SCENIC™

Environmentally Aware

Feature-Packed DSP Hearing Aid Amplifier

INFORMATION SHEET

WIND NOISE REDUCTION

WIND CONTINUES TO BE A MAJOR SOURCE OF dissatisfaction for hearing aid users, with only around half of hearing aid users reporting that their hearing aid copes well in windy environments (Kochkin, 2010). As a key component of *Scenic's* Acoustic Scene Analysis, the Wind Noise Reduction module is a sophisticated algorithm that effectively suppresses wind noise.

Wind noise is created as the air passes the aid user's head, hearing device, or other obstacles. Research has shown that even in a light breeze of 6.7 mph (3 m/s or 5.8 knots) the long-term average wind noise level is approximately 80 dB SPL. By 27 mph (12 m/s or 23.3 knots), the wind noise level is limited to approximately 115 dB SPL by saturation in the microphone.

The wind noise spectrum is dominated by the lower frequencies (< 500 Hz), although at 27 mph when saturation is present, the wind noise level can be greater than 60 dB SPL at 8 kHz. It is clear that wind noise is at high levels at commonly encountered wind speeds and needs to be suppressed. This is reinforced by MarkeTrak (Kochkin, 2005; 2010) data that shows wind noise is the second-highest cause of dissatisfaction for hearing aid users (behind noisy situations).

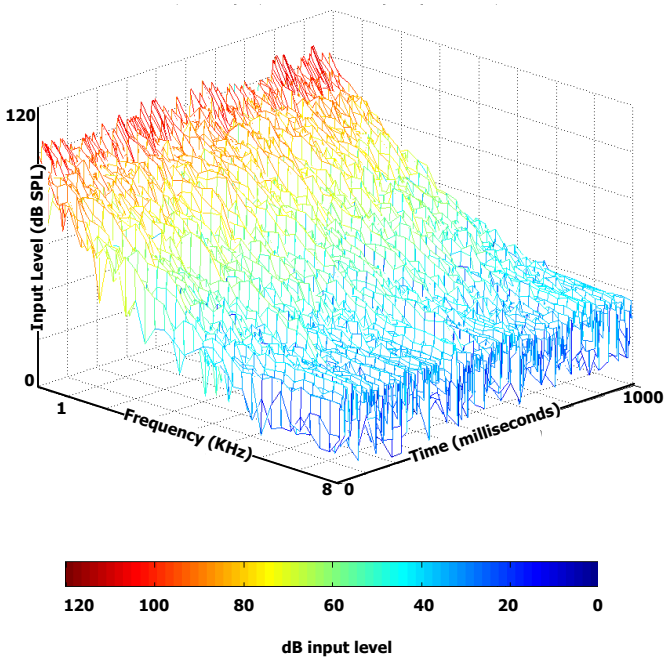

Figure 1. 3D image of wind input to a BTE hearing aid for 1 second. Wind was located at 0 degree azimuth and was at a speed of 13.4 mph (6m/s). The intensity level exceeded 100 dB SPL in the low frequencies.

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Wind Noise Detection

The Wind Noise Reduction module operates in two modes – single and dual microphone. The wind detection mechanism differs between the two modes, but once wind is detected the amount of suppression that is applied is the same for both modes.

Single Microphone Mode

In the single-microphone mode, the Wind Noise Reduction module compares the time-averaged, low-frequency spectrum with the spectral levels and shape that would be expected for wind. This gives a fairly stable estimate of the wind spectrum level, but it slows the reaction of the Wind Noise Reduction module to the onset of wind and limits the ability to suppress brief gusts of wind. Thus, the single-microphone mode is best for dealing with constant rather than intermittent wind conditions.

The expected wind spectrum depends on the suppression strength setting. The strongest setting (Strength 5) suppresses wind of approximately 6.7 mph or greater. The weakest setting (Strength 1) suppresses wind of approximately 13.4 mph or greater.

Note that it is possible that constant, loud, non-wind, low frequency sounds may trigger suppression.

For the strongest setting this could occur for non-wind sounds greater than approximately 75 dB SPL, while for the weakest setting, levels greater than approximately 90 dB SPL are required.

Dual Microphone Mode

In the dual-microphone mode, the Wind Noise Reduction module calculates the correlation between the two microphone signals.

When there is no wind the microphone signals are highly correlated (i.e. the audio signal is similar at both microphones). This is because speech and similar types of signals tend to reach both microphones at approximately the same time.

When wind noise dominates, the correlation between the two microphone signals is poor. This is because the amount of turbulence that causes wind noise depends on the location of each microphone, and wind moves relatively slowly compared with speech sounds. Wind is detected when the correlation is sufficiently low and the input level is greater than 75 dB SPL. This detection mechanism is extremely reliable and is unlikely to incorrectly identify non-wind sounds as wind. Detection should occur at wind speeds of approximately 6.7 mph or lower. The dual-microphone detection method can also react more quickly to sudden gusts of wind than the single-microphone method.

Wind Noise Suppression

Both the single microphone and dual microphone detection methods apply the same amount of suppression. There are five suppression settings, ranging from weak (Strength 1) to strong (Strength 5).

Single Microphone Mode

For the single-microphone system the weakest setting only detects faster wind speeds and provides gentler suppression, while the strongest setting is triggered at slower wind speeds and is more aggressive in its suppression.

Dual Microphone Mode

For the dual microphone system, the suppression is always triggered at lower wind speeds no matter what the strength setting.

The **mid strength setting (3)** is the suggested default, and was designed to provide effective suppression of wind noise while only slightly compressing speech peaks in channels where the speech dominates the wind. The **weakest setting (1)** was designed for people who only require a small amount of wind suppression, and does not compress the speech peaks. The **strongest setting (5)** provides aggressive suppression, allowing even gentle breezes to be suppressed.

STRENGTH SETTING	DETECTION		SUPPRESSION
	SINGLE MICROPHONE	DUAL MICROPHONE	SINGLE and DUAL MICROPHONE
STRENGTH 1	13.4 mph (6m/s)	~6.7 mph (3m/s)	WEAK (strong gusts)
STRENGTH 2		~6.7 mph (3m/s)	
STRENGTH 3		~6.7 mph (3m/s)	MID
STRENGTH 4		~6.7 mph (3m/s)	
STRENGTH 5	6.7 mph (3m/s)	~6.7 mph (3m/s)	STRONG (all wind, including light breezes)

Table 1. Summary of detection and suppression characteristics for each of the five strength settings for the single microphone and dual microphone wind noise reduction implementations. The ability to detect wind is dependent on the selected strength setting for the single microphone implementation, whereas wind is detected at the same sensitivity for all five strength settings in the dual microphone implementation.

The suppression method is to apply compression in 32 bands with center frequencies at multiples of 250 Hz. This compression is separate to the WDRC module. The compression kneepoints are generally shaped to follow the long-term average speech spectrum to minimize the potential suppression of speech. The attack and release time constants are the same in all bands. The compression kneepoints and ratios depend on the suppression strength.

When suppression is initially triggered, the hearing aid user will probably notice it “kick in” as the compression reduces the gain over 200 ms. This is because the wind noise level is likely to be above the suppression kneepoints when the wind is detected. If the wind level continues to increase, the compression will increase the amount of suppression according to the compression ratio while allowing the perceived wind level to increase slightly. This use of compression maintains awareness of environmental conditions and retains a natural sound quality for wind.

Configuration

The Wind Noise Reduction module has the following adjustable settings:

Enable:
This turns the module on (checked =1) or off (unchecked =0).

Dual-microphone mode:
This enables either single-microphone (unchecked =0) or dual-microphone (checked =1) wind-noise detection.

It is possible for manufacturers to select the single microphone setting for a dual microphone hearing aid if desired (although there are minimal power consumption advantages). The recommended setting is dual microphone wind-noise detection for appropriate devices.

Strength Setting:
Strength of suppression ranges from weak (Strength 1) to strong (Strength 5).