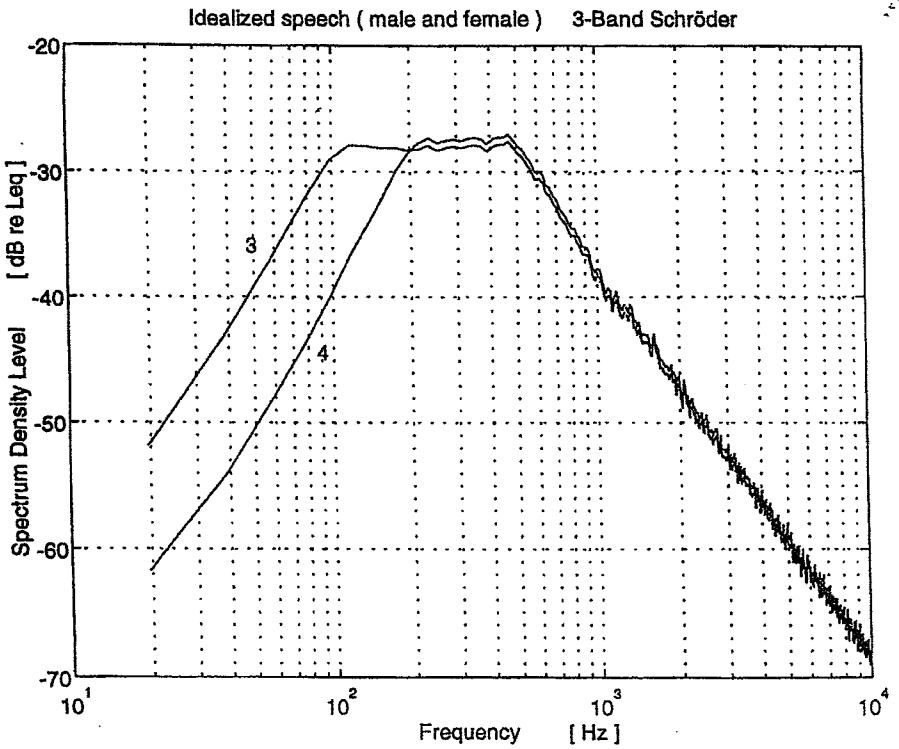


## SPECIFICATION OF ICRA-NOISE

The ICRA-Noise has been developed for the International Collegium of Rehabilitative Audiology by the HACTES work group (Hearing Aid Clinical Test Environment Standardization) in order to establish an international defacto standard of noise signals to be used in clinical tests of hearing aids in background noise and possibly for measuring characteristics of nonlinear instruments.

Specification:

The signals are based on live english speech taken from the CD from the EU SAM project (a female speaker explaining about the system of arithmetical notation (number scale)). Two signals are generated using the exact same process, one resulting in male speech-noise and one resulting in female speech-noise.

The process is done completely digital (sampling rate = 44 kHz) and consists of first splitting the signal into three bands with cross over frequencies of 850 Hz and 2500 Hz using very steep filters (>100 dB/octave, >50 dB damping outside passband) in order for the following processing to handle the 1.st formant in the low band, the 2.nd formant in the mid band and the unvoiced fricatives in the high band. Next, each of the three bands are processed according to Schröeder (JASA 1968, 44, p1735-1736), which means that with a propability of 50% the sign of each sample of the speech is at random either reversed or kept unaltered. Since the numerical value of all samples are preserved by this process, each of the modified signals have the same modulation properties as the original speech, but will be completely unintelligible and have a flat, white spectrum. Next, the Schröeder processed signals are again filtered by the same filters by which they were originally separated and then scaled to have the same RMS-value. Now the three bands are added together forming one signal with a white spectrum but with the original modulation preserved in each of the three frequency ranges. In order to obtain the correct spectrum the signal is now filtered with a male respectively female speech shaped filter in close accordance with LTASS (Byrne et al., JASA 1994, 96, p2108-2120) and the ANSI S3.79 proposed standard (for the calculation of the SII). Since these signals have an unpleasant scratchy sound, the phase is modified in a 512 point FFT procedure by randomizing the phase and overlap-add the segments after an inverse FFT.

The resulting signals have long-term spectrums according to LTASS and modulation characteristics like natural speech.

These signals are representative of normal speech. Furthermore signals representative of raised and loud voices will be generated by modifying the above speech shaped filter with the difference between normal and raised respectively between normal and loud speech spectra as defined by ANSI S3.79.

CONTENTS OF THE FINAL ICRA CD:

| | | |
|---|---|---|
| Track 1: | 2 min | Speech-shaped unmodulated random gaussian noise (normal voice) |
| Track 2: | 2 min | Same as Track 1, but modified with raised voice difference according to ANSI S3.79 (raised voice) |
| Track 3: | 2 min | Same as Track 1, but modified with loud voice difference according to ANSI S3.79 (loud voice) |

Track 4: 5 min Female 3-band Schröeder single speaker in left and right channel

Track 5: 5 min Male 3-band Schröeder single speaker in left and right channel

Track 6: 10 min One female + one male 3-band Schröeder speaker in both left and right channel

Track 7: 20 min One female + one male 3-band Schröeder speaker and 2 female + 2 male 3-band Schröeder speakers each reduced 6 dB in level (to simulate a distance) in both left and right channel

Track 8: 10 min As Track 7, but with raised voice spectra

Track 9: 10 min As Track 7, but with loud voice spectra

Track 10: 2 min Calibration tone

**All voices on each track are uncorrelated.**

Tracks 4 + 5 can be used to verify fitting of nonlinear hearing aids simulating the speech situation. The associated test will require a sequence (e.g. 20-30 seconds) to be played by (or for) the test equipment and a powerfull DSP will have to sample the output of the instrument (in a coupler or using probe type microphones in real ears) and make statistical analysis and calculations of the resulting output.

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