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Title: Some Considerations on Extending the Artificial Mouth Characteristics in ITU-T Recommendation P.58 to Superwideband and Fullband

1 Introduction

Superwideband or fullband measurements in sending direction call for an HATS artificial mouth that is capable of to reproducing frequencies well above 8kHz and below 100Hz. Although the frequency response characteristic does not need to be flat, the amount of (amplifying) equalisation should remain reasonable low, thus ensuring the speaker will not be pushed to its limits resulting in distortion. This applies especially to low frequencies.

Another factor of interest is the directivity of the artificial mouth especially in the high frequency range above 8 kHz. However, currently there are no data from human experiments available which could be used to compare to the HATS mouth directivity. Therefore this topic is not addressed in this contribution.

This contribution provides information about the capabilities of the HEAD acoustics artificial mouth of HMS II.3. Several tests have been run at HEAD acoustics, the results of which are presented in this paper.

2 Description of measurements

All measurements were performed in a semi-anechoic room at the MRP with a ¼ inch pressure microphone, connected to an HEAD acoustics MFE VI.1, which also served as amplifier for the mouth input signal.

For assessing the full band characteristics of HMS II.3 different parameters have been measured at three different devices. The mouth's frequency response was measured using a pink noise signal ranging from 40Hz to 24kHz. The equalized frequency responses shown in this document were achieved by using a 1024 point FIR filter at 48 kHz sampling rate. Distortion measurements were performed after equalising the mouth's frequency response. For frequencies from 40Hz to 10kHz in 3rd octave steps, the total harmonic distortion was measured for several levels from -20dBPa to 0dBPa. Total distortion measurements were performed in the frequency range from 40Hz to 20kHz, again in 3rd octave steps and with the same levels as above.

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3 Results

Frequency Response Characteristics

The figures below show the frequency response characteristics (Figure 1, top) and the corresponding frequency response after equalization (Figure 1, bottom) for three HMS II.3.

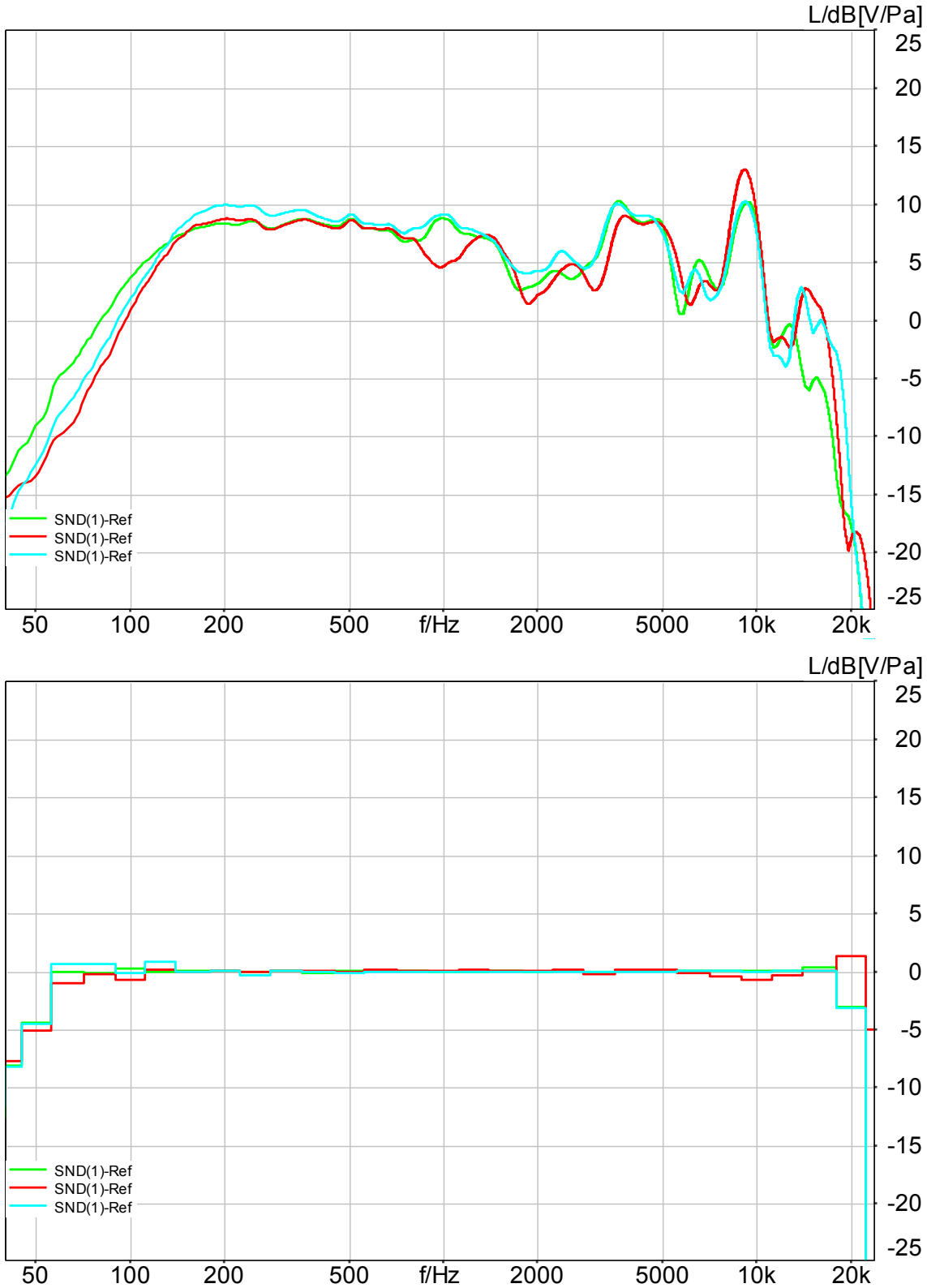

Figure 1: Frequency responses (upper part), equalized responses (lower part)

Total Harmonic Distortion vs. Frequency

In addition to presenting the measured signal-to-total **harmonic** distortion ratio in dB for levels -10dBPa and 0dBPa of one typical HMS II.3, Figure 2 shows thresholds for 1% and 5% distortion and the P.58 distortion requirement which is set at a signal level of 0 dBPa at the MRP.

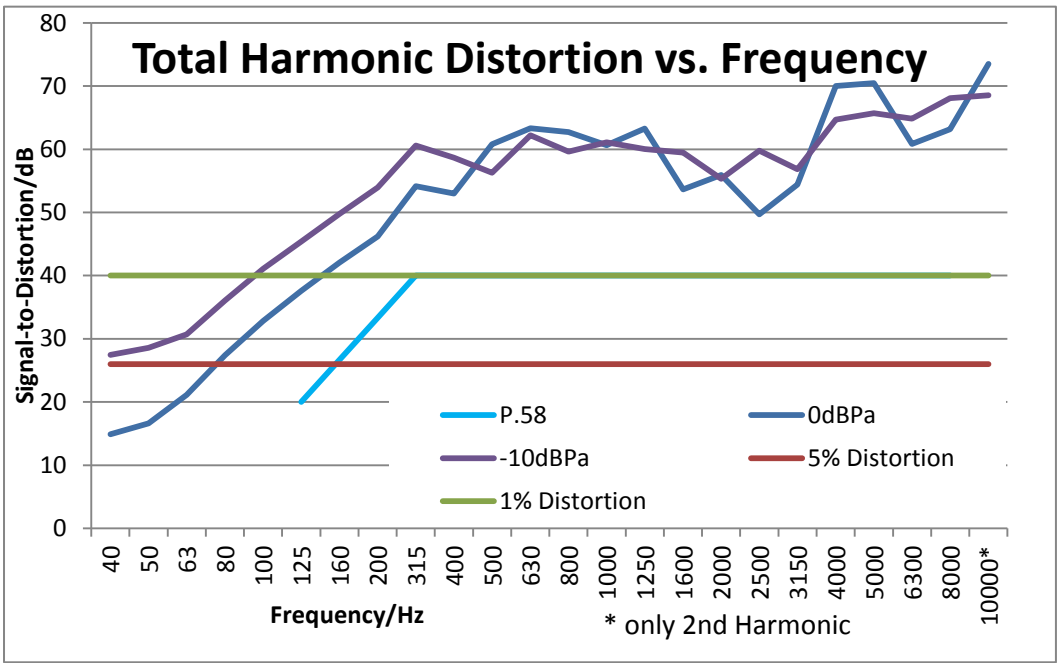

Figure 2: Total harmonic distortion of a typical HMS II.3 at -10 dBPa and 0 dBPa at the MRP

4 Discussion

Frequency Response

From the upper part of Figure 1 it can be seen that the frequency response of all tested HMS II.3 is relatively flat from 80Hz to 14kHz, which is essentially the range required for super wide band measurements.

Above 14kHz, one can observe a roll-off with a steepness of about 12dB per octave. The same holds for frequencies below 80Hz.

However, since a typical spectrum of real speech is known to drop by about 5 dB/oct starting from its typical maximum at around 500 Hz it can be concluded that there is no problem to reproduce full band speech.

The lower part of Figure 1 shows the equalized frequency responses. Almost flat equalisation is possible down to 60Hz. The roll-off below this is uncritical regarding real speech reproduction. It should be noted that there may be some limitations to reproduce high level speech signals with a very low fundamental frequency at low distortion.

Up to 20kHz, the curves remain reasonable flat allowing easily to reproduce the low energy speech components of speech above 14kHz.

Harmonic Distortion

Figure 2 shows the curves for both levels, -10dBPa and 0dBPa, lying well above the 5% line and even above 1% for most parts of the full band spectrum.

As stated above – there maybe some limitations to reproduce high level speech with a low fundamental frequency at low distortion.

What can be concluded is that the harmonic distortion remains sufficiently low for full band real speech reproduction. The two curves aligning quite close show that the loudspeaker is not yet pushed to its limits, except of course in the low frequency range as it can be seen in Figure 2.

5 Conclusion

It has been shown that the artificial mouth of HMS II.3 is capable of reproducing full band speech and thus allowing in general to conduct superwideband and fullband measurements in sending direction.

Roll-off in low and high frequency regions are sufficiently moderate to be equalized enabling the HMS II.3 to reproduce fullband speech at typical levels.

Distortion values are sufficiently low over the entire frequency range with some limitations in the low frequency range.

The data provided could be used to update P.58 and define requirements for HATS artificial mouth to be used for superwideband and potentially fullband testing.

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