fuse

This is where the somatosensory stimulus system receives power (47-63 Hz; 90-260 VAC). When used with the Magnes system, the unit receives power from the utility rack's power supply via a power strip located inside the rack utility. (Replaceable 5 x 20mm, 0.5A, 250V fuse)

Connectors 1 through 4

These connectors deliver compressed air to the four sensory output devices via flexible tubing. The output device connectors are color coded for easy matching with the connection end of the stimulators.

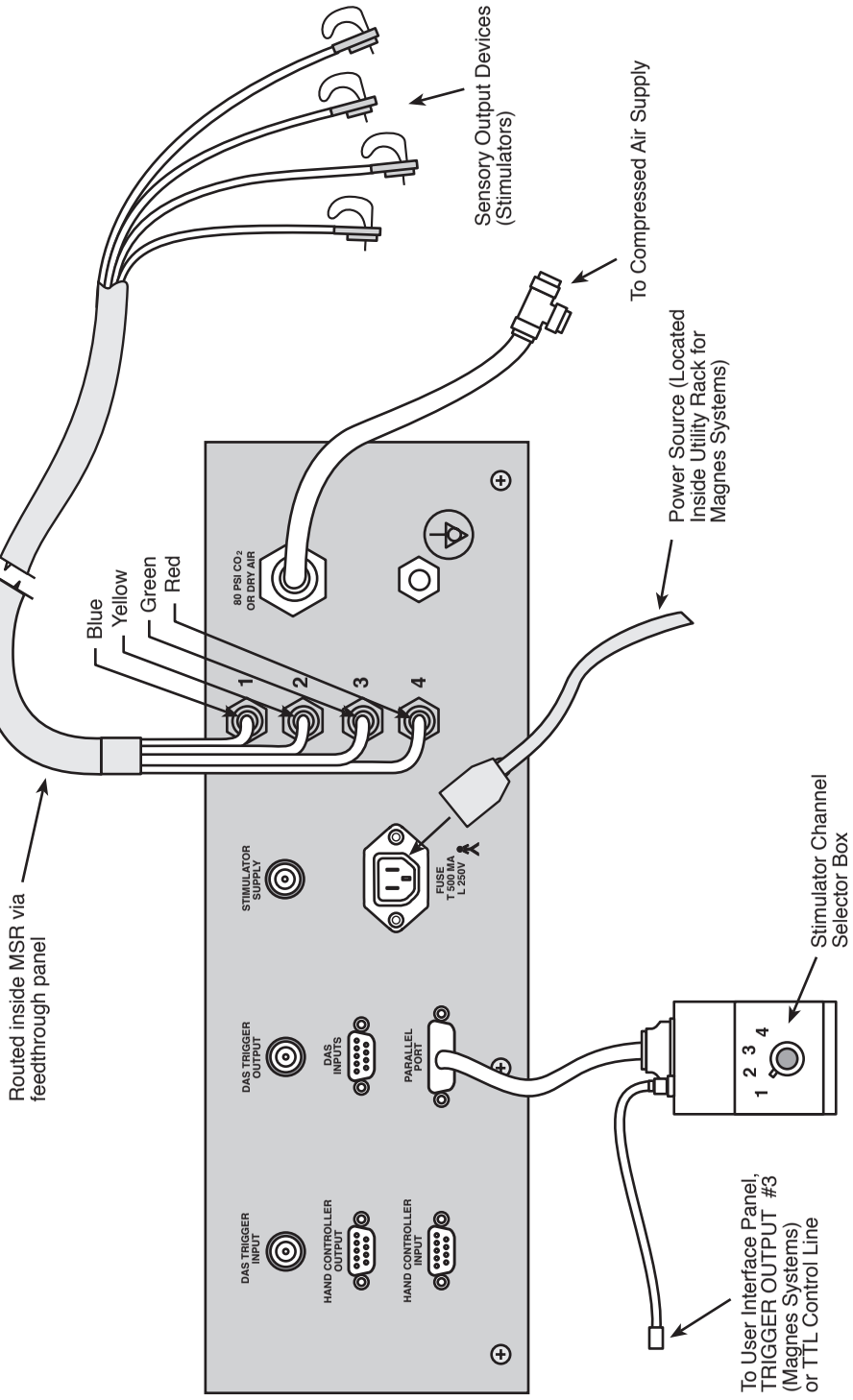

Figure 2. Somatosensory Stimulus System, Rear Panel and Hookups

80 PSI CO_2 or Dry Air

Compressed air or CO_2 is received from a compressed air supply or pressurized gas cylinder via this connector. The input pressure can range from 80 to 125 PSI.

Sensory Output Devices

Also referred to as "stimulators", these devices are small flexible plastic clips that are attached directly to the patient; usually to the fingers or lip, for which the clips were designed. Connected to each clip is a long flexible plastic tube, which connects to the back of the somatosensory stimulus panel at one of the sites labeled 1 through 4. For easy identification, both the stimulator and the connector end of each tube are color coded, corresponding to that of the connectors on the back of the stimulus panel.

A pressure pulse of air, controlled by the pneumatic delivery system, is delivered through the connector on the back of the stimulus panel and travels down the tubing to the stimulator. When it reaches the stimulator, it mechanically displaces a soft plastic diaphragm against the patient's skin, stimulating the patient's somatosensory nerves evoking responses in the brain.

The time that it takes for the pulse of air to travel down the tubing to the stimulator creates a delay between the trigger and the stimulation of the patient. This delay is dependent upon the length of the tubing and has been measured for your system; DO NOT adjust the length of the tubing without having this delay value remeausured. (When the system is used with a Magnes biomagnetometer system, the delay can be accounted for in the Magnes acquisition software setup, as explained later in this Guide.)

The maximum pulse length is determined by a "one-shot" timing circuit that should be approximately 240 milliseconds long. A relay is used to activate the air solenoid; the relay takes about 8 msec to activate and the solenoid takes about 6 msec, creating an approximate 14-15 msec delay from the trigger edge to the flow of air from the solenoid.

The deactivating edge of the trigger pulse, if the pulse is less than 240 msec long, will deactivate the relay and close the air solenoid. The relay takes about 1 msec to open, while the solenoid remains active for 6 msec, creating about a 7 msec delay from the deactivation edge until the solenoid is closed.

As described above, there is an additional turn on and turn off delay associated with the air pulse traveling down the tube to the membrane. At a minimum, if we assume a speed close to the speed of sound (~1000ft/sec), every foot of tubing would create about a 1 msec delay.

4-D Neuroimaging recommends that the number of stimulations per second be less than 10, and that the inter-trigger-internal (the time between successive triggers on a given channel) be 100 ms or greater, assuming a trigger length of 30 ms. Note that if the TTL front panel BNC ports are used to control the somatosensory stimulus system, the triggers for each of the four sensory output devices can overlap.

Maintenance and Service

Cleaning

The pneumatic tubing may be cleaned with a mild detergent or germicidal solution. The somatosensory stimulators on the finger clips may be sanitized before each use by rinsing with isopropyl alcohol or another mild disinfectant. Stimulators may be replaced if they become inoperative due to normal wear and tear. (Contact 4-D Customer Service to order replacements). If the plastic lip clip is to be reused, the clip itself as well as the plastic stimulator should be sanitized in a similar manner.

Service

The pneumatic tubing should be periodically inspected for leaks and/or dirt.

There are no user serviceable parts in this system. If a problem is encountered, check the system hookup and function as described below under "Equipment Check". If no solution is found, contact 4-D Neuroimaging Customer Service.

Note:

DO NOT adjust the length of the tubing without having the delay value remeasured.

Symbols Used on the System

Symbol	Meaning
	Equipotential attachment point
	Off (only for this system)
	On (only for this system)
	Type B Equipment (pluggable with industrial plug/socket - compliant with IEC 60309)

Table 1. Symbols Used on the Somatosensory Stimulus System

Equipment Check Procedure

Before you use the somatosensory stimulus system, check that the equipment has been set up correctly and that all components are operating properly. Follow the guidelines provided below.

1. Check Pressure Settings

The nominal pressure of the input compressed air should be 80 PSI, but can be as high as 125 PSI if necessary. Verify that the stimulator pressure gauges (located on the front panel) show appropriate pressure settings for the stimulators in use.

2. Check Connections

Toggle each of the manual trigger switches on the front panel and verify that the corresponding sensory output device is activated when triggered; you should feel a mechanical pulse at the tactile stimulator diaphragm.

3. Verify Proper Computer Control

(If using the Somatosensory System with a Magnes System)

A. In the "Patient Selection" window of the Magnes software, post any patient.

B. Invoke the Magnes "Acquisition Setup" window. Set up an internal epoch acquisition with a trigger output on the trigger channel attached to the Selector Box. Send idle parameters for this acquisition setup. Refer to the Sample Software Setup for details.

C. Press the **Start Initialization** button. After initialization completes, acquisition will begin. The "Acquisition in Progress" window will automatically appear to display the status of the acquisition.

D. Switch the channel selector knob to the **1** position and verify that a pulse is being produced by the stimulator that is connected to port number **1** on the back panel. Repeat for the other 3 positions.

Sample Acquisition Setup

The somatosensory stimulus system, when used with a Magnes biomagnetometer, is controlled by triggers generated from by the DAS, which are determined by the acquisition scan parameters. There are many different protocols that can be defined for activating the stimulators and collecting data. One commonly used setup is shown here as a Magnes-based example.

In the Magnes "Acquisition Setup" window, define the following:

Acquisition Mode	Internal
High Pass Filter	1 Hz
Data Type	Raw
Epoch Duration	0.3000
Pre trigger Duration	0.15000
Number of Epochs	256

In the "Acquisition Setup: Channel Information" window, select all MEG channels.

In the "Acquisition Setup: Output Trigger" window, define the following:

Event A Latency	-44 (ms)
Event A Duration	30 (ms)
Event A Output Line	3

This setup instructs the system to collect 256 epochs for each run, where a run corresponds to the data collected for a particular stimulator, and an epoch corresponds to a single stimulation.

By definition, the occurrence of the Magnes DAS internal trigger defines time = 0. This is the time at which we want the pulse to reach the patient so that when we look at the data, we know the stimulation event occurs at time = 0. To compensate for the time it takes for the pulse to travel down the tubing, the DAS must trigger the somatosensory stimulus system earlier than time = 0. In this example, assume that the known delay time is 44 ms. Therefore, we instruct the DAS to trigger the stimulus system 44 ms before time = 0 by defining trigger Event A to occur at latency -44 ms. The duration of the pulse in this example is defined to be 30 ms, and it will be output via the user interface panel's TRIGGER OUTPUT #3.

Because collected data is stored in a buffer before epochs are created, we can save data collected prior to time = 0. In this case, the Pre trigger Duration value of 0.15 and the Epoch Duration value of 0.30 instructs the DAS to save 300 ms of data starting at time = -150 ms (150 ms before the pulse reaches the patient). This enables us to capture data just before (150 ms) and just after (150 ms) the pulse reaches the patient.

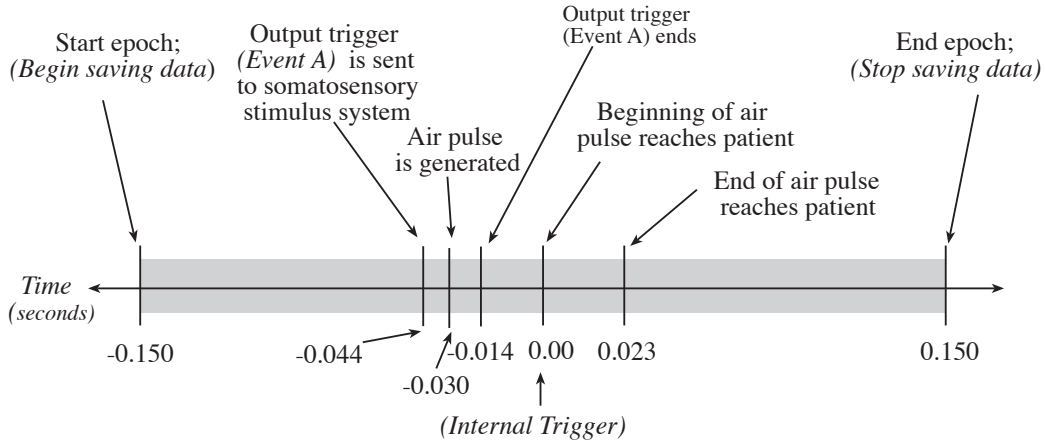

Figure 3. Time Line for Somatosensory Stimulus System Triggering