

Distortion Product OAE

using SmartDPOAE

What is DPOAE?

Distortion Product Otoacoustic Emissions are responses generated by the test subject's cochlea when provided with a two-tone stimulation. These emissions are generated commonly by healthy ears. When the cochlea is stimulated by these two frequencies (F1 and F2), the cochlea hair cells generate a resonance in response, with a direct relationship to the stimulus signals. The largest intensity of the distortion product response has been found to be at the frequency component given by the following formula:

$$DPF = 2 * F1 - F2$$

Due to the reduced intensity of the signals, the responses are recorded using a very sensitive microphone. Once the responses have been acquired, they can be presented in graphic or text form for further examination.

Why acquire OAE?

OAEs may be used to diagnose certain auditory conditions. It can provide a health professional with very useful information about types of hearing loss in a patient and other conditions. OAEs can help with:

- Detection Cochlear auditory dysfunction
- Investigation of frequency specific hearing loss
- Diagnosis of CAPD
- Monitoring of drug ototoxicity
- Confirmation of cochlear malfunction on patients with tinnitus
- Differentiation between sensory and neural hearing loss in certain patients
- Detection of genetic diseases

Patient Preparation

The patient must be placed in a comfortable and quiet environment, preferably a sound booth where the patient lies down or sits comfortably. Even though the patient does not need to be in a relaxed state for this test, it is recommended, in order to minimize noise.

To obtain a better recording it is also recommended to inspect the patient's ear canal. Cerumen or debris may partially block the stimulus signals, resulting in incorrect results. Cleaning of the ear canal shall only be performed by a person trained in such procedure in order to prevent any irreversible middle ear damage.

Probe Usage

There are two types of probes available:

- Microphone-Stimulator probes, like the 10D, are self contained units that can deliver the stimulus and pick up the response. This is the type of probe used for clinical diagnostics.
- Microphone probes, like the 10B+, contain only microphones and stimulus delivery tubes, which allow any kind of stimulator to be attached, forgoing bulk in benefit of flexibility. Microphone only probes are especially useful when testing at frequencies higher than the ones allowed by probes with a built in stimulator. This type of probe is used for investigational research purposes.

Probes should be used with an appropriate tip to provide a good seal and reduce external noise.

Setting up SmartDPOAE

Acquiring Distortion Product OAE's is SmartDPOAE function. The system may be setup with a few clicks of the mouse. Complete the following steps in the order outlined, use the test setting that best fit your requirements or use the recommended settings shown on the next section:

1. Go to the Acquire screen and press the **[PARAMETERS]** button.
2. Set the number of sweeps, block size, intensity levels, artifact level allowed and number of retries; on the General tab.
3. On the Frequency tab, define your start and end frequencies, number of frequencies per octave and F2/F1 ratio.
4. Select the desired stopping criteria, if necessary, and click **[OK]**.
5. Press the **[RIGHT]** or **[LEFT]** buttons to acquire DPOAE's for that particular ear.

Note that more frequencies per octave will increase test times dramatically, however it will give you a more accurate picture of the cochlear response. It is also possible to modify the testing order, or to test only one frequency at a time by selecting the appropriate options in the frequency tab of the parameters window.

Recommended Test Settings

This list shows the recommended settings for diagnostic DPOAE acquisition:

- **Frequencies:** 500 – 8000 Hz.
- **Frequencies per Octave:** 3 or more
- **F2/F1 ratio:** 1.2
- **Sweeps:** 16 sweeps per frequency.
- **Block Size:** 8 sweeps per block.
- **Level:** 65dB SPL Maximum for Level 1
55dB SPL for Level 2
- **Passing Criteria:** 65% or better

Recommended settings for screening:

- **Frequencies:** 1500 – 6000 Hz.
- **Frequencies per Octave:** 2
- **F2/F1 ratio:** 1.2
- **Sweeps:** 16 sweeps per frequency.
- **Block Size:** 8 sweeps per block.
- **Level:** 65dB SPL Maximum for Level 1
55dB SPL for Level 2
- **Passing Criteria:** 60% or better

References:

Hall, J. W. (2015, August). A clinician's guide to OAE measurement and analysis. AudiologyOnline, Article 14981. Retrieved from <http://www.audiologyonline.com>.

Abdala C, Visser-Dumont L. Distortion Product Otoacoustic Emissions: A Tool for Hearing Assessment and Scientific Study. The Volta review. 2001;103(4):281-302.

Notes on High Frequency Testing

SmartDPOAE systems with the high frequency option installed need some extra considerations when performing a test, especially when performing human testing. Due to the extended bandwidth of the high frequency systems, testing low frequencies while the system is on high frequency mode may cause increased response side bin noise. To switch between high frequency mode and normal mode, turn ON or OFF the High Frequency option listed under System in the SmartDPOAE main menu. In addition, you must also consider that due to the nature of high frequency testing, the procedure is recommended for use in cross-population ototoxicity and genetic studies, not for diagnostic of individual subjects.

Analysis

As the test is being completed, the system will average the responses to each sweep and place them in a DP Gram, facilitating response analysis. A DP Gram 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.

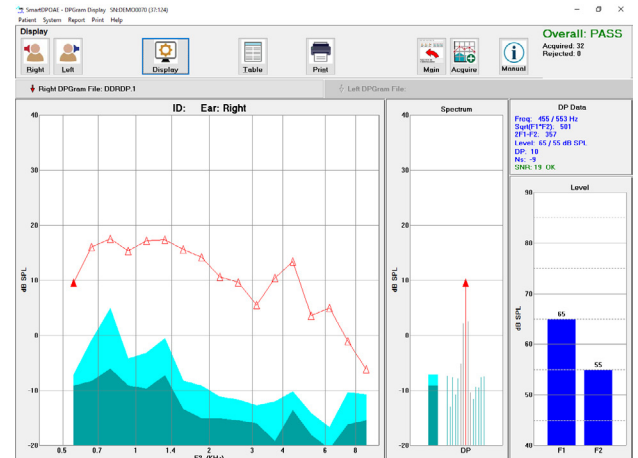


Fig.1 - DPOAE right ear DP Gram

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