

# AppNote

*The Desired Sensation Level (DSL) method is a systematic, scientific approach to hearing instrument selection and fitting. It provides specific electroacoustic performance criteria for selecting and adjusting hearing instruments<sup>1-4</sup>. Speechmap/DSL is a joint development of Audioscan and the National Centre for Audiology at The University of Western Ontario. It combines the novel, time-varying test signals of Audioscan's real-ear Speechmap system with DSL's attention to individual ear canal acoustics to provide a comprehensive method for fitting all types of hearing aids and FM systems to both children and adults.*

*The Speechmap/DSL fitting system departs from conventional insertion gain target methods in numerous ways:*

- *The concept of insertion gain is not used at all.*
- *Amplification targets for average speech and maximum real-ear output are calculated in terms of eardrum SPL, not insertion gain.*
- *Audiometric data (threshold, uncomfortable loudness level) are converted from dB HL to dB SPL at the eardrum.*

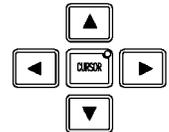
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## Fitting Hearing Aids with the Speechmap®/ DSL® Fitting System using the Audioscan® RM500

This AppNote provides procedures for a **basic implementation** of the Speechmap/DSL fitting system. At a basic level, the Speechmap/DSL fitting system predicts uncomfortable listening levels (UCL) from threshold and uses age-appropriate average values to reflect acoustic factors relevant to the selection and fitting of hearing aids. For greater accuracy in the fitting process, individual measurements of UCL, real-ear-to-coupler difference (RECD) and real-ear-to-dial difference (REDD) may be included. The measurement procedures for, and application of, individual RECD and REDD measurements are described in AppNotes 99-07 and 99-08, respectively.

### RM500 KEYBOARD LAYOUT

The RM500 keyboard is divided into 3 sections: HEARING AID TEST (HAT), REAL-EAR MEASUREMENT (REM) and CONTROL. To change from HAT mode to REM mode, press any key in the REM area of the keyboard; to change from REM mode to HAT mode, press any key in the HAT area of the keyboard.



The ARROW keys located in the center of the RM500 keyboard are used to highlight items in menus and lists, to display choices and to plot audiometric data.

### BEFORE STARTING: CALIBRATE THE RM500

Before starting, calibrate the HAT box following instructions outlined in the HAT section of the User's Guide. Calibrate the REM system of the RM500 using instructions outlined in the REM section of the User's Guide.

### IMPLEMENTING THE DSL METHOD: SPL MODE

These instructions are written assuming an SPL mode of operation. The SPL mode of operation is selected by pressing the HL/SPL key to illuminate the SPL light (if necessary).



### ACCESSING THE SPEECHMAP/DSL METHOD ON THE RM500:

Ensure that the RM500 is in REM mode.

1. Press the <ADVANCED FEATURES> key.
2. Highlight TESTS, SPEECHMAP/DSL and Press <CONTINUE>.

### THE ASSESSMENT DATA ENTRY POSTER:

Press <AGRAM> to display the ASSESSMENT DATA ENTRY POSTER.

Use the left/right ARROW keys at each scroll window to indicate specific client information (e.g., client's age, transducer used for the hearing test, etc.). Use the up/down ARROW keys to move between items (AGE, TRANSDUCER, UCL, RECD, REDD).

1. Indicate your client's age.
2. Indicate the transducer type.
3. Leave UCL, RECD and REDD at USE AVG.
4. Press <CONTINUE> to proceed.

ASSESSMENT DATA ENTRY	
AGE	ADULT
TRANSDUCER	HEADPHONE
UCL	USE AVG
RECD	USE AVG
REDD	USE AVG

The RM500 automatically advances to the Threshold Entry screen.

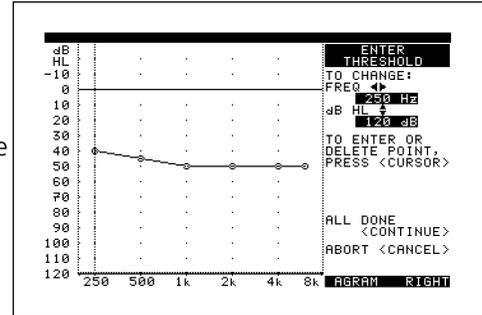
- Provision is made to correct threshold and UCL data for individual acoustic factors.
- Provision is made to incorporate individual acoustic factors in target values for 2cc coupler hearing instrument gain and OSPL90.
- Test signals for soft, average and loud conversational speech, as well as loud environmental sounds are provided.

The Speechmap/DSL fitting system converts audiometric data (entered in dB HL values) to SPL at the eardrum and plots the results on a SPLogram. Conversion may use age-appropriate average or measured RECD and REDD values. If not entered, UCL values are estimated from threshold. Real-ear measurements of hearing aid output in the ear canal are presented on the same SPLogram. By directly comparing hearing aid output for a range of meaningful test signals to the client's auditory area, audibility and comfort can be established.

Simulated Real-Ear Measurements (S-REM) is a unique simulation of real-ear performance from HAT box measurements. Microphone location effects are included in the test signals and average RECD values (or measured, if available) are used in this simulation.

### ENTERING THRESHOLD INFORMATION:

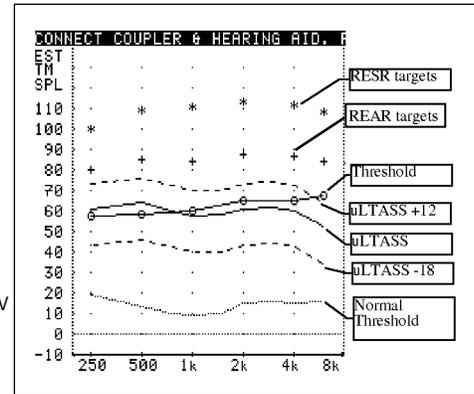
1. Use the left/right ARROW keys to change frequency.
2. Use the up/down ARROW keys to change dB HL value.
3. Press the <CURSOR> key to enter or delete a threshold point.
4. Press <CONTINUE> once all audiometric data has been entered.



### THE UNAIDED SPLOGRAM:

Following entry of the assessment information, an **unaided SPLogram** appears on the Speechmap/DSL screen. All variables presented on the graph are plotted as ear canal SPLs as a function of frequency.

Curves plotted include: average normal hearing sensitivity; the client's hearing threshold levels transformed from dB HL to dB SPL (at the eardrum); the unamplified long-term average speech spectrum (uLTASS) with a +12/-18 dB range; target levels for amplified 70 dB speech (REAR); and target levels for the real-ear saturation response (RESR). Generally, speech sounds above threshold will be audible, while sounds below threshold will not be audible. Theoretically, we would like to amplify soft speech to threshold, 70 dB speech to the REAR targets (+) and limit maximum real-ear output to the RESR targets (\*). Pressing <PRINT SCREEN> will provide a hard copy of the SPLogram screen for the client record.



**NOTE:** The unamplified long-term average speech spectrum (uLTASS) is displayed by pressing the <UNAIDED> key located in the DISPLAY section of the REM keyboard.

### DERIVING 2CC TARGETS FOR HEARING AID SELECTION PURPOSES:

It is desirable to have real-ear targets defined in terms of 2cc coupler values when ordering a hearing instrument for the client.

1. At the upper right-hand corner of the SPLogram screen use the left/right ARROW keys to scroll to the desired hearing aid type (BTE, ITE, ITC, CIC, BODY).
2. Press <ADVANCED FEATURES>.
3. Highlight TOOLKIT, 2cc TARGETS and press <CONTINUE>.
4. Use the left/right ARROW key to scroll to DSL in the Select 2cc Target poster and press <CONTINUE>.
5. If desired, the left/right ARROW keys can be used to change RESERVE GAIN.



FREQ	OSPL90 OUTPUT	USER GAIN	FULL-ON GAIN
250	96	15	25
500	105	18	28
750	105	21	31
1000	106	25	35
1500	107	28	38
2000	110	31	41
3000	106	34	44
4000	101	27	37
6000	99	29	39

The values appearing on-screen are the desired 2cc full-on-gain, user gain and OSPL90 values for the style of hearing instrument selected. These 2cc coupler values will provide the appropriate response on an age-appropriate acoustically average ear to match the real-ear targets derived by the DSL method. Therefore, they can be used to facilitate the initial selection of an appropriate hearing aid for the candidate client.

# AppNote

*Real-ear targets are converted to 2cc coupler gain and OSPL90 targets by using average RECD values (or measured RECD values if available) and the appropriate microphone location effects (MLEs) for the desired style of hearing aid. The gain values given assume the hearing aid is linear for average speech. (This assumption is necessary to allow the MLEs to be incorporated).*

*For BTE and body aid instruments, the user gain, full-on-gain and OSPL values provided assume a fully-occluding earmold with #13 tubing extending to the medial tip of the earmold. If a different type of mold is utilized, alterations to these values must be made to account for the different acoustic characteristics.*

*For CIC instruments, user gain, full-on-gain and OSPL values take into account that the CIC instrument, when deeply inserted into the ear canal, will produce a greater SPL in the ear than that measured in the ITE coupler.*

**A note on “hitting” targets:** The + marks on the SPLogram are the real-ear Desired Sensation Level for amplified 70 dB speech (aLTASS70). For children, who are in the process of learning to listen, and who are developing speech and language skills, it is important to try to approximate the DSL REAR “targets” across the broadest relevant frequency range

## HEARING INSTRUMENT FITTING PROCEDURES:

The Speechmap/DSL fitting system provides two hearing instrument fitting options: (1) real-ear measurement (REM) mode and (2) a unique method of verification utilizing the 2cc coupler – simulated real-ear measurement (S-REM) mode. Both modes utilize special test signals (SWEPT and DYNAMIC) that reflect the temporal and spectral properties of soft, average and loud speech. The predicted, or measured, real-ear performance is displayed on an aided SPLogram, which also shows the client’s auditory area. If you wish to work in S-REM mode:

1. Attach the hearing aid being fitted to the appropriate 2cc coupler as for a hearing aid test.
2. Set the user volume control (VC) to provide 5 – 15 dB of reserve gain. Note that for some hearing aids, the OSPL90 may be higher at other settings of the VC. This should be considered when fitting children.
3. Lay the entire assembly on the foam floor of the HAT box such that the hearing aid’s microphone lies within the test circle and the HAT reference microphone is positioned as close as possible to the hearing aid microphone without actually touching it.
4. Run any programming leads out over the rubber gasket of the HAT box where they will not be sharply bent. Close and seal the HAT box.
5. On the SPLogram screen, use the up/down ARROW keys to highlight the HA TYPE and use the left/right ARROW keys to select the style of hearing aid.
6. Use the down ARROW key to highlight MODE, and change REM to S-REM.

If you wish to work in REM mode, set the MODE to REM in step 6. Position the probe microphone assembly on the ear and the probe tube and hearing aid in the ear as for a basic aided real-ear measurement.

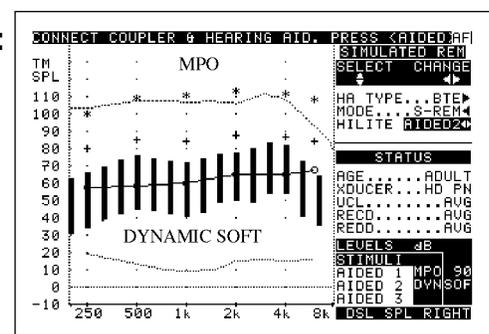
The goal in hearing instrument fitting is to amplify soft speech to levels above threshold, but limit amplification so that loud sounds do not exceed uncomfortable loudness levels. The most efficient order for making adjustments to a hearing aid depends on the controls available and the way in which they interact. The following instructions assume there are controls that adjust the gain for soft and loud sounds independently. If these controls interact, some steps may need to be repeated.

## SETTING THE GAIN/FREQUENCY RESPONSE OF THE HEARING AID:

1. Press TEST<AIDED 1> to start the QUIKSCAN stimulus.
2. At the STIMTYPE scroll window, use the left/right ARROW keys to highlight DYNAMIC.
3. Use the down ARROW key to move to the STIMLEVEL scroll window and use the left/right ARROW keys to highlight SOFT.
4. Adjust the low-level gain (gain, tone, TK, VC) so that the SOFT QUIKSCAN measurement curve is just above threshold across the widest frequency range possible.
5. Press <CONTINUE> to complete the DYNAMIC SOFT test.

At the end of the test, 50% to 75% of the length of the dynamic range bars should be above the threshold curve between 500 and 4000 Hz.

**NOTE:** When adjusting hearing aids with long adaptation times – such as the WIDEX SENSO™ - you will need to wait until the QUIKSCAN curve stabilizes before running the complete DYNAMIC test.



and not to exceed the recommended (RESR). A recent study of children using linear and WDRC hearing aids has shown that, in the majority of cases, this approach results in an acceptable listening level for average speech<sup>5</sup>.

We continue to receive reports that, for some adults wearing compression amplification, "hitting" the DSL REAR targets results in a fitting that is judged "too loud". Fitting amplification to adults who have acquired a hearing loss over time requires consideration of listening preferences and acclimatization. In addition, some types of compression amplification may result in a wide range of input levels being "concentrated" in a small portion of the residual auditory area. The protocol given in this note seeks to make maximum use of the residual auditory area by placing soft speech at threshold and loud sounds below UCL. When this is achieved, the aLTASS70 may not match the DSL REAR "targets" (+). During subsequent visits, as the client becomes acclimatized to wearing amplification, it may be desirable to adjust the hearing aid to place more of the aLTASS70 close to the DSL REAR "targets".

## SETTING THE HEARING AID MAXIMUM OUTPUT:

**NOTE:** The MPO should be limited first in S-REM mode (as opposed to directly on the client's ear) to pre-set the OSPL90 to a safe and comfortable level. In REM mode, for safety reasons, the MPO test has no QUIKSCAN sweep – a single sweep at 70 dB SPL occurs when you select the MPO stimulus type. **Nothing else will happen until you press the <CONTINUE> key.** Then a series of 85 dB tone bursts will be presented. In S-REM mode a continuous sweep is presented at 90 dB.

1. Press TEST <AIDED 2> to start the QUIKSCAN stimulus. Use the up/down ARROW keys to highlight the STIMTYPE scroll window; use the left/right ARROW keys to highlight MPO.
2. In REM mode, press the CONTINUE key to generate a curve. This step is not necessary in S-REM mode.
3. Adjust the hearing aid output limiting controls (PC, TK, CR, VC) so that the MPO curve is at or below the RESR targets (\*) at all frequencies.

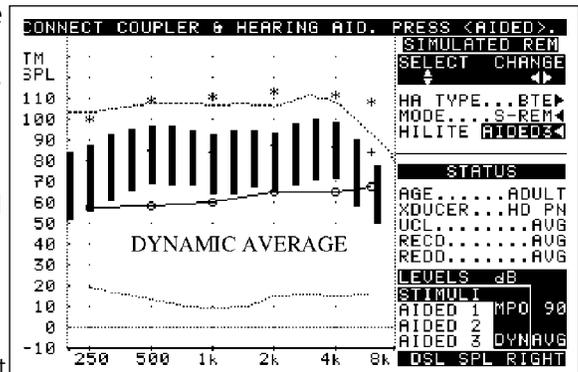
**NOTE:** If you have to open the HAT box to make changes to the hearing aid controls, first press <CANCEL> to stop the MPO stimulus before opening the HAT box (to prevent very loud sounds from the speaker). Re-run the test and check the MPO test relative to RESR targets. If you are using a computer or programmer to adjust the hearing aid, you can make these adjustments, in real time, without having to open the HAT box during the MPO test.

4. To store the QUIKSCAN curve, press TEST <AIDED 2> a second time (or press <CONTINUE> to run a more detailed measurement curve).

## CHECKING AVERAGE SPEECH FOR AUDIBILITY AND COMFORT

The DYNAMIC AVERAGE test may be used to ensure that average conversational speech lies within the client's dynamic range of hearing, and that the hearing aid has been adjusted in previous steps such that appropriate headroom for average conversational speech is provided.

1. Press TEST <AIDED 3> to start the QUIKSCAN stimulus. At the STIMTYPE scroll window, use the left/right ARROW keys to highlight DYNAMIC. Use the down ARROW key to move to STIMLEVEL and scroll to AVERAGE.
2. Press <CONTINUE> to run the DYNAMIC AVERAGE test. At the end of the test, the length of the dynamic range bars should lie above threshold and below the RESR targets. The goal in fitting is to ensure that soft speech sounds soft, average speech is audible and comfortable, and loud speech is not uncomfortably loud.



## REFERENCES

- 1 Cole WA, Sinclair ST (1998). The Audioscan RM500 Speechmap/DSL fitting system. Trends in Amplification 3(4):125-139.
- 2 Cornelisse LE, Seewald RC, Jamieson DG (1995). The input/output formula: A theoretical approach to the fitting of personal amplification devices. JASA 97(3):1854-1864.
- 3 Moodie KS, Seewald RC, Sinclair ST (1994). Procedure for predicting real-ear hearing aid performance in young children. AJA 3:23-31.
- 4 Seewald RC, Ramji KV, Sinclair ST, Moodie KS, Jamieson DG (1993). Computer-Assisted Implementation of the Desired Sensation Level Method for Electroacoustic Selection and Fitting In Children:Version 4.1 User's Manual. London The University of Western Ontario.
- 5 Scollie SD, Seewald RC, Moodie KS, Dekok K (2000). Preferred listening levels of children who use hearing aids: Comparison to prescriptive targets. JAAA 11:230-238.