PATHNEWS
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Welcome to the new PATH MEDICAL NEWSLETTER. This publication is intended to highlight features of our products, tips on best practices, and how-to's. We hope that you find the information valuable and would love to have your feedback and suggestions for topics. Please write to us at academy@pathme.de.

FMDPOAEs® - Frequency Modulated Distortion Product Otoacoustic Emissions

Path Medical uses a patented technology (Lodwig, 2014) to reduce fine structure interference in DPOAE testing. Basilar membrane fine structure are the peaks and valleys that are seen when conducting fine resolution measurements. Fine structure arises from the interaction between the two sources of the DPOAE, the place of maximum overlap between f1 and f2 (close to f2) and the reflected component of 2f1-f2 (Shera & Guinan, 1999). The interaction from these two sources can interfere in a constructive or destructive way resulting in either a peak or valley. The peaks and valleys are unique to each person and thus cannot be predicted where they will occur in a measurement. The picture is an example of fine structure peaks and valleys as can be seen in the upper DP grams .

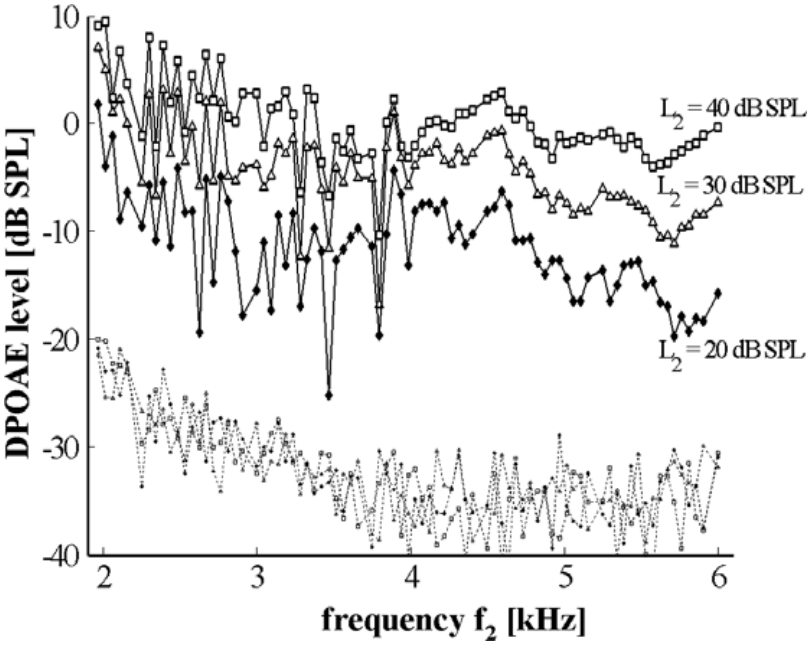

***Fig. 1**: Example of measurement of DPOAE fine structure. Three primary tone level combinations with L2 = 20, 30 and 40 dB SPL and L1 = L2 · 0.4 + 39 dB were used. The three bottom lines represent the three noise floor levels. (Wagner et al., 2008, Fig. 1)*

While fine structure peaks and valleys may not be evident under most clinical protocols they can still interfere with clinical findings. The positive peak to negative trough can be as large as 20 dB and thus can enhance or reduce the amplitude of the response. The danger comes mostly from reducing a response leading to a false positive finding.

There are different ways to eliminate fine structure and a commonly cited clinical method is to produce a suppressor tone. The suppressor tone is close to the reflective frequency (Kalluri and Shera 2001; Johnson et al. 2006; Konrad-Martin et al. 2001). This method though requires an additional microphone in the probe. An alternative way is to use a *frequency modulated* signal for the two primary tones. Use of a frequency modulated tone increases the test specificity by eliminate the reflected source. This is the patented technology that is in the PATH MEDICAL equipment for DPOAE measurements. The use of an FM signal is not mandatory as it can be turned off to test using DPOAEs with pure tones only.

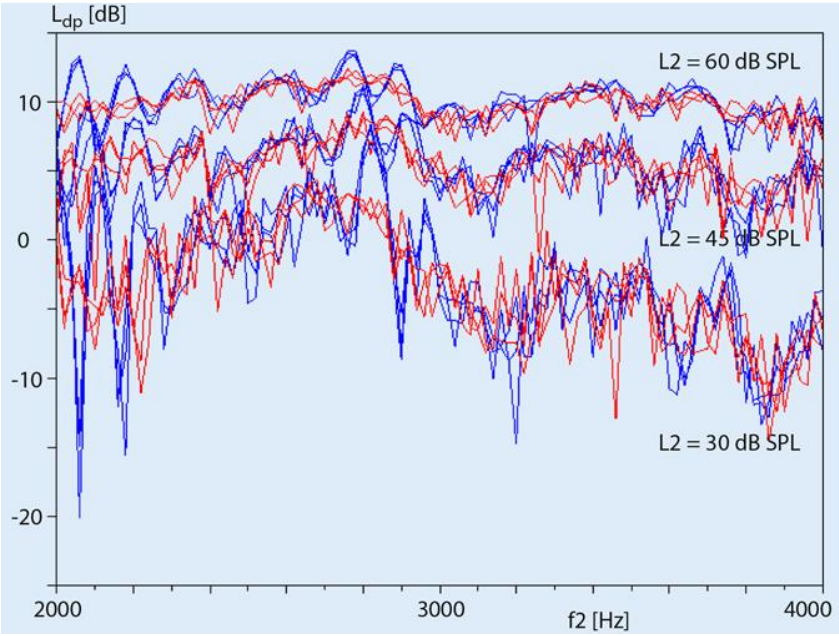

***Fig. 2**: High-resolution DPOAE grams with (red) and without suppression (blue) of the second source in the frequency range between 2 and 4 kHz at three different primary sound levels (L2=60, 45 and 30 dB SPL) (Janssen et al., 2014, Fig. 2)*

The use of the FM signal also has an advantage when conducting input-output functions. Fine structure is enhanced i.e. larger peaks and valleys when testing at lower intensity levels. The use of the FM signal reduces the large deflections and thus allows for more precision in input and output functions. In the PATH MEDICAL devices, the input-ouptut functions are used to produce a cochlear audiogram or a prediction of cochlear threshold levels, which is useful for those who cannot cooperate for behavioral testing and have present emissions.

A recent study by Marcrum et al., (2020) using the PATH MEDICAL Sentiero desktop device doing DPOAEs with the FM signal and compared it to the use of a suppressor tone to evaluate the effects on the conventional measurements of DPOAE. They found that the use of the frequency modulated signal did not reduce the DPOAE measurement but did reduce fine structure.

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