

## SPEAR3 Speech Processing System

*Product Brief – 16/5/2003*

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## SPEAR3 Speech Processing System

The Speech Processing System provides a means for programming the SPEAR3 processor for speech coding research with cochlear implants. The system comprises two components: (1) CSPEAK (Configurable SPEAK) a core speech coding program for the SPEAR3 processor and (2) Seed-Speak, a GUI application that runs under MS-Windows, which configures/seeds parameters of CSPEAK, and programs the SPEAR3 processor.

The Speech Processing System drives unilateral and bilateral implant configurations and both the Nucleus CI22 (mini) and/or CI24 (micro) implants are supported. Many program and client parameters, such as rate of stimulation, analysis (update) rate, number of bands (channels), number of maxima, loudness growth mapping parameters, and subjective threshold and comfortable stimulation levels can be configured by the system.

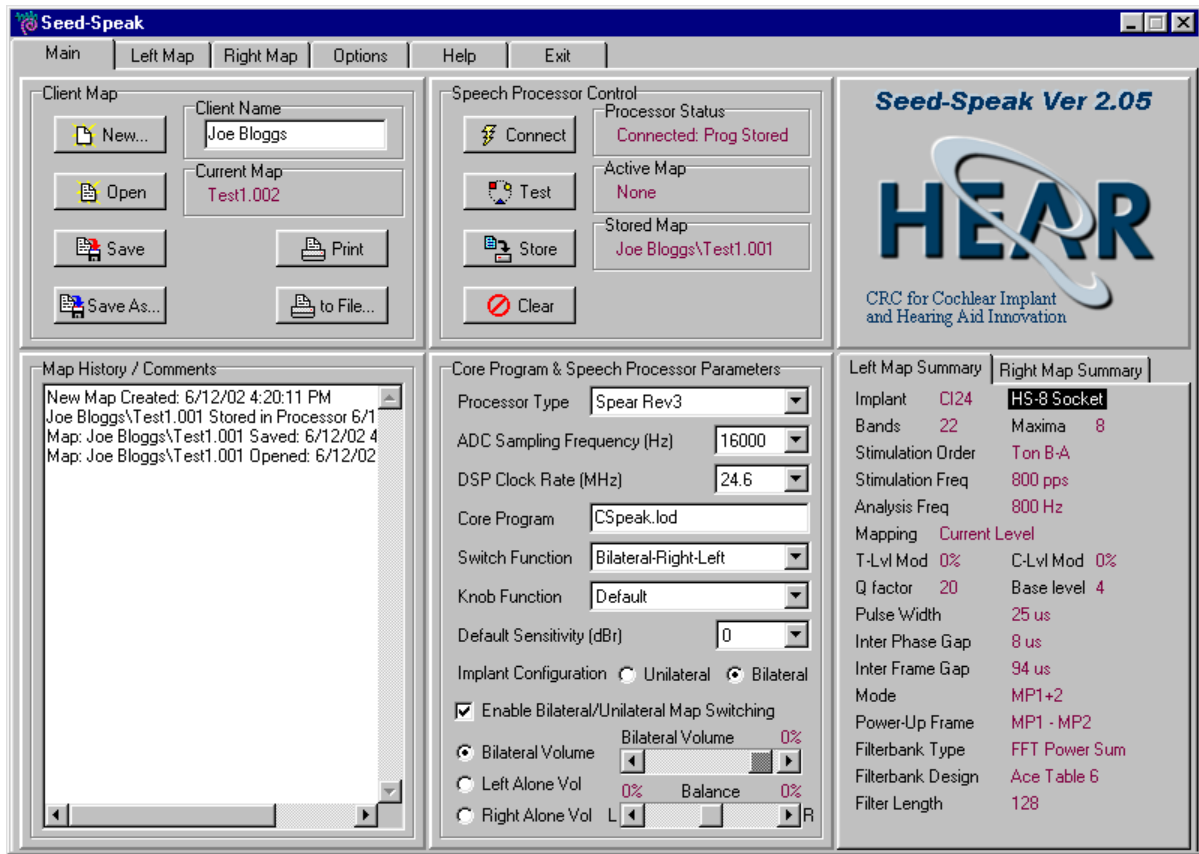
## Core Speech Coding Program

CSPEAK, the core speech coding program is a configurable version of the SPEAK strategy that can be configured to emulate the SPEAK, ACE or CIS strategies. New speech coding strategies that are developed for the SPEAR3 processor can be easily interfaced to the Seed-Speak. For instance both the ADRO (Adaptive Dynamic Range Optimisation) and TESM (Transient Emphasis Spectral Maxima) strategies have been implemented as SPEAR3 core programs and their functionality can be accessed via the Seed-Speak interface.

## Seed-Speak

Seed-Speak is a GUI application that runs under MS-Windows which configure parameters of the core program, such as those described above, as well as to provide a mechanism for maintaining client (patient) maps and to load these maps into the SPEAR3 processor. Seed-Speak can also be used to configure the filter bank used by the core program. The filter bank can be matched to that used by the ACE or SPEAK (SPrint) speech coding strategies or designed to some other specification. In addition, Seed-Speak provides some psychophysics functions for measurement of subjective threshold and comfortable loudness levels, sweeping of electrodes, tasks for estimation and ranking of loudness or electrode-pitch, and a task for loudness balancing electrodes.

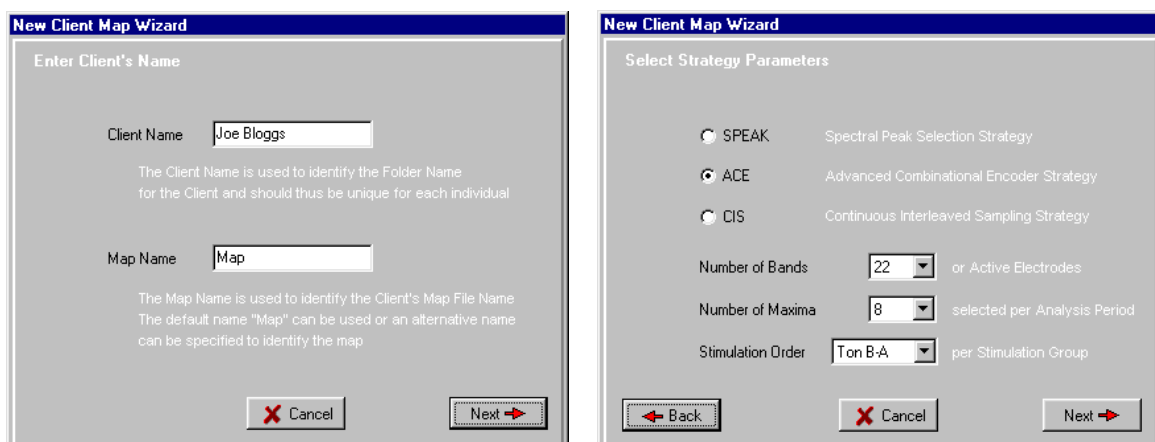
Seed-Speak's main window (see figure below) provides controls for maintaining client maps (top-right), interfacing to the speech processor (top-middle), modifying core program and speech processor parameters (bottom-middle), viewing and editing map history (bottom-left) and viewing a summary of client map settings (bottom-right). In addition tab buttons located at the top of the main window provide access to the client map settings (Left, Right or Unilateral) and Seed-Speak options.



--- The Seed-Speak main window ---

## Client Map Interface

An interface for maintaining client maps is provided in Seed-Speak. The interface includes mechanisms for creating new client maps, saving client maps (to hard disk), opening existing client maps and printing client maps to a printer or file. In addition, client map numbers are automatically incremented when saved so that a complete history of maps for a client can be maintained. To assist in creation of new client maps, a wizard is used to provide a step-by-step specification process for parameters of the new map (see figures below).



--- New Client Map Wizard windows ---

## Speech Processor Control

Seed-Speak provides controls for interfacing to the SPEAR3 processor: connect, test, save and clear. Connect is used to establish a connection with the speech processor. Test is used to test the current client map or a map that was previously saved in the speech processor. Save is used to save the current client map in the speech processor, and Clear is used to erase a map saved in the speech processor.

## Core Program and Speech Processor Parameters

Controls for specifying the processor type (i.e. SPEAR rev 1, 2 or 3), the ADC sampling frequency (12, 14 or 16 KHz), the DSP clock rate (8 to 65 MHz), the core program (e.g. CSpeak.lod), the function of the front-panel switch and knob, the implant configuration (i.e. unilateral or bilateral) and global volume and balance settings are provided.

## Client Map Settings

The Client Map Settings window (see figure below) is used to configure client specific parameters. For bilateral maps, two client map settings window are provided for independent parameter specification for both the left and right implant side. The client map settings provide controls for selecting the implant type (i.e. CI22 or CI24), the number of bands and maxima, the stimulation order, the group stimulation and analysis Frequency, loudness growth function parameters (i.e. Q factor and base level), stimulus parameters (i.e. T & C level modifiers, pulse width, inter phase gap, inter frame gap and power-up frame parameters). In addition, an interface for specification of the active and reference electrode number, threshold and comfortable levels of stimulation and the channel gain for each band of the system is provided. Psychophysics tools are also provided for measurement of threshold and comfortable levels of stimulation, and performing some psychophysics tasks.

Band	Active EI	Ref Elec	Threshold	Comfortable	Gain (dB)	PW (us)	Rate pps	Lower Hz	Upper Hz
1	22	30	100	255	0.0	25	800	188	313
2	21	30	100	255	0.0	25	800	313	438
3	20	30	100	255	0.0	25	800	438	563
4	19	30	100	255	0.0	25	800	563	688
5	18	30	100	255	0.0	25	800	688	813
6	17	30	100	255	0.0	25	800	813	938
7	16	30	100	255	0.0	25	800	938	1063
8	15	30	100	255	0.0	25	800	1063	1188
9	14	30	100	255	0.0	25	800	1188	1313
10	13	30	100	255	0.0	25	800	1313	1563
11	12	30	100	255	0.0	25	800	1563	1813
12	11	30	100	255	0.0	25	800	1813	2063
13	10	30	100	255	0.0	25	800	2063	2313
14	9	30	100	255	0.0	25	800	2313	2688
15	8	30	100	255	0.0	25	800	2688	3063
16	7	30	100	255	0.0	25	800	3063	3563
17	6	30	100	255	0.0	25	800	3563	4063
18	5	30	100	255	0.0	25	800	4063	4688
19	4	30	100	255	0.0	25	800	4688	5313
20	3	30	100	255	0.0	25	800	5313	6063
21	2	30	100	200	0.0	25	800	6063	6938
22	1	30	100	200	0.0	25	800	6938	7938

--- Client Map Settings window ---

## Measurement of Threshold and Comfortable Loudness Levels

The Client Map Settings window provides basic psychophysics tools for measurement of subjective threshold and comfortable loudness stimulation levels. This includes a mechanism for stimulating on a single electrode pair or sweeping stimulation across electrodes (see figures below).



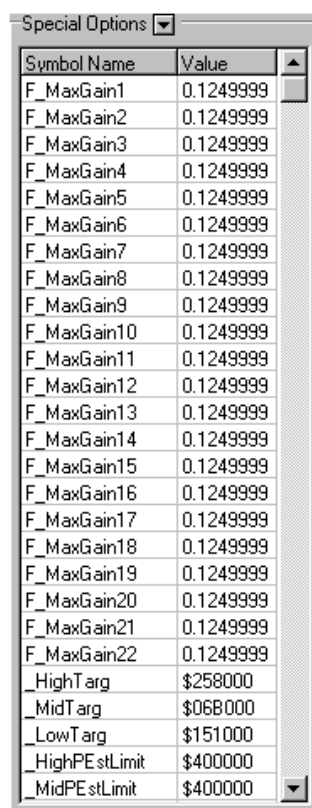
--- Stimulation Control Box ---



--- Sweep window ---

## Special Options

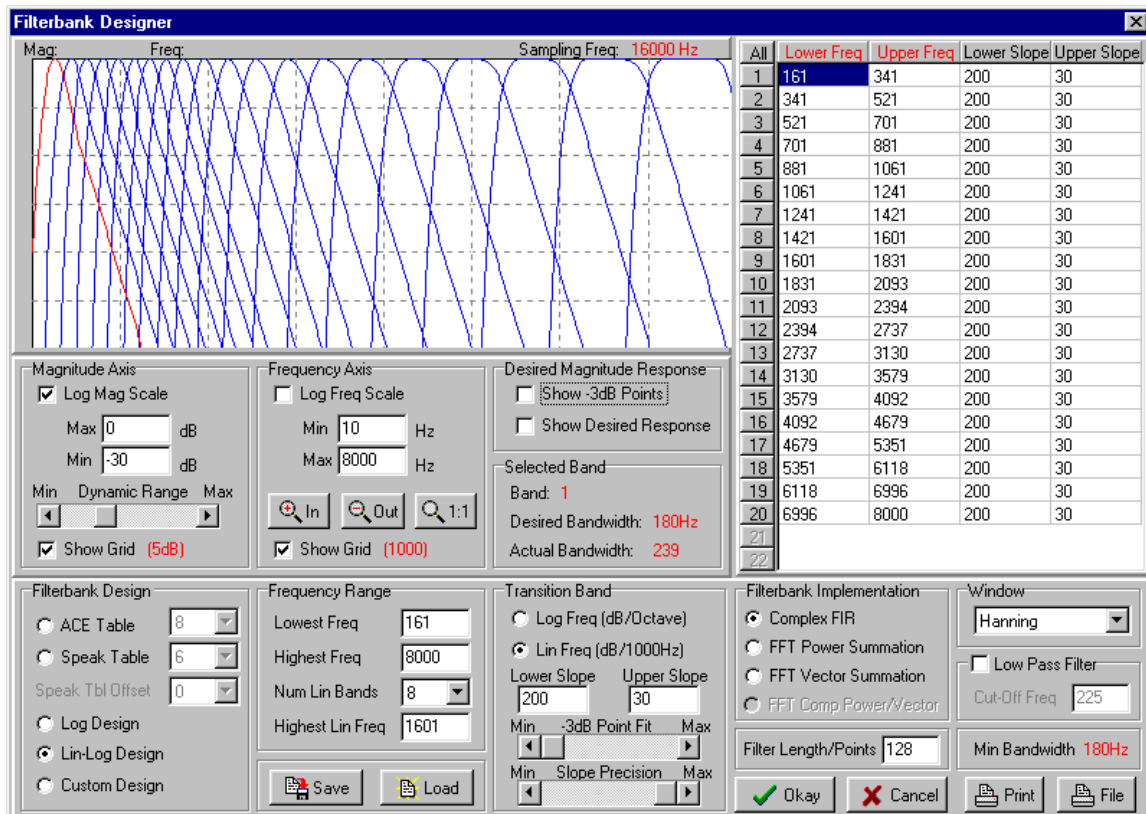
An interface for accessing any parameters specific to newly developed core programs that are not recognised by Seed-Speak is provided in an expandable special options list box in the Client Map Settings window (see figure below). Parameters can be specified as floating-point, integer, hexadecimal or boolean values and are loaded into the SPEAR3 processor during programming. This interface effectively provides a mechanism for manipulation of new speech coding strategy parameters without the need of developing new speech processing system software (i.e. Seed-Speak).



--- Special Options List Box ---

### Filterbank Specification

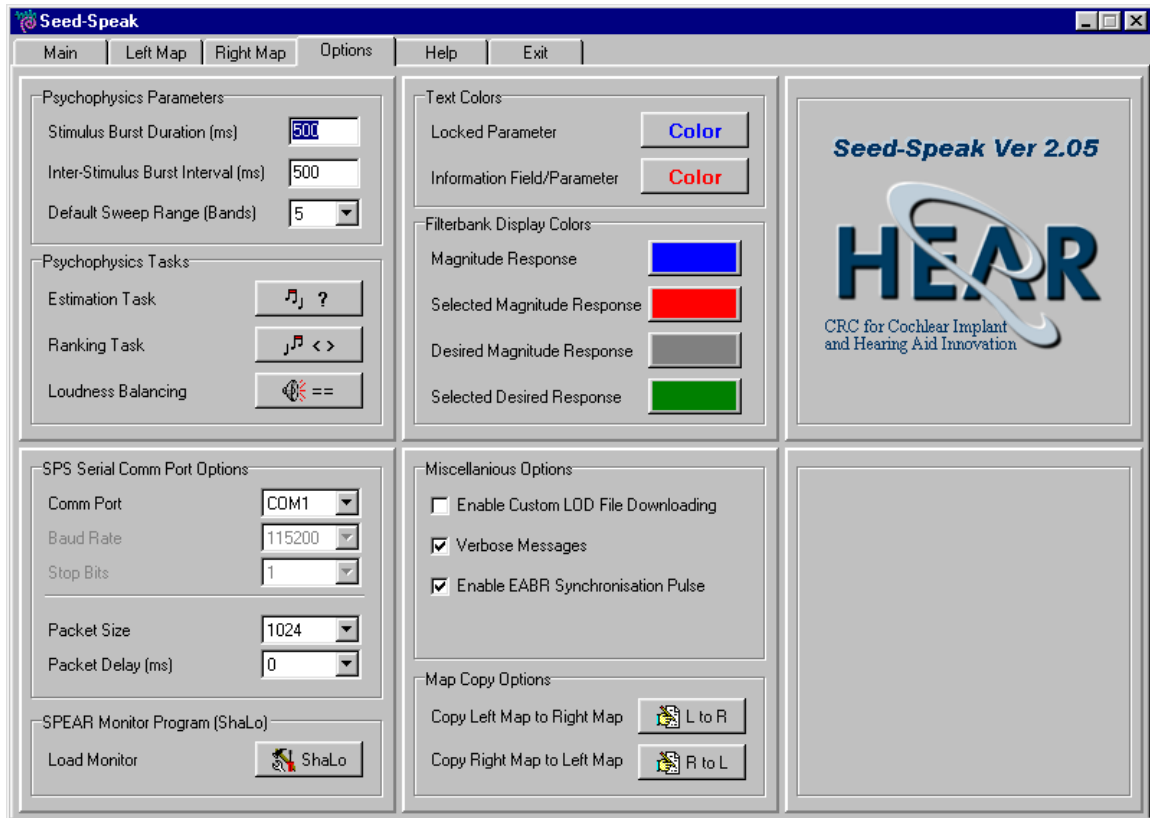
The band-pass filter bank employed by the core program can be selected from those normally available in Cochlear’s ACE or SPEAK maps, or designed according to some arbitrary specification. The filter bank designer window, as shown in the figure below, contains controls for specifying filter bank design model (i.e. ACE, SPEAK, log design, lin-log design or custom design), and selecting the implementation method (i.e. complex FIR/hilbert transform, FFT power summation or FFT vector summation). In the case of log and lin-log design models the frequency range and transition band characteristics can be specified. For custom design models the lower and upper frequency bounds for each band-pass filter band can be specified as well as their transition band slopes. To visually verify the design the magnitude response of the band-pass filter bank is displayed and controls are provided for adjusting display parameters.



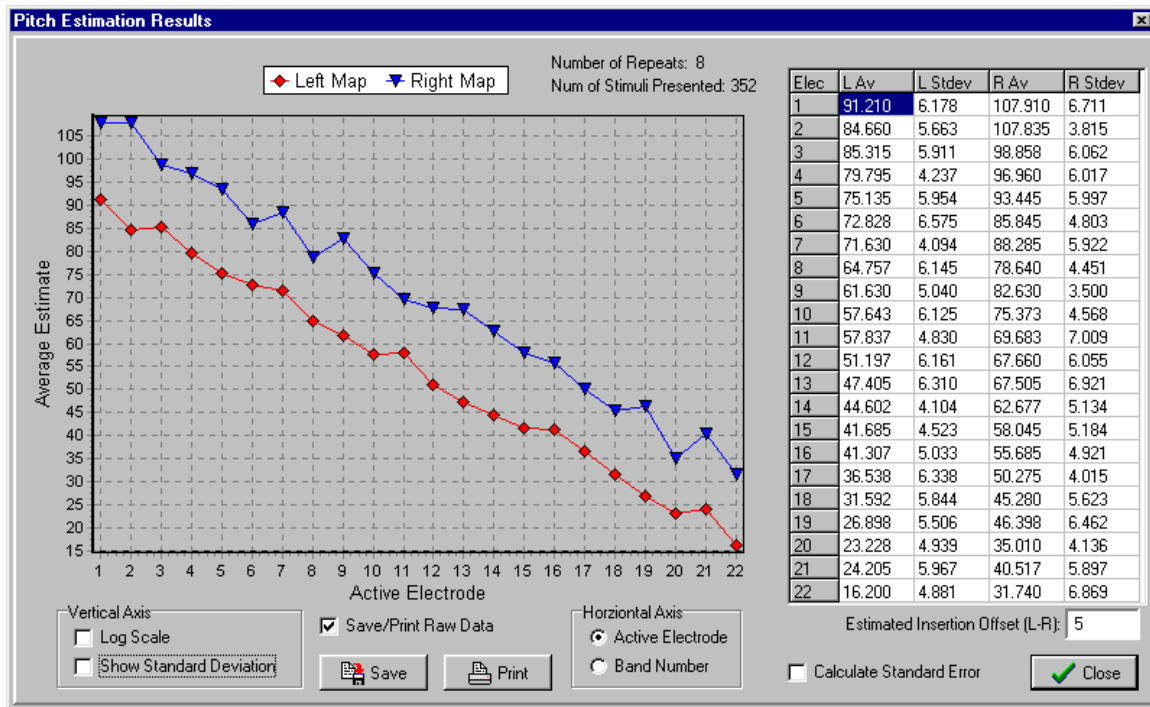
--- Filterbank Design window ---

### Seed-Speak Options

The Options window (see figures below) allows for configuration of psychophysics parameters, execution of psychophysics tasks (Estimation, Ranking and Loudness Balancing tasks), adjustment of SPS Serial Communication Port parameters, adjustment of colors used in Seed-Speak and setting of other general options.



--- Options window ---



--- Pitch Estimation Task Results window ---