

# ON Semiconductor

## Is Now

# onsemi™

To learn more about onsemi™, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

---

**onsemi** and **onsemi** and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi** product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner. Other names and brands may be claimed as the property of others.

## Impulse Noise Reduction



ON Semiconductor®

<http://onsemi.com>

### 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.

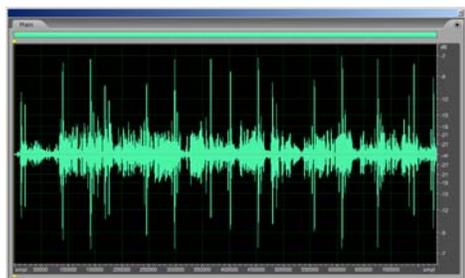


Figure 1. Audio without INR

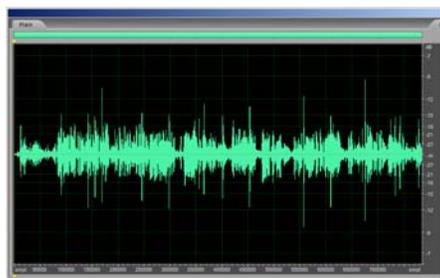


Figure 2. Audio with INR

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.

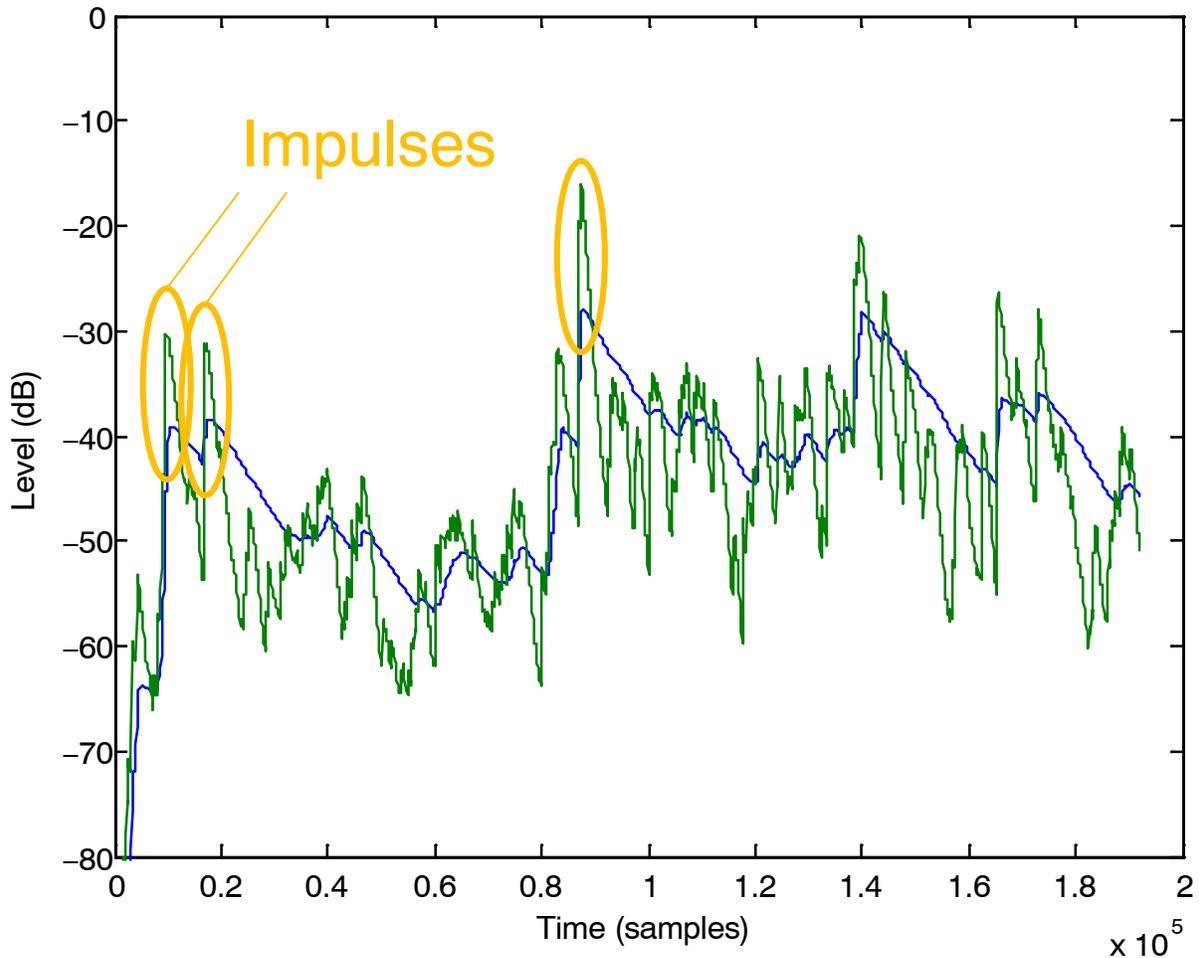
In the following sections, the INR parameters are discussed in the context of the Interactive Data Sheet (IDS) settings for ON Semiconductor preconfigured products. For more information about IDS and preconfigured products, refer to the documents available at the following web sites:

<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:

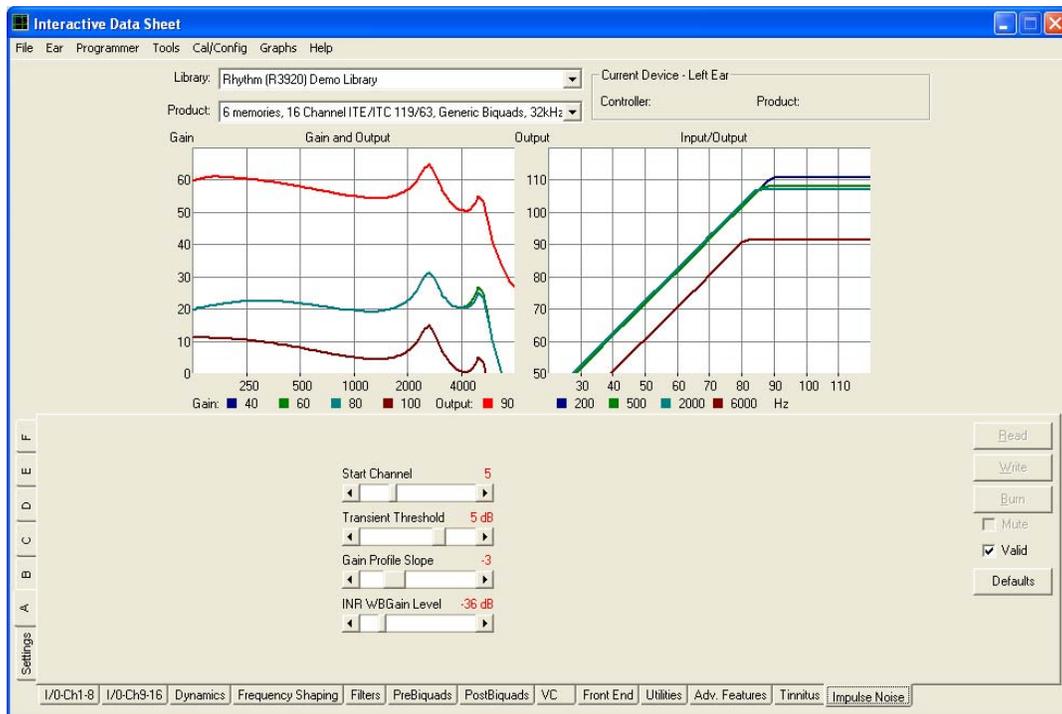


Figure 3. IDS Impulse Noise Reduction Settings

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.

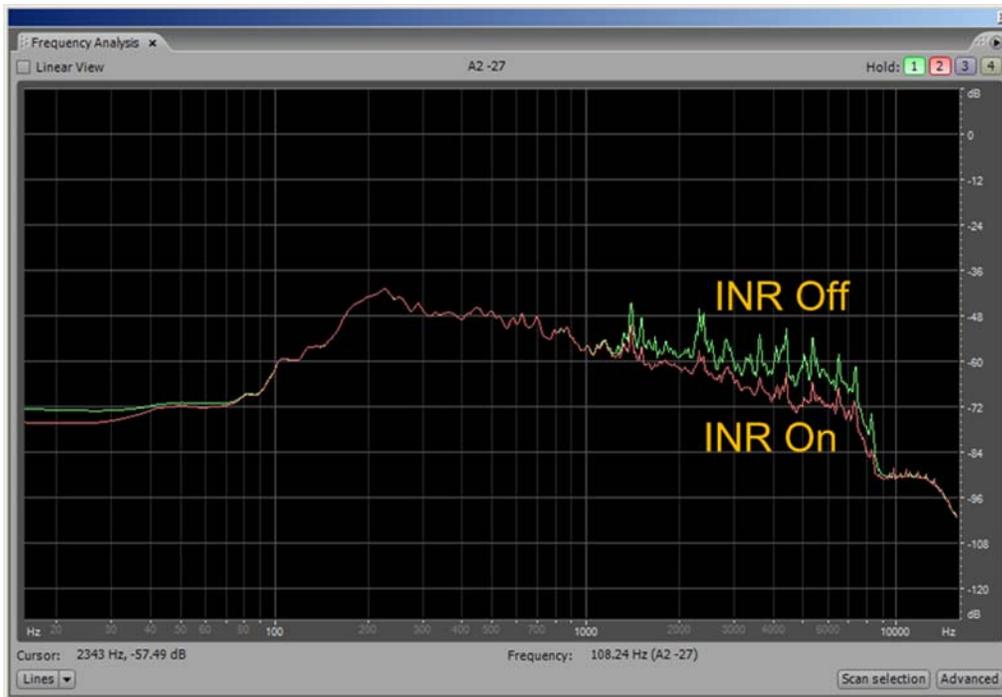


Figure 4. Input with Large Frequency Rate of Change Before and After INR

**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.

**ON Semiconductor** and **ON** are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

**PUBLICATION ORDERING INFORMATION**

**LITERATURE FULFILLMENT:**  
 Literature Distribution Center for ON Semiconductor  
 P.O. Box 5163, Denver, Colorado 80217 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
 USA/Canada  
**Europe, Middle East and Africa Technical Support:**  
 Phone: 421 33 790 2910  
**Japan Customer Focus Center**  
 Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>  
 For additional information, please contact your local Sales Representative