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AND9156/D

Impulse Noise Reduction

ON Semiconductor®

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APPLICATION NOTE

Introduction

Loud impulsive sounds in the environment such as slamming doors, dropped items or even cutlery rattling in a drawer can become uncomfortably or dangerously loud in a traditional hearing aid. Hearing aids incorporating the Impulse Noise Reduction (INR) algorithm will actively monitor the acoustic signal for such impulsive sounds, and process the signal to ensure that the sound at the output remains descriptive of the environment without being uncomfortably loud.

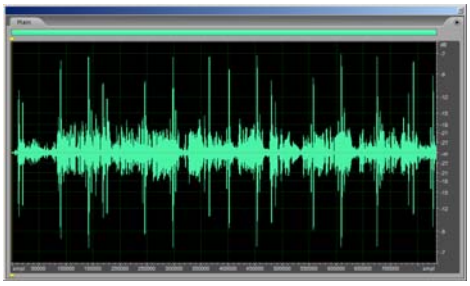


Figure 1. Audio without INR

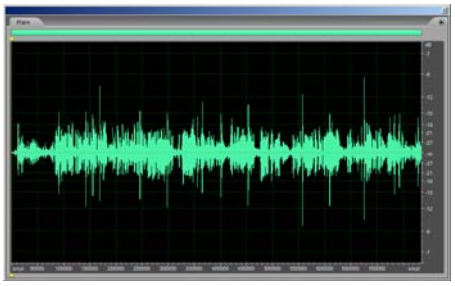


Figure 2. Audio with INR

The INR algorithm is specifically designed not to interfere with speech and other slow changing sounds, and to pass these audio signals transparently.

As with all hearing aid algorithms, the INR algorithm requires parametric adjustment to accommodate different listening environments and hearing aid transducers.

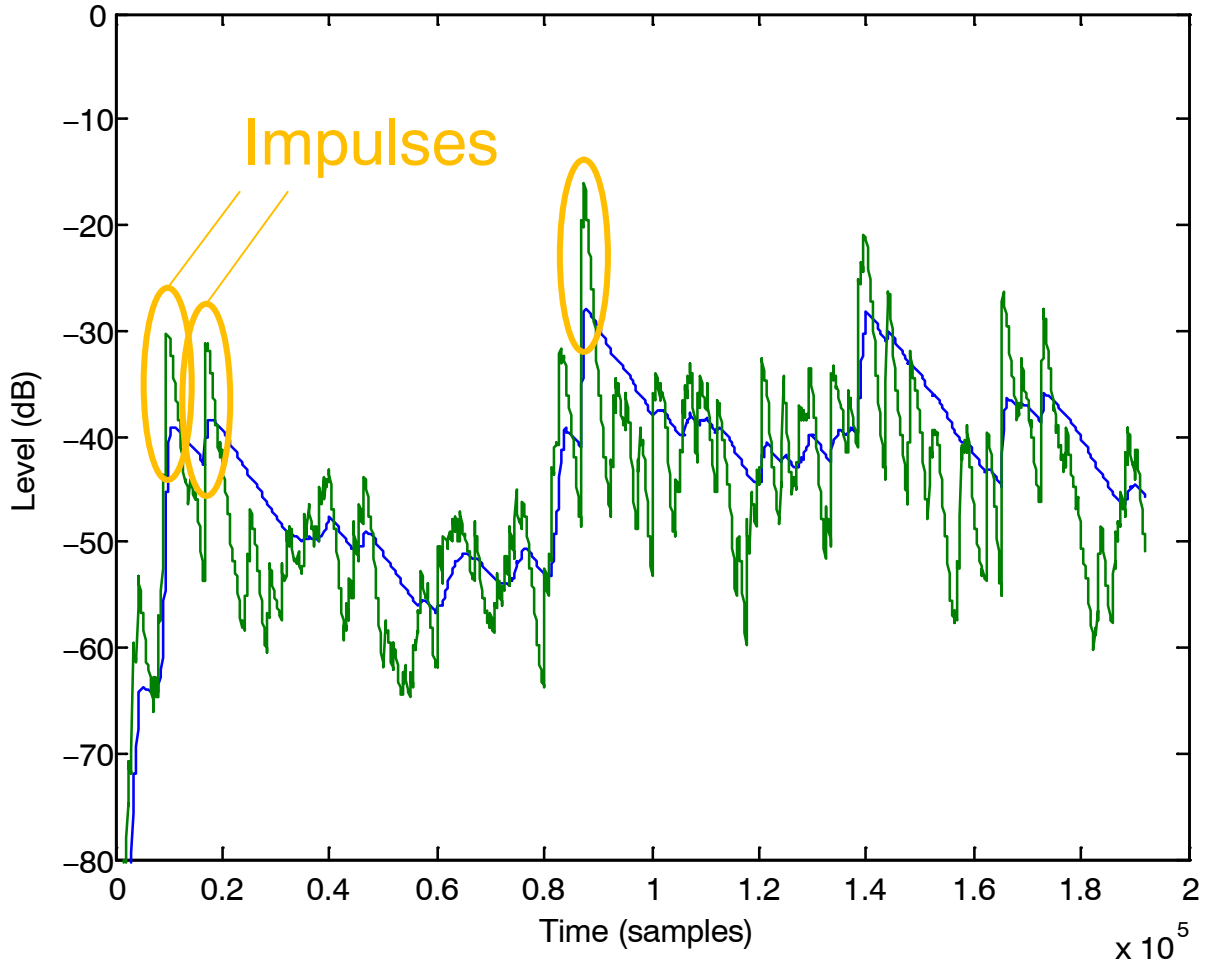
In the following sections, the INR parameters are discussed in the context of the Interactive Data Sheet (IDS) settings for ON Semiconductor preconfigured products. For more information about IDS and preconfigured products, refer to the documents available at the following web sites:

http://ark.onsemi.com/

http://www.onsemi.com/PowerSolutions/parametrics.do?id=101769

INR Operation

The incoming audio is divided into 16 channels, each with their own center frequency and compression settings. The INR algorithm uses a select number of these input channels to further process the audio.



Example of Impulse Noise

When a transient is detected, the INR reduces the transient without affecting slower signals such as speech. To maintain speech quality, the default settings for INR only reduce frequency content above 2 kHz. Different amounts of INR are applied to the individual channels to further maximize speech quality.

When a transient is detected, the INR stays active for a short time after the impulse. This avoids rapid changes from suppression to no suppression, which reduces audio disturbances.

The INR algorithm uses two characteristics of the incoming audio signal to determine whether an impulse is present or not:

1. Impulse Level
   This is the minimum amplitude level of the incoming audio that the INR algorithm considers an impulse sound. An impulse transient must have an instantaneous amplitude level greater than the Impulse Level to be considered an impulse.
2. Rise−Time Measurement
   A transient noise must be loud and sudden. The rise−time measurement determines how quickly the transient occurs, as well as how much attenuation is applied to each channel.

INR Settings in IDS

Four parameters are available in IDS to adjust the INR algorithm as shown in the following illustration:

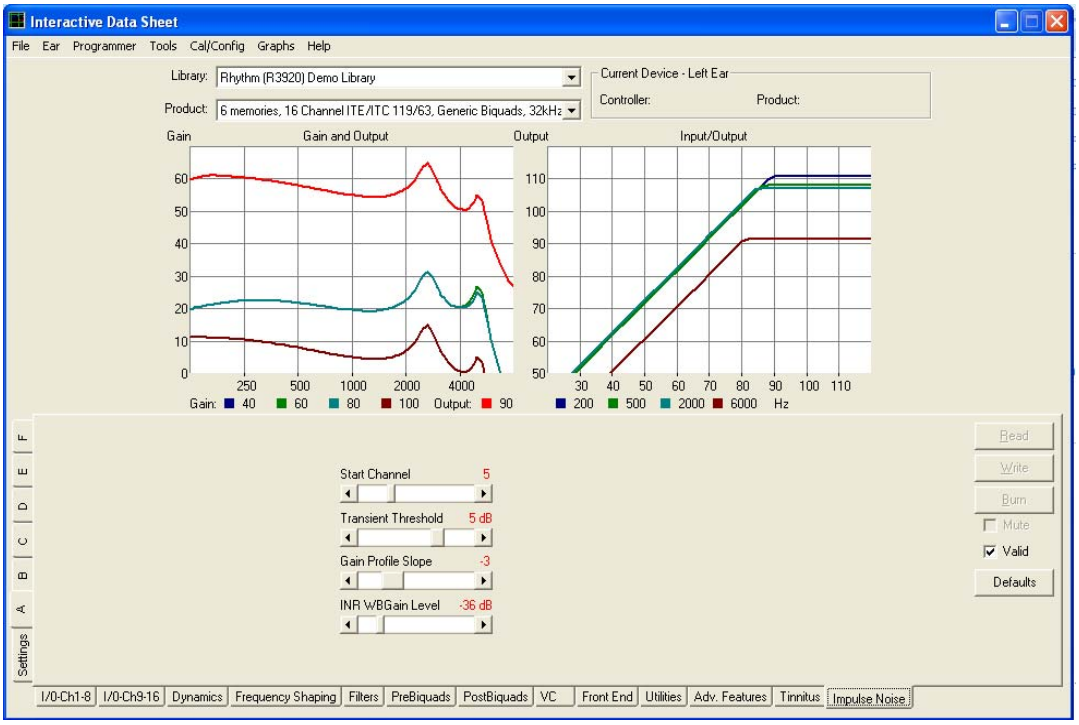


Figure 3. IDS Impulse Noise Reduction Settings

Parameter	Description
Start Channel	The INR algorithm will be applied to this WDRC channel and all higher ones.
Transient Threshold	The minimum input rate of change required for the INR to engage
Gain Profile Slope	The amount of reduction that will be applied to transients when the INR engages.
INR WBGain Level	Adjusts how loud a signal must be before the algorithm decides whether it is a transient to reduce.

Start Channel

The start channel determines the start frequency that will be affected by INR.

A default value of 5 is chosen to minimize audio artifacts in the lower audio frequency bands.

If this parameter value is adjusted from the default setting, take care to prevent gain reduction in the speech frequency region to help preserve speech quality. Depending on the other INR parameter values, Start Channel values below the channel number corresponding to 2 kHz might introduce noticeable speech artifacts.

Transient Threshold

This is the minimum rate of change of the input signal that is required for the INR to engage. The rate of change is measured in the frequency domain, and is expressed in dB.

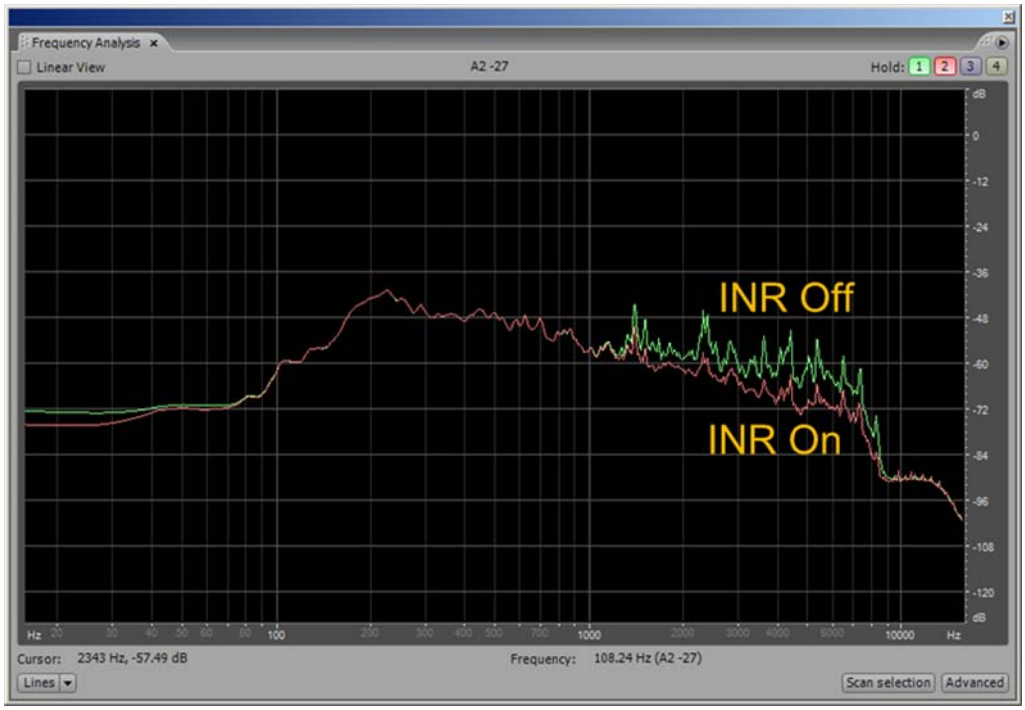


Figure 4. Input with Large Frequency Rate of Change Before and After INR

Gain Profile Slope

This is the amount of attenuation applied to the impulse transients. The 0 to −4 value range corresponds to an impulse attenuation between 0 and −10 dB.

The algorithm can be turned off by setting the Gain Profile Slope to 0.

The default setting is −3. If this default value is increased, speech artifacts might become noticeable.

INR WBGain Level

This parameter determines the minimum input amplitude (in dB) required to activate the INR.

The minimum level default value is −36 dB. Any impulse noise below this amplitude is ignored by the INR processing regardless of the slope of the transient.

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