INTELLIGENT HEARING SYSTEMS

Smart Notes

# DPOAE Testing with 10B+ and High Frequency Transducers

## Introduction

SmartDPOAE systems with the high frequency option installed and a 10B+ microphone need some extra considerations when performing testing at high frequencies, due to the limitations of the 10B+ microphone. Additionally, the physical nature of the cochlea and ear canal hinders testing in three ways. First, the high frequency portion of the cochlea, especially in humans, contains a fewer amount of hair cells that are able to respond to high frequency stimulation causing the intensity of the response to decrease and therefore become more susceptible to noise. Second, the high frequency portion of the cochlea is located at the beginning of the cochlea, making it more difficult to separate the stimulus from the returning signal. Third, standing waves in the ear canal are more prevalent at higher frequencies which can potentially introduce increased measurement error.

As a result of these limitations, high frequency testing becomes tenuous for testing of individual subject hearing. However, even with those limitations, High Frequency testing has shown to be useful when considering an average of several tests on a single animal or when comparing populations of two different animal groups, such as when researching ototoxicity effects of drugs and genetic defect effects. Because of these limitations it is imperative that the system be properly calibrated in order to obtain the most reliable results possible.

## The 10B Losses Table

When performing OAE testing at high frequencies, since the correction values applied are affecting only the actual sound output; the losses recorded in the 10B+ microphone will still affect the acquired recordings. It is necessary to take into consideration the effects of the 10B+ losses on the response.

In order to do this, you must copy your DP levels to a spreadsheet or use your DP printout and add the values from the DP losses table that was provided to you with your system. At this point, it is necessary to perform this operation manually; in the future, a 10B+ losses table correction will be implemented in the software. The following table is a sample of a 10B+ losses table:

| Frequency | Value to be added to DPOAE Amplitudes in dB |
|---|---|
| 14k | 13 |
| 16k | 15 |
| 18k | 15 |
| 20k | 6 |
| 22k | 18 |
| 24k | 18 |
| 26k | 7 |
| 28k | 2 |
| 30k | 0 |
| 32k | 6 |

The values outlined in the losses table will need to be applied to the DP Amplitude, Average Noise Floor, The Standard Deviation of the noise and the A1 and A2 values.

## Performing a Test

The following procedure outlines the steps to take when acquiring DPOAE recordings using a 10B+ microphone with high frequency transducers.

1. Start SmartDPOAE from the launch pad.
2. Under the system menu, make sure that high frequency is turned ON if you plan to test at frequencies of 16 kHz and higher. This options should be turned OFF when testing at lower frequencies to prevent excessive noise.
3. Also, under the system menu, select the 10B+ probe as your recording microphone and the High Frequency transducers as your current stimulator.

4. Click on the Acquire button to switch to the acquisition page.
5. Click on the parameters button and modify the sweeps, block size, levels, starting frequency, end frequency and other parameters as needed for the required type of acquisition.
6. Make sure that the 10B+ OAE probe with HF transducers are fitted properly into the subject's ear.
7. If testing frequencies up to and including 16 kHz, make sure the sound output booster box is set to "Direct." If testing at frequencies higher than 16 kHz, set the sound output booster box to "High Pass Filter"
8. Begin DPOAE acquisition by clicking on the Left or Right buttons as required.

## Analysis

As the test is being completed, the system will average the responses to each sweep and place then in a DPGram, facilitating response analysis. A DPGram will display the intensity of the response at each frequency point and the noise level around it. The SmartDPOAE system also displays SNR and response indication information for each point based on the previously defined passing criteria.

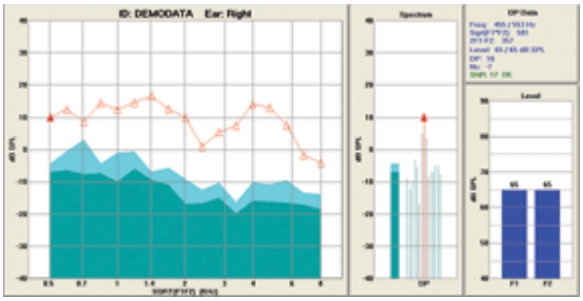

Figure 1 - DPOAE Recording

Once you have your results, for frequencies of 14 kHz and higher, you must add the corresponding values from the 10B+ losses table. The values from the table must be added to the measured levels A1 and A2, the Distortion Product level (DP) and the Noise Level (NS). The following table shows an example of data acquired at 14 kHz and corrected using the values from the sample table previously shown. Suppose F1 is 20 kHz, F2 is 24 kHz and the DP is around 16kHz.

| Value | A1 | A2 | DP | NS |
|---|---|---|---|---|
| Recorded | 59 | 37 | -10 | -32 |
| Correction | 6 | 18 | 15 | |
| Corrected | 65 | 55 | 5 | -17 |

## Screening Protocols

SmartDPOAE is both Diagnostic and Screening distortion product OAE system. To use the system as a screening system, it is only necessary to set the parameters to perform fast screening. Depending on the requirements and needs for your project, set the frequency limits, a low number of frequencies per octave and be sure to select all stopping criteria options to accelerate screening. Passing criteria may also need to be modified to comply with the requirements of your project.

## Scripting Language

Since automatic calculation of frequencies with the normal settings causes certain limitations, SmartDPOAE has the capability of running tests based on user-defined scripts. Scripting can be accessed by clicking on the Use Script radio button in the parameters window. Each script line requires F1, F2, L1, L2 and number of sweeps, in that order, as comma separated values. The following is an example of a 1, 2, 3 and 4 kHz OAE script running a 65/55 dB protocol, with F2/F1 of 1.22, with eight sweeps per frequency pair:

905, 1105, 65, 55, 8
1810, 2211, 65, 55, 8
2714, 3316, 65, 55, 8
3619, 4416, 65, 55, 8

In order to create the frequency pairs needed to generate a DP response at a certain frequency, it is possible to use the automatic frequency generation. To do this, enter an estimated starting frequency in the parameters window, along with the desired F2/F1 ratio you wish to use; on the right, you can read the calculated values for F1 and F2.