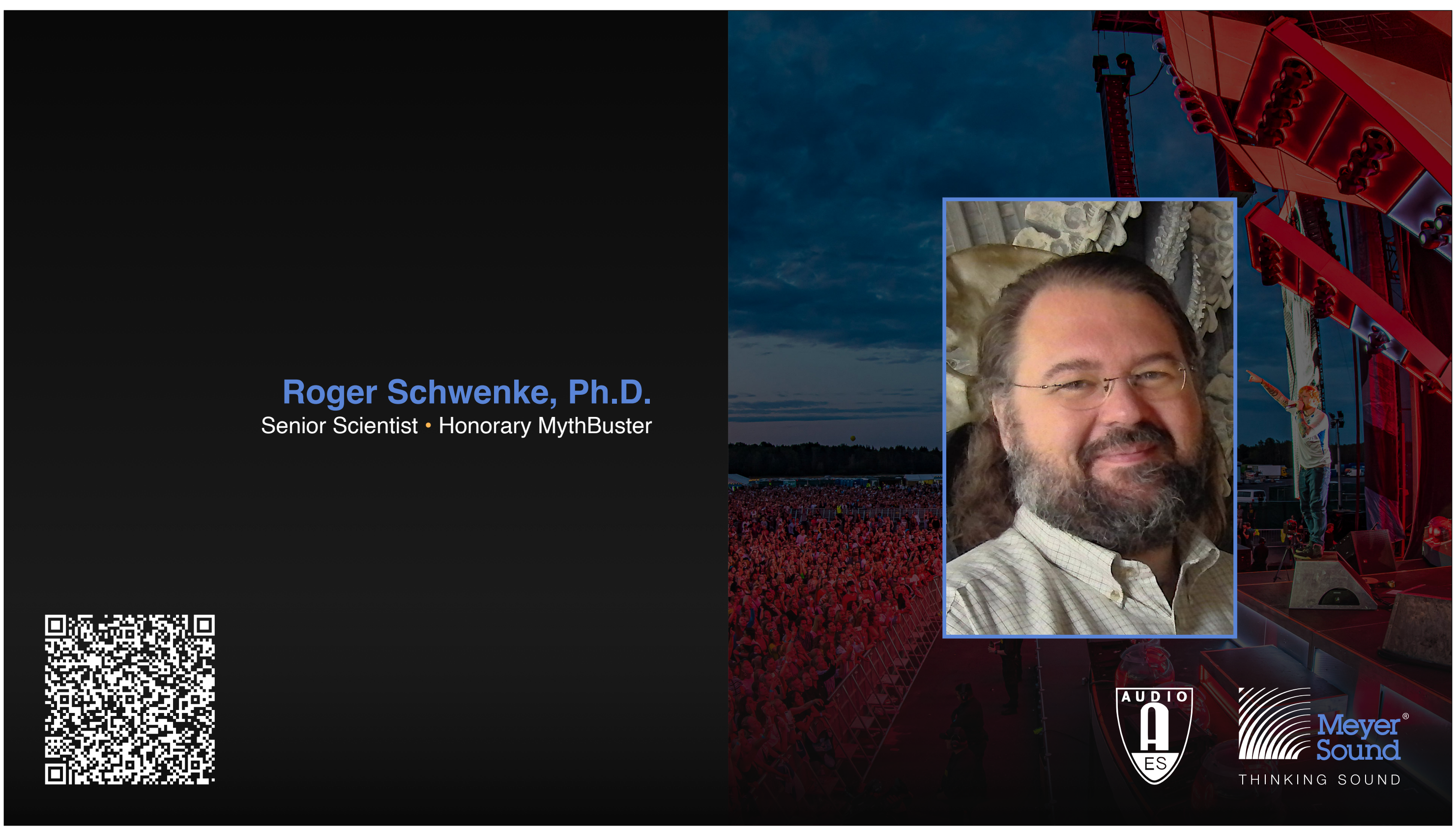

WEBINAR
MARCH 29, 2021
Loudspeaker Test and Measurement
AUDIO ES
Standards
Audio Engineering Society
aesshow.com
Loudspeaker Test & Measurement
SCHWENKE & VAN VEEN • ENGLISH • MARCH 29, 2021
AUDIO ES
Meyer Sound
THINKING SOUND


Roger Schwenke, Ph.D.
Senior Scientist • Honorary MythBuster
AUDIO ES
Meyer Sound
THINKING SOUND

Merlijn van Veen

Senior Technical Support & Education Specialist

SC-04-03-A

Task group on:

Project ID: X250

Measuring maximum linear peak SPL using noise

Standard Development

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

THINKING SOUND

Acknowledgements

X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

- Colleen Harper — AES Executive Director
- Bruce Olson — AES Standards Committee Chair
- Richard Cabot — AES Standards Manager
- Steve Hutt — Chair SC-04-03 Parent Committee (Speaker Modelling & Measurement)

- SC-04-03-A
  - 70+ Task Group Members
  - Meet Every Two Weeks (During a Pandemic)
  - 25+ Meetings

AUDIO ES

Meyer Sound®
THINKING SOUND

John & Helen Meyer

Meyer Sound's CEO & Executive Vice President

AUDIO ES

Meyer Sound®
THINKING SOUND

INTRODUCING

M NOISE

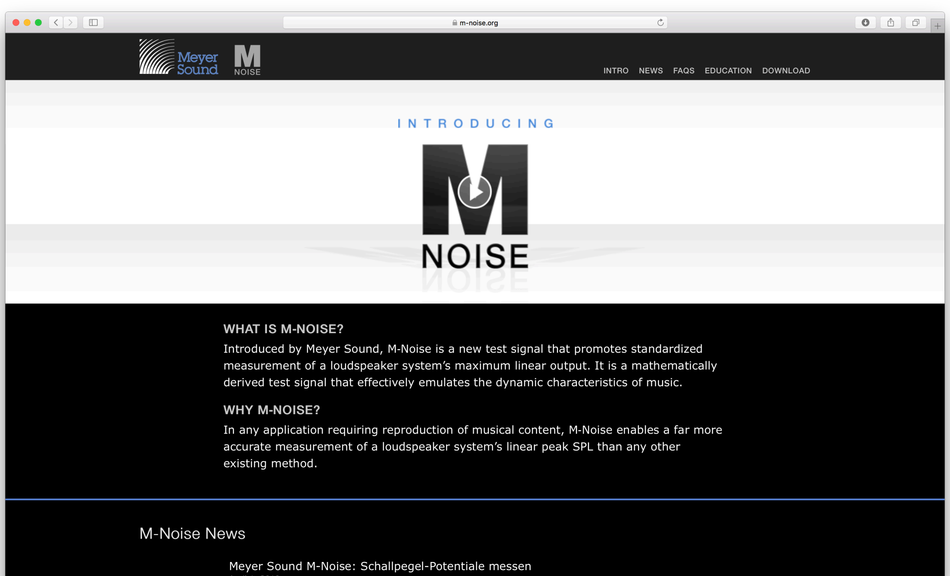
Timeline

X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

• Throughout 2018	M-Noise videos
• January 2019	Launch M-Noise Website
• April 2019	Expo Soundcheck CDMX
• October 2019	1st Task Group Meeting at AES NY
• October 2019	AES Engineering Brief at AES NY
• October 2019	SMPTE Paper at SMPTE 2019
• November 2020	IOA Paper at Reproduced Sound 2020

AUDIO ES

Meyer Sound
THINKING SOUND

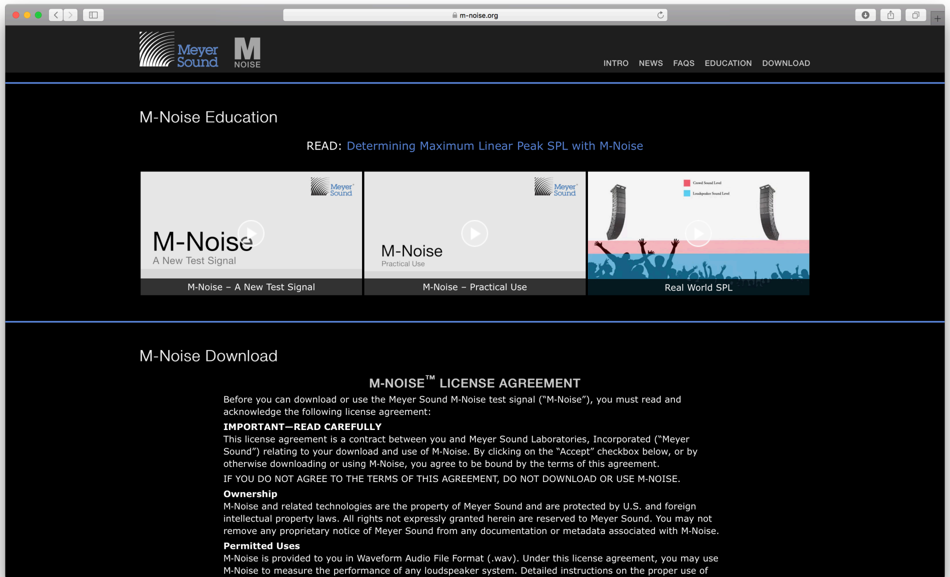


M-Noise.org

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

AUDIO ES

Meyer Sound
THINKING SOUND

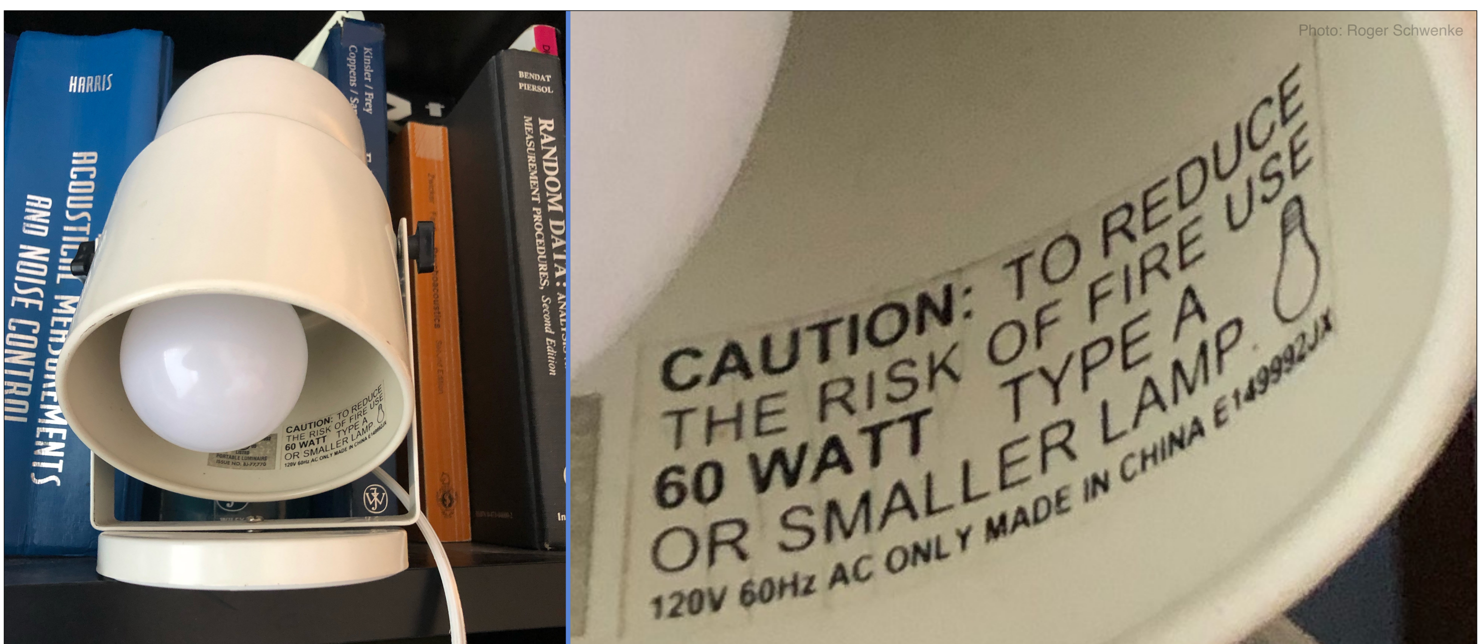


M-Noise.org

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

AUDIO ES

Meyer® Sound THINKING SOUND

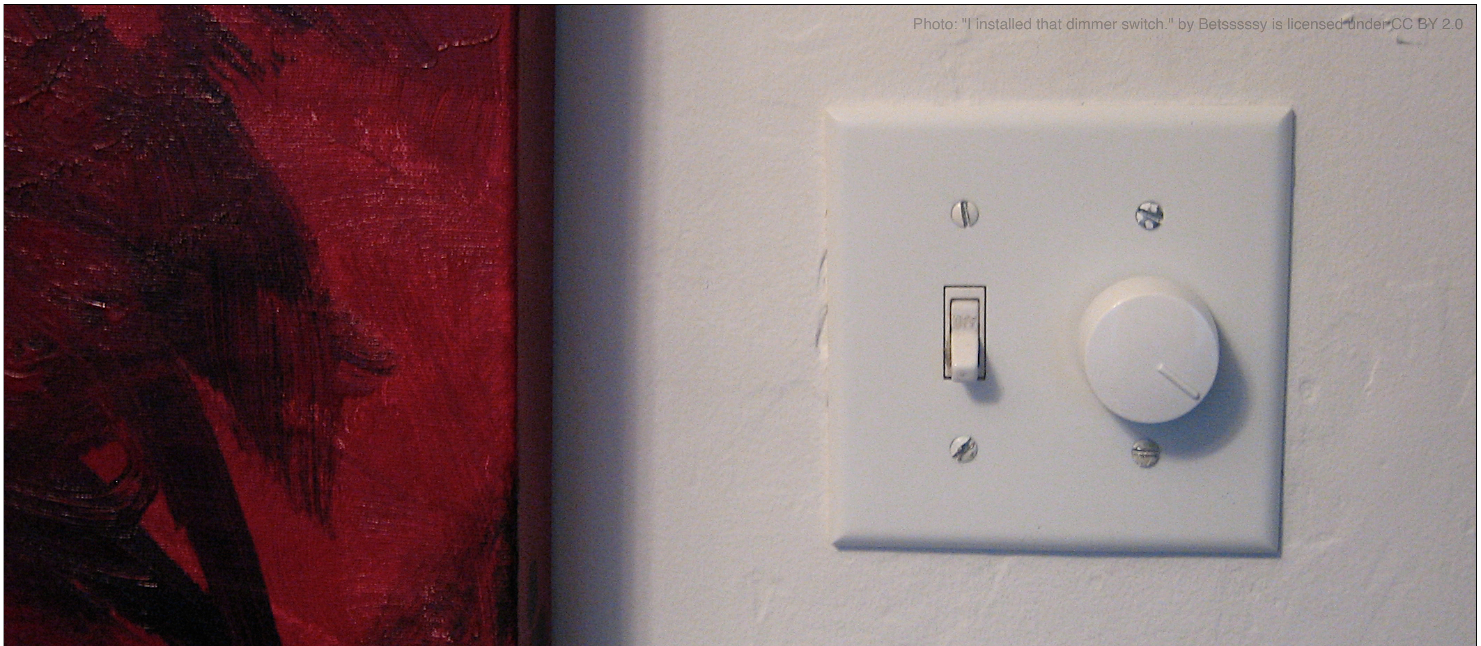


Power Ratings

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

AUDIO ES

Meyer® Sound THINKING SOUND



How Much Can You Turn it Up?

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

THINKING SOUND

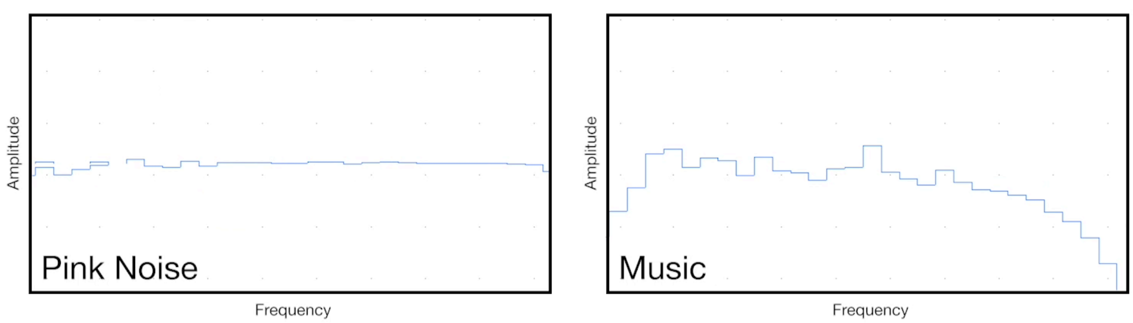
How Much Can You Turn it Up?

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

THINKING SOUND

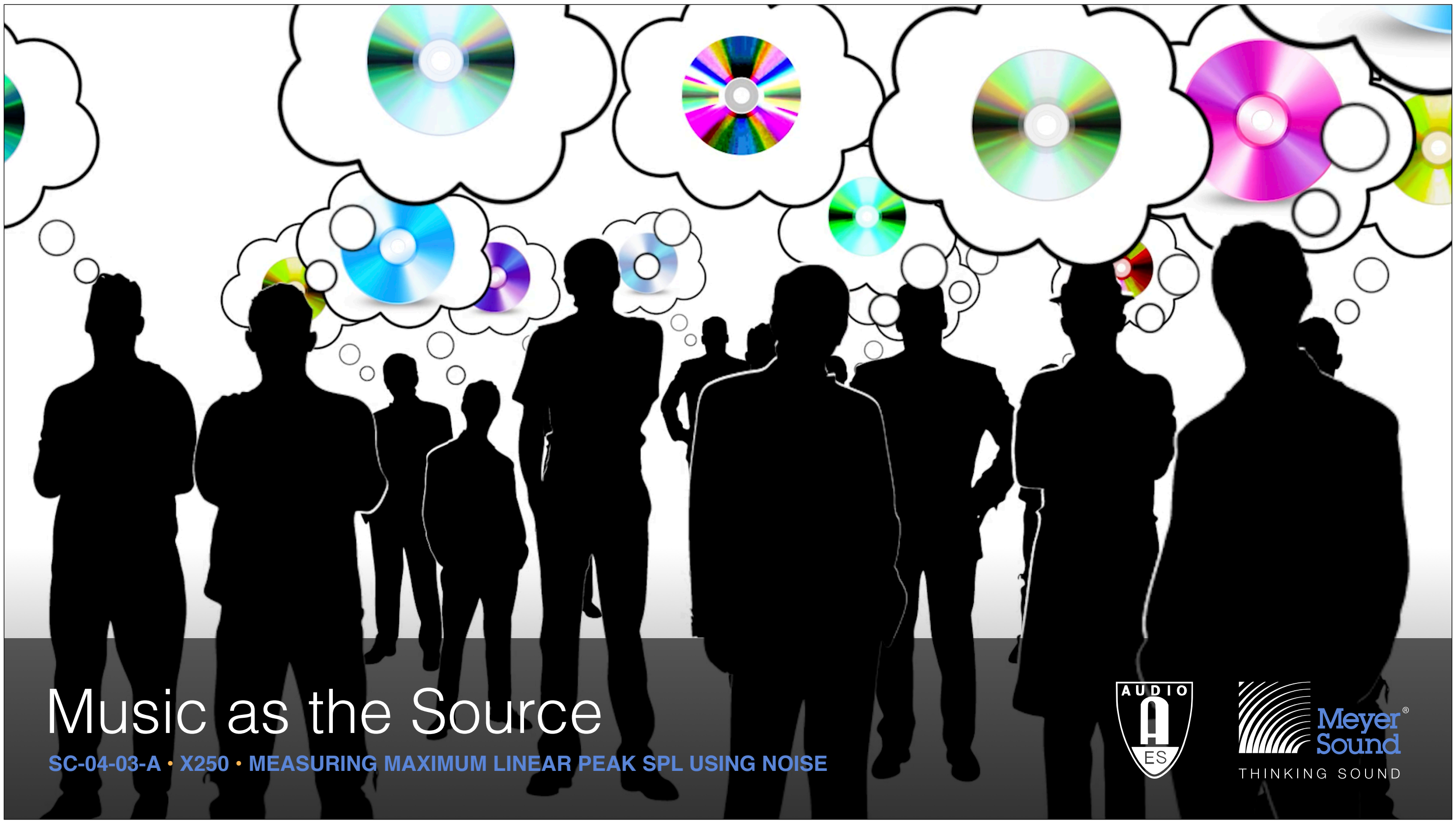
Weight

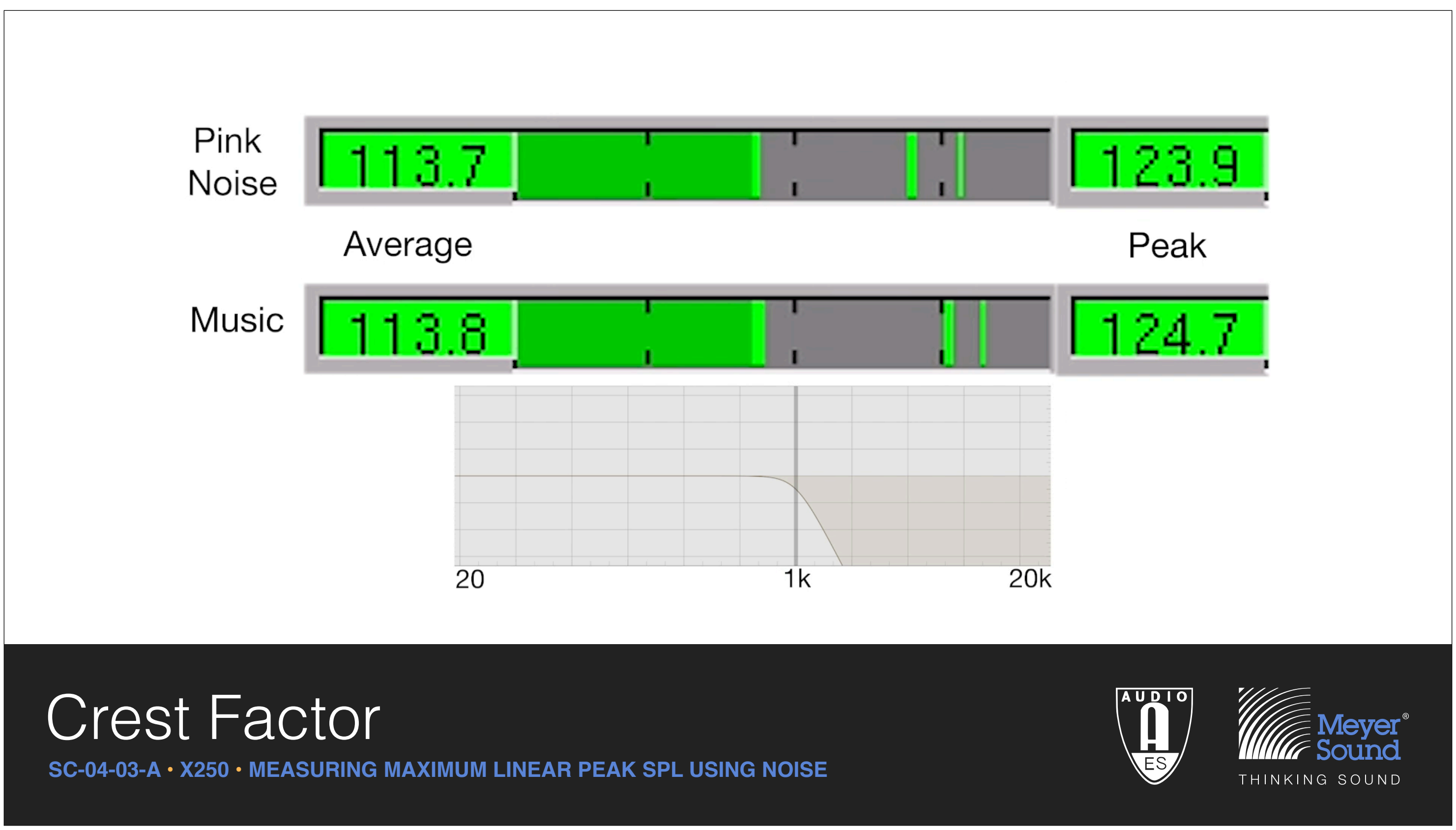
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE



Band Spectra

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE


Music as the Source
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE
AUDIO
ES
Meyer Sound
THINKING SOUND


Pink Noise
113.7
123.9
Average
Peak
Music
113.8
124.7
20
1k
20k
Crest Factor
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE
AUDIO
ES
Meyer Sound
THINKING SOUND

A New Signal for Measuring Loudspeaker Maximum Linear SPL

Roger Schwenke, Ph.D.
Meyer Sound Laboratories
2832 San Pablo Ave
Berkeley, CA 94702
rogers@meyersound.com

Abstract. *Knowing the peak to average ratio (crest factor) of the signal a loudspeaker needs to reproduce is important for determining the maximum level a loudspeaker can attain with that signal. An investigation has been made into the crest factor of real signals as a function of frequency. It was found (not very surprisingly) that the crest factor increases with increasing frequency. However, in contrast, it is easily shown that the crest-factor of pink noise (and other standard noise signals) changes minimally with frequency. A new test signal has been created whose crest-factor-as-a-function-of-frequency is modeled after real signals. A procedure is proposed for finding the maximum SPL that a given loudspeaker can reproduce this signal linearly. This signal and procedure has been made publicly available so that comparable measurements can be made by multiple independent individuals. As a signal level is increased and approaches the maximum capacity of the loudspeaker, peaks may be clipped, frequency content may be added that was not in the original signal, and other "non-linear" effects may occur. To measure the onset of non-linearity of a loudspeaker, a test signal must be used which not only has the average spectrum as a function of frequency expected from real signals, but also the crest factor as a function of frequency. Traditional distortion measurements (while valuable) can not be used with sounds that have energy at all frequencies simultaneously. For this reason, the proposed procedure uses coherence. Coherence is a measure of the correlation between the input and output of a system and can be determined from quantities already produced in the course of calculating a transfer function. The transfer function shows the reduction in sensitivity that occurs when the input is increased but the output does not increase proportionally. These two quantities provide a reliably repeatable of the onset of non-linearity and the corresponding maximum SPL.*

Keywords. Peak to Average Ratio, Crest Factor, Test Signal, Loudspeaker Headroom, Maximum SPL, Onset of Non-Linearity, Distortion Measurement, Coherence.

SMPTE Paper

SMPTE 2019

A New Signal for Measuring Loudspeaker Maximum SPL

by Schwenke

Abstract

Knowing the peak to average ratio (crest factor) of the signal a loudspeaker needs to reproduce is important for determining the maximum level a loudspeaker can attain with that signal. An investigation has been made into the crest factor of real signals as a function of frequency. It was found (not very surprisingly) that the crest factor increases with increasing frequency. However, in contrast, it is easily shown that the crest-factor of pink noise (and other standard noise signals) changes minimally with frequency. A new test signal has been created whose crest-factor-as-a- function-of-frequency is modeled after real signals. A procedure is proposed for finding the maximum SPL that a given loudspeaker can reproduce this signal linearly. This signal and procedure has been made publicly available so that comparable measurements can be made by multiple independent individuals...

AUDIO ES

Meyer Sound® THINKING SOUND

A New Signal for Measuring Loudspeaker Maximum Linear SPL

Roger Schwenke, Ph.D.
Meyer Sound Laboratories
2832 San Pablo Ave
Berkeley, CA 94702
rogers@meyersound.com

Abstract. *Knowing the peak to average ratio (crest factor) of the signal a loudspeaker needs to reproduce is important for determining the maximum level a loudspeaker can attain with that signal. An investigation has been made into the crest factor of real signals as a function of frequency. It was found (not very surprisingly) that the crest factor increases with increasing frequency. However, in contrast, it is easily shown that the crest-factor of pink noise (and other standard noise signals) changes minimally with frequency. A new test signal has been created whose crest-factor-as-a-function-of-frequency is modeled after real signals. A procedure is proposed for finding the maximum SPL that a given loudspeaker can reproduce this signal linearly. This signal and procedure has been made publicly available so that comparable measurements can be made by multiple independent individuals. As a signal level is increased and approaches the maximum capacity of the loudspeaker, peaks may be clipped, frequency content may be added that was not in the original signal, and other "non-linear" effects may occur. To measure the onset of non-linearity of a loudspeaker, a test signal must be used which not only has the average spectrum as a function of frequency expected from real signals, but also the crest factor as a function of frequency. Traditional distortion measurements (while valuable) can not be used with sounds that have energy at all frequencies simultaneously. For this reason, the proposed procedure uses coherence. Coherence is a measure of the correlation between the input and output of a system and can be determined from quantities already produced in the course of calculating a transfer function. The transfer function shows the reduction in sensitivity that occurs when the input is increased but the output does not increase proportionally. These two quantities provide a reliably repeatable of the onset of non-linearity and the corresponding maximum SPL.*

Keywords. Peak to Average Ratio, Crest Factor, Test Signal, Loudspeaker Headroom, Maximum SPL, Onset of Non-Linearity, Distortion Measurement, Coherence.

The authors are solely responsible for the content of this technical presentation. The technical presentation does not necessarily reflect the official position of the Society of Motion Picture and Television Engineers (SMPTE), and its printing and distribution does not constitute an endorsement of views which may be expressed. This technical presentation is subject to a formal peer-review process by the SMPTE Board of Editors, upon completion of the conference. Citation of this work should state that it is a SMPTE meeting paper. EXAMPLE: Author's Last Name, Initials. 2010. Title of Presentation, Meeting name and location.: SMPTE. For information about securing permission to reprint or reproduce a technical presentation, please contact SMPTE at jwelch@smpte.org or 914-761-1100 (3 Barker Ave., White Plains, NY 10601).

SMPTE Paper

SMPTE 2019

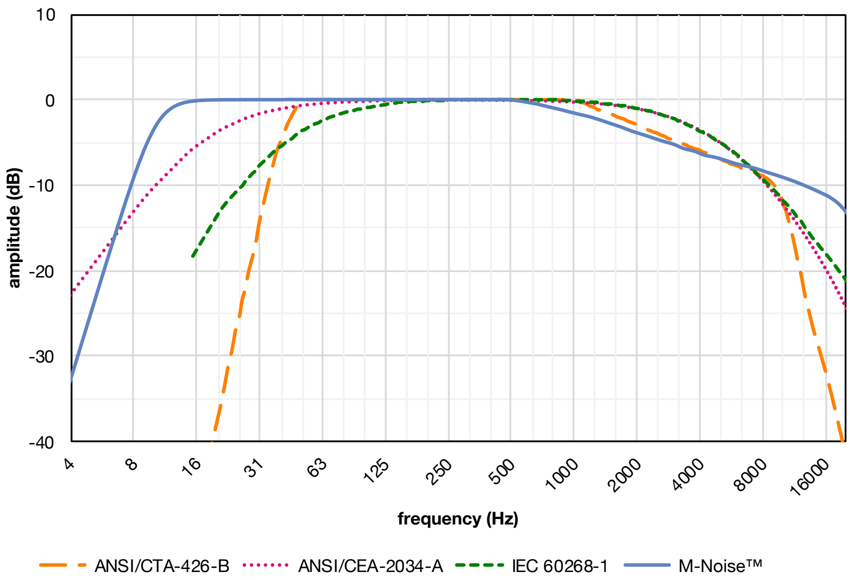
A New Signal for Measuring Loudspeaker Maximum SPL

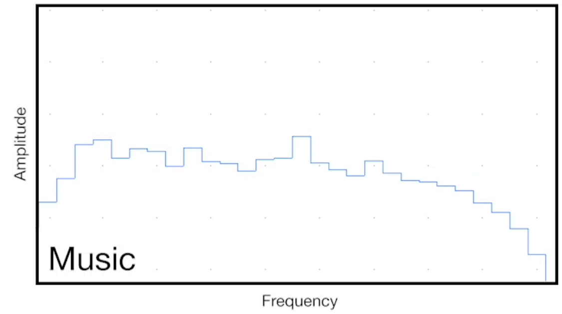
by Schwenke

YouTube

AUDIO ES

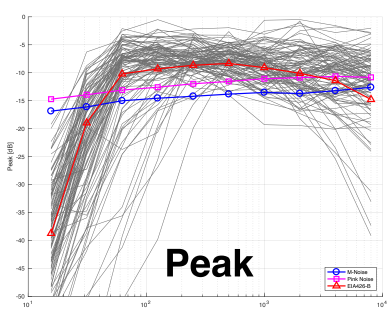
Meyer Sound® THINKING SOUND

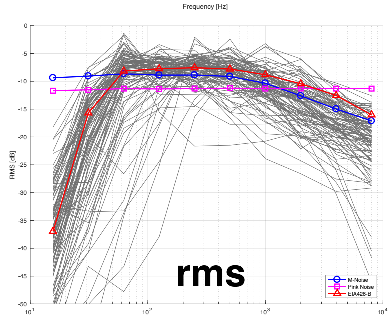


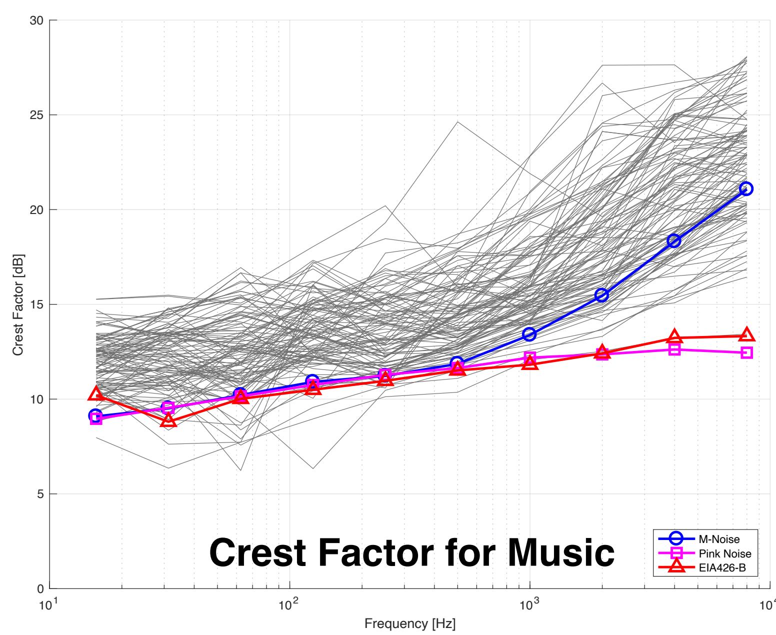


Spectra Various Simulated Programme Content

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

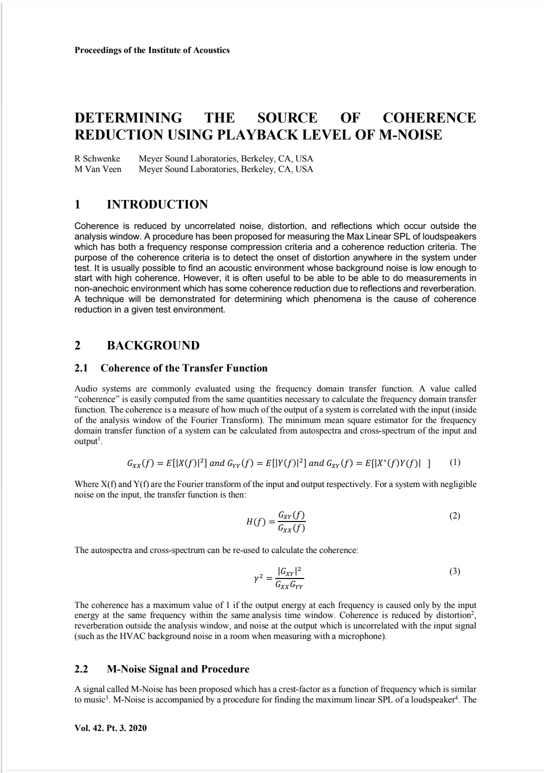






Best of Both Worlds

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE



Proceedings of the Institute of Acoustics

DETERMINING THE SOURCE OF COHERENCE REDUCTION USING PLAYBACK LEVEL OF M-NOISE

R Schwenke   Meyer Sound Laboratories, Berkeley, CA, USA
M Van Veen   Meyer Sound Laboratories, Berkeley, CA, USA

1 INTRODUCTION

Coherence is reduced by uncorrelated noise, distortion, and reflections which occur outside the analysis window. A procedure has been proposed for measuring the Max Linear SPL of loudspeakers which has both a frequency response compression criteria and a coherence reduction criteria. The purpose of the coherence criteria is to detect the onset of distortion anywhere in the system under test. It is usually possible to find an acoustic environment whose background noise is low enough to start with high coherence. However, it is often useful to be able to be able to do measurements in non-anechoic environment which has some coherence reduction due to reflections and reverberation. A technique will be demonstrated for determining which phenomena is the cause of coherence reduction in a given test environment.

2 BACKGROUND

2.1 Coherence of the Transfer Function

Audio systems are commonly evaluated using the frequency domain transfer function. A value called "coherence" is easily computed from the same quantities necessary to calculate the frequency domain transfer function. The coherence is a measure of how much of the output of a system is correlated with the input (inside of the analysis window of the Fourier Transform). The minimum mean square estimator for the frequency domain transfer function of a system can be calculated from autospectra and cross-spectrum of the input and output[1].

$$G_{XX}(f) = E[|X(f)|^2] \; and \; G_{YY}(f) = E[|Y(f)|^2] \; and \; G_{XY}(f) = E[|X^*(f)Y(f)| \;] \quad (1)$$

Where X(f) and Y(f) are the Fourier transform of the input and output respectively. For a system with negligible noise on the input, the transfer function is then:

$$H(f) = \frac{G_{XY}(f)}{G_{XX}(f)} \quad (2)$$

The autospectra and cross-spectrum can be re-used to calculate the coherence:

$$\gamma^2 = \frac{|G_{XY}|^2}{G_{XX} G_{YY}} \quad (3)$$

The coherence has a maximum value of 1 if the output energy at each frequency is caused only by the input energy at the same frequency within the same analysis time window. Coherence is reduced by distortion[2], reverberation outside the analysis window, and noise at the output which is uncorrelated with the input signal (such as the HVAC background noise in a room when measuring with a microphone).

2.2 M-Noise Signal and Procedure

A signal called M-Noise has been proposed which has a crest-factor as a function of frequency which is similar to music[3]. M-Noise is accompanied by a procedure for finding the maximum linear SPL of a loudspeaker[4]. The

Institute of Acoustics Paper

REPRODUCED SOUND 2020

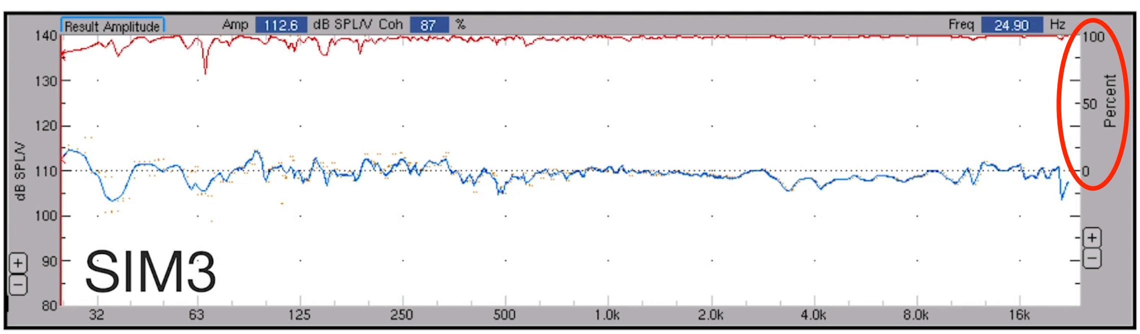
Determining the Source of Coherence Reduction Using Playback Level of M-Noise

by Schwenke & van Veen

Abstract

Coherence is reduced by uncorrelated noise, distortion, and reflections which occur outside the analysis window. A procedure has been proposed for measuring the Max Linear SPL of loudspeakers which has both a frequency response compression criterion and a coherence reduction criterion. The purpose of the coherence criterion is to detect the onset of distortion anywhere in the system under test. It is usually possible to find an acoustic environment whose background noise is low enough to start with high coherence. However, it is often useful to be able to be able to do measurements in a non-anechoic environment which has some coherence reduction due to reflections and reverberation. A technique will be demonstrated for determining which phenomenon is the cause of coherence reduction in a given test environment.

THINKING SOUND



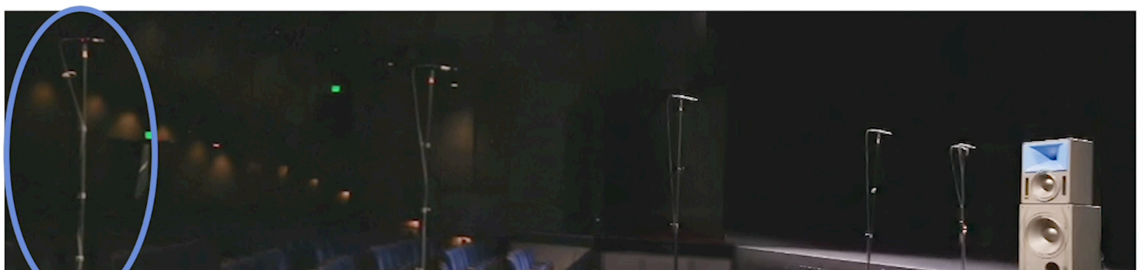
Uncorrelated Sounds

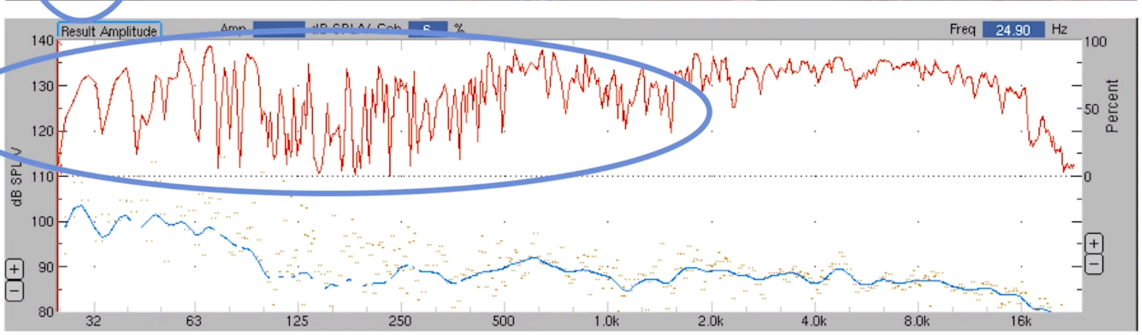
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

THINKING SOUND

Transient Uncorrelated Sounds

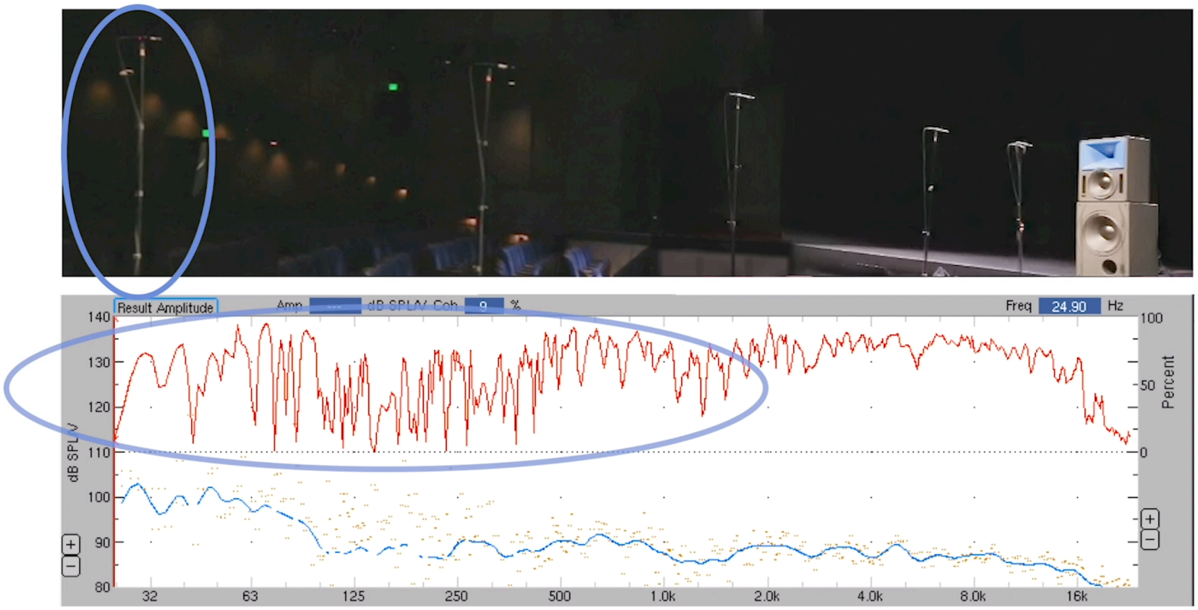
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE





Room Interaction

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE



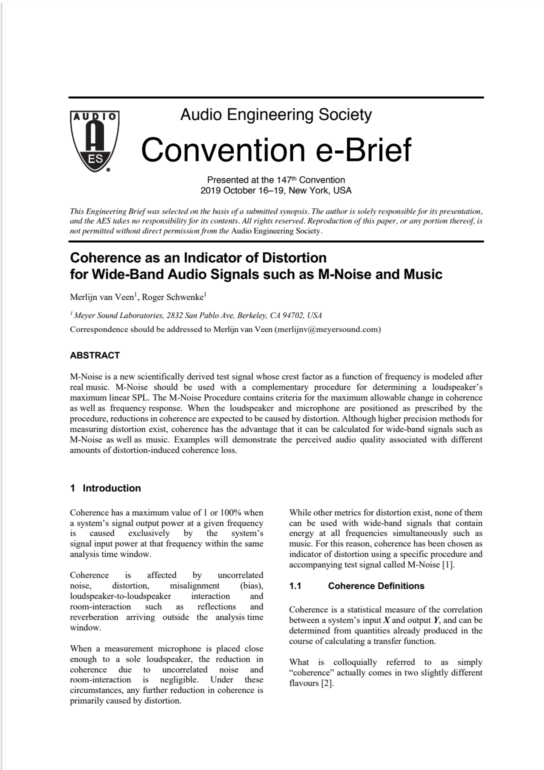
Room Interaction

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

Condition	Effect of Increased Playback Level	Coherence at a Particular Frequency
Background Noise	**Increased** Coherence	$$\gamma^2 = \frac{1}{1 + \frac{G_{NN}}{\lvert H \rvert^2 G_{XX}}}$$
Reflections and Reverberation	Constant Coherence	
Distortion	**Reduced** Coherence	

Conditions that Affect Coherence

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE



Audio Engineering Society

Convention e-Brief

Presented at the 147th Convention
2019 October 16–19, New York, USA

Coherence as an Indicator of Distortion for Wide-Band Audio Signals such as M-Noise and Music

Merlijn van Veen[1], Roger Schwenke[1]

[1] *Meyer Sound Laboratories, 2832 San Pablo Ave, Berkeley, CA 94702, USA*

Correspondence should be addressed to Merlijn van Veen (merlijnv@meyersound.com)

ABSTRACT

M-Noise is a new scientifically derived test signal whose crest factor as a function of frequency is modeled after real music. M-Noise should be used with a complementary procedure for determining a loudspeaker's maximum linear SPL. The M-Noise Procedure contains criteria for the maximum allowable change in coherence as well as frequency response. When the loudspeaker and microphone are positioned as prescribed by the procedure, reductions in coherence are expected to be caused by distortion. Although higher precision methods for measuring distortion exist, coherence has the advantage that it can be calculated for wide-band signals such as M-Noise as well as music. Examples will demonstrate the perceived audio quality associated with different amounts of distortion-induced coherence loss.

1 Introduction

Coherence has a maximum value of 1 or 100% when a system's signal output power at a given frequency is caused exclusively by the system's signal input power at that frequency within the same analysis time window.

Coherence is affected by uncorrelated noise, distortion, misalignment (bias), loudspeaker-to-loudspeaker interaction and room-interaction such as reflections and reverberation arriving outside the analysis time window.

When a measurement microphone is placed close enough to a sole loudspeaker, the reduction in coherence due to uncorrelated noise and room-interaction is negligible. Under these circumstances, any further reduction in coherence is primarily caused by distortion.

While other metrics for distortion exist, none of them can be used with wide-band signals that contain energy at all frequencies simultaneously such as music. For this reason, coherence has been chosen as indicator of distortion using a specific procedure and accompanying test signal called M-Noise [1].

1.1 Coherence Definitions

Coherence is a statistical measure of the correlation between a system's input ***X*** and output ***Y***, and can be determined from quantities already produced in the course of calculating a transfer function.

What is colloquially referred to as simply "coherence" actually comes in two slightly different flavours [2].

AES Engineering Brief

147TH AES CONVENTION • 2019

Coherence as an Indicator of Distortion for Wide-Band Audio Signals such as M-Noise and Music

by van Veen & Schwenke

Abstract

M-Noise is a new scientifically derived test signal whose crest factor as a function of frequency is modelled after real music. M-Noise should be used with a complementary procedure for determining a loudspeaker's maximum linear SPL. The M-Noise Procedure contains criteria for the maximum allowable change in coherence as well as frequency response. When the loudspeaker and microphone are positioned as prescribed by the procedure, reductions in coherence are expected to be caused by distortion. Although higher precision methods for measuring distortion exist, coherence has the advantage that it can be calculated for wide-band signals such as M-Noise as well as music. Examples will demonstrate the perceived audio quality associated with different amounts of distortion-induced coherence loss.

Coherence is a statistical measure of the correlation between a system's input ***X*** and output ***Y***.

It can be determined from quantities already produced in the course of calculating a transfer function.

Transfer Function

$$H(f) = \frac{G_{XY}(f)}{G_{XX}(f)}$$

Coherence

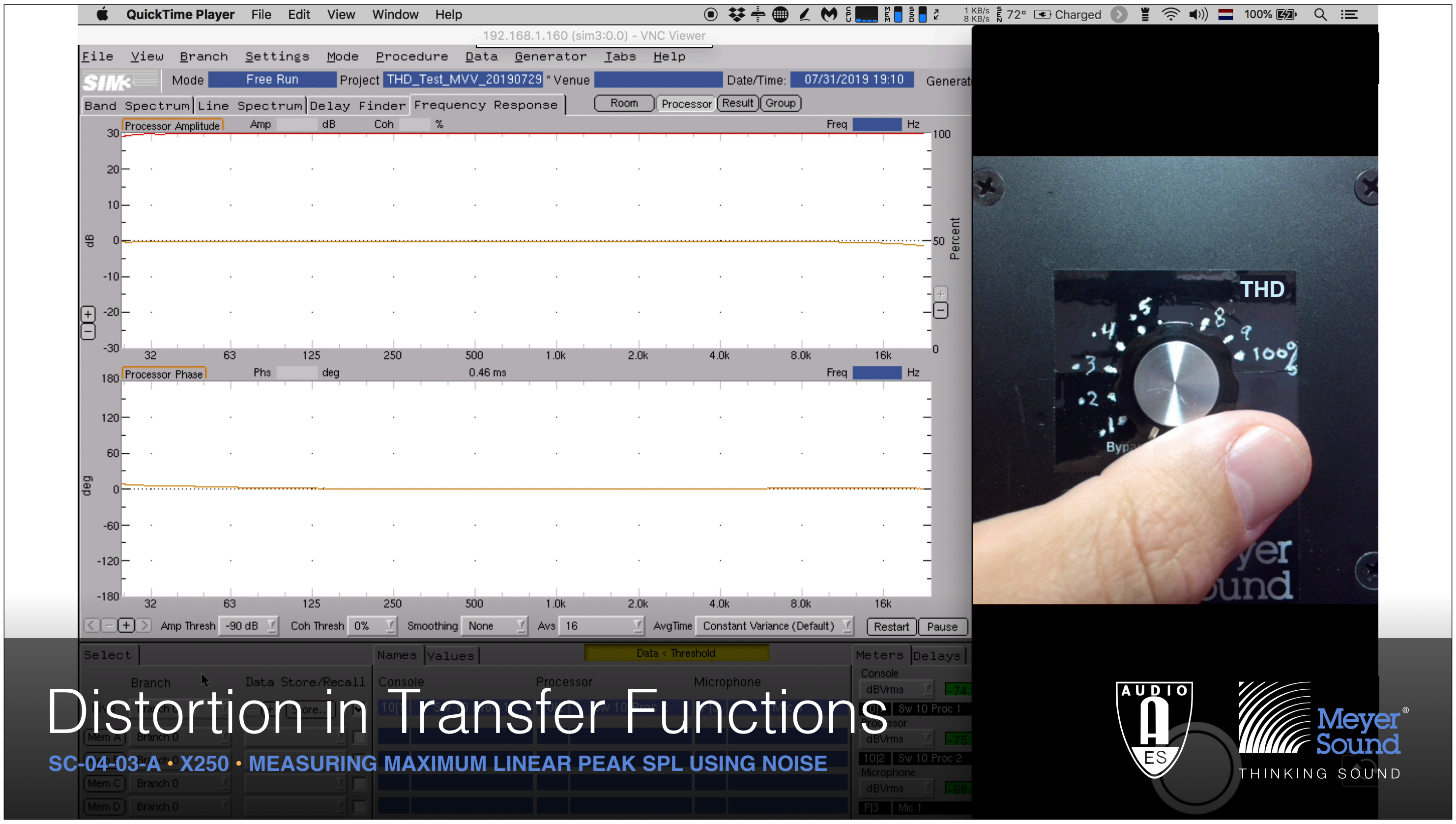
$$\gamma^2(f) = \frac{\left| G_{XY} \right|^2}{G_{XX}G_{YY}}(f)$$

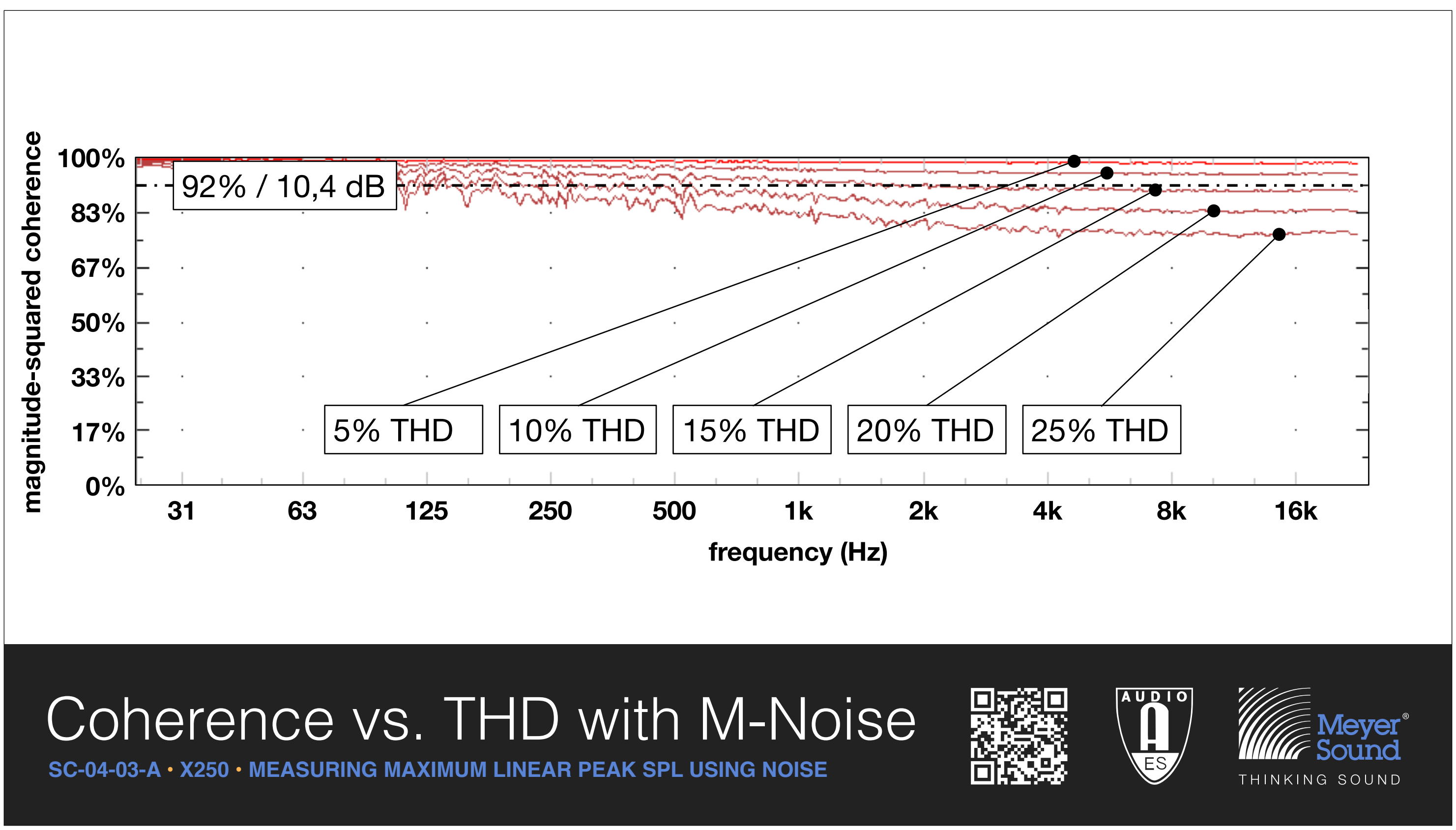
Transfer Function & Coherence

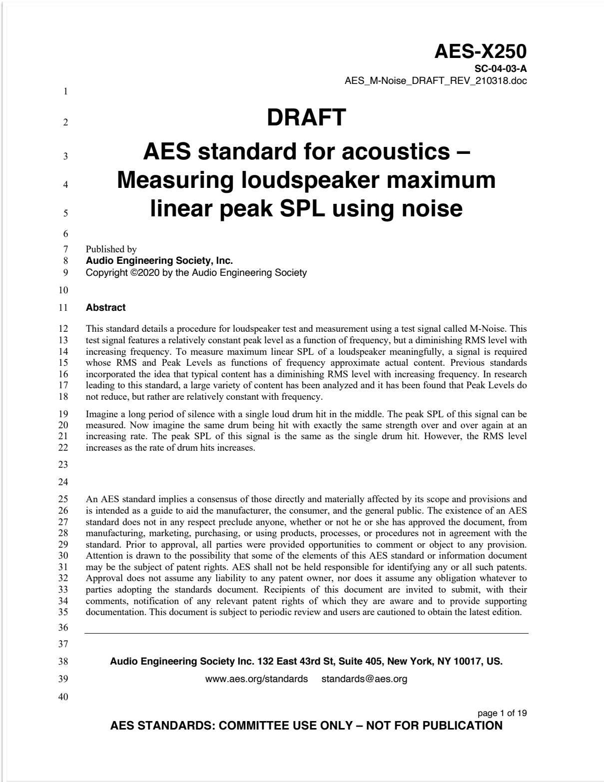
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

Distortion and Noise in Band Spectra

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE


QuickTime Player File Edit View Window Help
192.168.1.160 (sim3:0.0) - VNC Viewer
File View Branch Settings Mode Procedure Data Generator Tabs Help
Mode Free Run Project THD_Test_MVV_20190729 Venue Date/Time: 07/31/2019 19:10
Band Spectrum Line Spectrum Delay Finder Frequency Response
Processor Amplitude
Processor Phase
THD
Distortion in Transfer Functions
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE
AUDIO ES
Meyer Sound
THINKING SOUND


magnitude-squared coherence
100%
83%
67%
50%
33%
17%
0%
92% / 10,4 dB
5% THD
10% THD
15% THD
20% THD
25% THD
31
63
125
250
500
1k
2k
4k
8k
16k
frequency (Hz)
Coherence vs. THD with M-Noise
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE
AUDIO ES
Meyer Sound
THINKING SOUND



AES-X250
SC-04-03-A
AES_M-Noise_DRAFT_REV_210318.doc

DRAFT

AES standard for acoustics – Measuring loudspeaker maximum linear peak SPL using noise

Published by
Audio Engineering Society, Inc.

Abstract

This standard details a procedure for loudspeaker test and measurement using a test signal called M-Noise. This test signal features a relatively constant peak level as a function of frequency, but a diminishing RMS level with increasing frequency. To measure maximum linear SPL of a loudspeaker meaningfully, a signal is required whose RMS and Peak Levels as functions of frequency approximate actual content. Previous standards incorporated the idea that typical content has a diminishing RMS level with increasing frequency. In research leading to this standard, a large variety of content has been analyzed and it has been found that Peak Levels do not reduce, but rather are relatively constant with frequency.

Imagine a long period of silence with a single loud drum hit in the middle. The peak SPL of this signal can be measured. Now imagine the same drum being hit with exactly the same strength over and over again at an increasing rate. The peak SPL of this signal is the same as the single drum hit. However, the RMS level increases as the rate of drum hits increases.

Audio Engineering Society Inc. 132 East 43rd St, Suite 405, New York, NY 10017, US.
www.aes.org/standards standards@aes.org

AES STANDARDS: COMMITTEE USE ONLY – NOT FOR PUBLICATION

AES-X250

SC-04-03-A • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

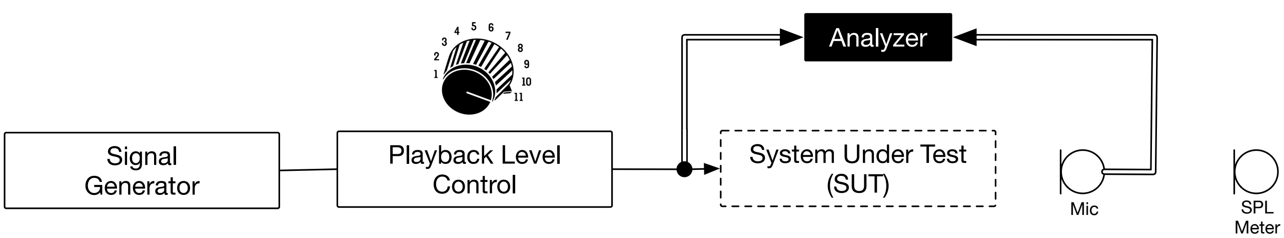
Measuring maximum linear peak SPL using noise

by SC-04-03-A

Abstract

This standard details a procedure for loudspeaker test and measurement using a test signal called M-Noise. This test signal features a relatively constant peak level as a function of frequency, but a diminishing RMS level with increasing frequency. To measure maximum linear SPL of a loudspeaker meaningfully, a signal is required whose RMS and Peak Levels as functions of frequency approximate actual content. Previous standards incorporated the idea that typical content has a diminishing RMS level with increasing frequency. In research leading to this standard, a large variety of content has been analyzed and it has been found that Peak Levels do not reduce, but rather are relatively constant with frequency…

THINKING SOUND



Conceptual Test

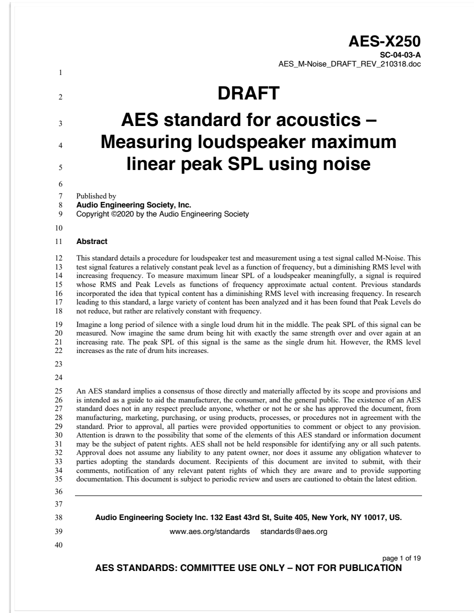
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

THINKING SOUND

1. Play M-Noise at a low level
   you expect will be reproduced linearly

2. Increase the Playback Level by a small amount
   and make sure it is still reproduced linearly

3. Continue increasing the Playback Level until
   it is no longer reproduced linearly
   i.e., stop conditions are met



AES-X250
SC-04-03-A
AES_M-Noise_DRAFT_REV_210318.doc

DRAFT

AES standard for acoustics – Measuring loudspeaker maximum linear peak SPL using noise

Published by
Audio Engineering Society, Inc.
Copyright ©2020 by the Audio Engineering Society

Abstract

This standard details a procedure for loudspeaker test and measurement using a test signal called M-Noise. This test signal features a relatively constant peak level as a function of frequency, but a diminishing RMS level with increasing frequency. To measure maximum linear SPL of a loudspeaker meaningfully, a signal is required whose RMS and Peak Levels as functions of frequency approximate actual content. Previous standards incorporated the idea that typical content has a diminishing RMS level with increasing frequency. In research leading to this standard, a large variety of content has been analyzed and it has been found that Peak Levels do not reduce, but rather are relatively constant with frequency.

Imagine a long period of silence with a single loud drum hit in the middle. The peak SPL of this signal can be measured. Now imagine the same drum being hit with exactly the same strength over and over again at an increasing rate. The peak SPL of this signal is the same as the single drum hit. However, the RMS level increases as the rate of drum hits increases.

An AES standard implies a consensus of those directly and materially affected by its scope and provisions and is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an AES standard does not in any respect preclude anyone, whether or not he or she has approved the document, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in agreement with the standard. Prior to approval, all parties were provided opportunities to comment or object to any provision. Attention is drawn to the possibility that some of the elements of this AES standard or information document may be the subject of patent rights. AES shall not be held responsible for identifying any or all such patents. Approval does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the standards document. Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation. This document is subject to periodic review and users are cautioned to obtain the latest edition.

Audio Engineering Society Inc. 132 East 43rd St, Suite 405, New York, NY 10017, US.
www.aes.org/standards standards@aes.org

page 1 of 19
AES STANDARDS: COMMITTEE USE ONLY – NOT FOR PUBLICATION

Conceptual Procedure

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

THINKING SOUND

- 2 dB compression
  over at least two contiguous octaves

- 3 dB compression anywhere

- Coherence < 91% (SDR < 10 dB)
  over at least 1/3-octave anywhere

AES-X250
SC-04-03-A
AES_M-Noise_DRAFT_REV_210318.doc

DRAFT

AES standard for acoustics – Measuring loudspeaker maximum linear peak SPL using noise

Published by
Audio Engineering Society, Inc.
Copyright ©2020 by the Audio Engineering Society

Abstract

This standard details a procedure for loudspeaker test and measurement using a test signal called M-Noise. This test signal features a relatively constant peak level as a function of frequency, but a diminishing RMS level with increasing frequency. To measure maximum linear SPL of a loudspeaker meaningfully, a signal is required whose RMS and Peak Levels as functions of frequency approximate actual content. Previous standards incorporated the idea that typical content has a diminishing RMS level with increasing frequency. In research leading to this standard, a large variety of content has been analyzed and it has been found that Peak Levels do not reduce, but rather are relatively constant with frequency.

Imagine a long period of silence with a single loud drum hit in the middle. The peak SPL of this signal can be measured. Now imagine the same drum being hit with exactly the same strength over and over again at an increasing rate. The peak SPL of this signal is the same as the single drum hit. However, the RMS level increases as the rate of drum hits increases.

An AES standard implies a consensus of those directly and materially affected by its scope and provisions and is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an AES standard does not in any respect preclude anyone, whether or not he or she has approved the document, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in agreement with the standard. Prior to approval, all parties were provided opportunities to comment or object to any provision. Attention is drawn to the possibility that some of the elements of this AES standard or information document may be the subject of patent rights. AES shall not be held responsible for identifying any or all such patents. Approval does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the standards document. Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation. This document is subject to periodic review and users are cautioned to obtain the latest edition.

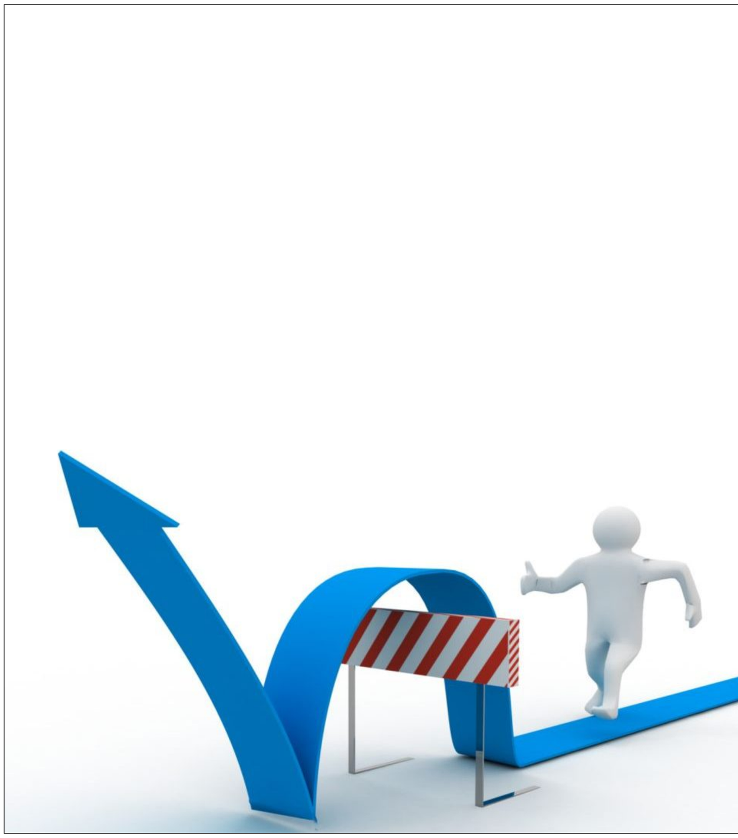
Audio Engineering Society Inc. 132 East 43rd St, Suite 405, New York, NY 10017, US.
www.aes.org/standards standards@aes.org

page 1 of 19
AES STANDARDS: COMMITTEE USE ONLY – NOT FOR PUBLICATION

Stop Conditions

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

THINKING SOUND



Consensus Building

X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

- Derivation of the test signal
- Filtering
- Finished Products vs. Components / Transducers
- Stop Conditions
- Coherence
- Frequency Weighting

---

1. Determine Maximum Playback Level
   i.e., increase drive level until:
   - At least 2 dB compression
     over at least two contiguous octaves
   - At least 3dB compression anywhere
   - Coherence < 91% (SDR < 10 dB)
     over at least 1/3-octave anywhere

2. Determine SPL at the Preferred Listening Position,
   at previously determined Maximum Playback Level
   i.e., recall Maximum Playback Level

AES-X250
SC-04-03-A
AES_M-Noise_DRAFT_REV_210318.doc

DRAFT

AES standard for acoustics – Measuring loudspeaker maximum linear peak SPL using noise

Published by
Audio Engineering Society, Inc.
Copyright ©2020 by the Audio Engineering Society

Abstract

This standard details a procedure for loudspeaker test and measurement using a test signal called M-Noise. This test signal features a relatively constant peak level as a function of frequency, but a diminishing RMS level with increasing frequency. To measure maximum linear SPL of a loudspeaker meaningfully, a signal is required whose RMS and Peak Levels as functions of frequency approximate actual content. Previous standards incorporated the idea that typical content has a diminishing RMS level with increasing frequency. In research leading to this standard, a large variety of content has been analyzed and it has been found that Peak Levels do not reduce, but rather are relatively constant with frequency.

Imagine a long period of silence with a single loud drum hit in the middle. The peak SPL of this signal can be measured. Now imagine the same drum being hit with exactly the same strength over and over again at an increasing rate. The peak SPL of this signal is the same as the single drum hit. However, the RMS level increases as the rate of drum hits increases.

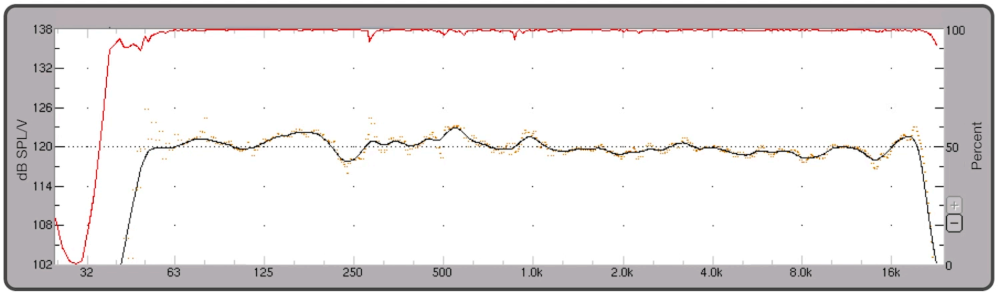
An AES standard implies a consensus of those directly and materially affected by its scope and provisions and is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an AES standard does not in any respect preclude anyone, whether or not he or she has approved the document, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in agreement with the standard. Prior to approval, all parties were provided opportunities to comment or object to any provision. Attention is drawn to the possibility that some of the elements of this AES standard or information document may be the subject of patent rights. AES shall not be held responsible for identifying any or all such patents. Approval does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the standards document. Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation. This document is subject to periodic review and users are cautioned to obtain the latest edition.

Audio Engineering Society Inc. 132 East 43rd St, Suite 405, New York, NY 10017, US.
www.aes.org/standards standards@aes.org

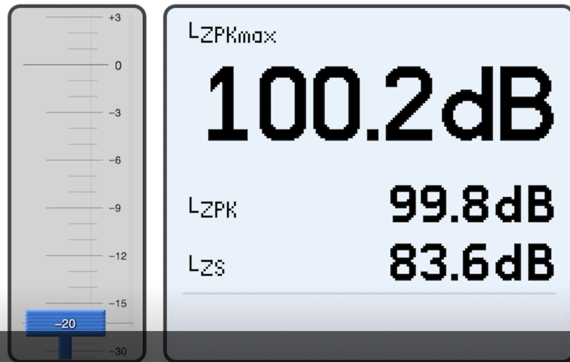
page 1 of 19
AES STANDARDS: COMMITTEE USE ONLY – NOT FOR PUBLICATION

Maximum Linear SPL Procedure

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE



Preliminary playback level

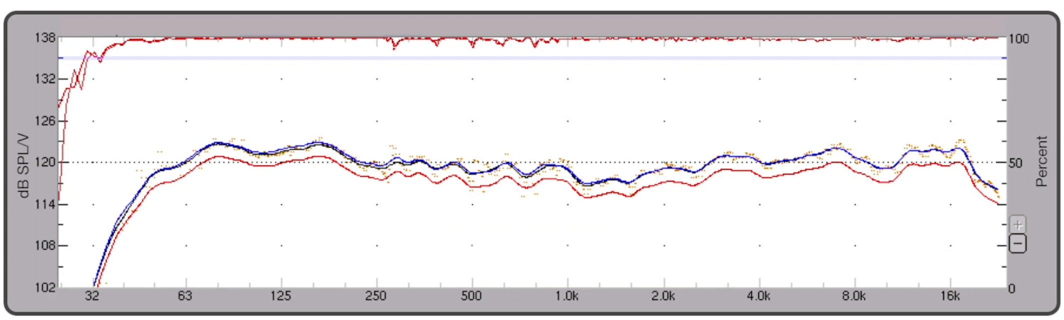


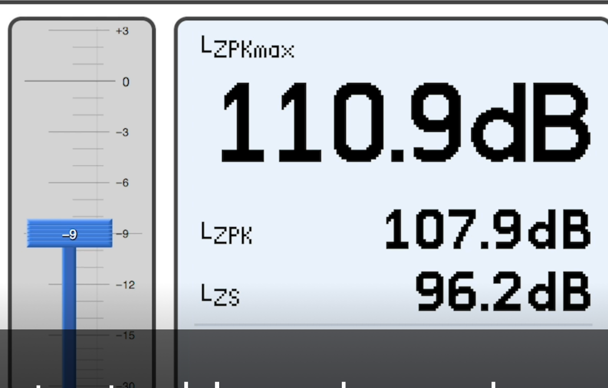
Procedure

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

AUDIO ES

Meyer Sound®
THINKING SOUND



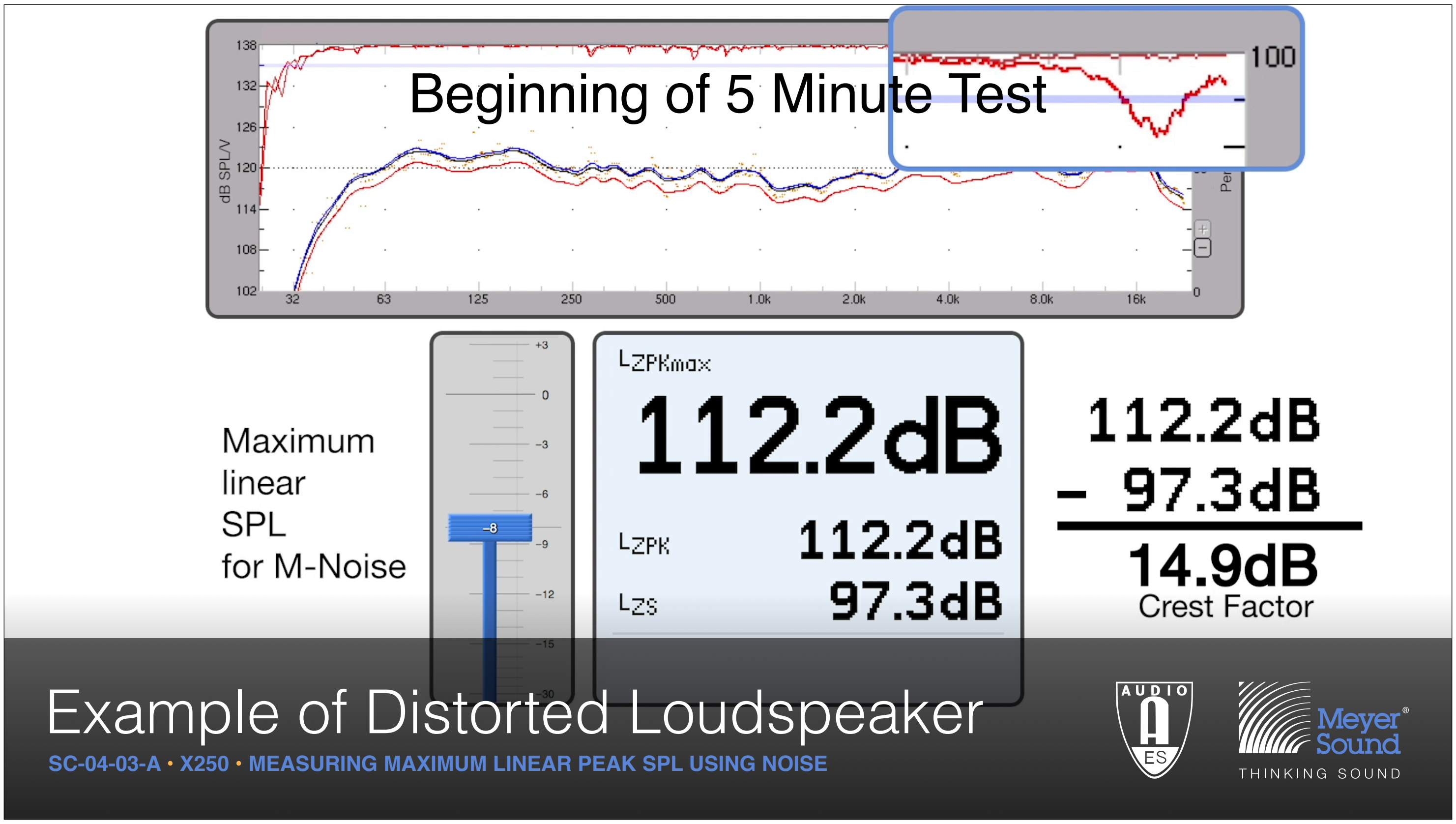


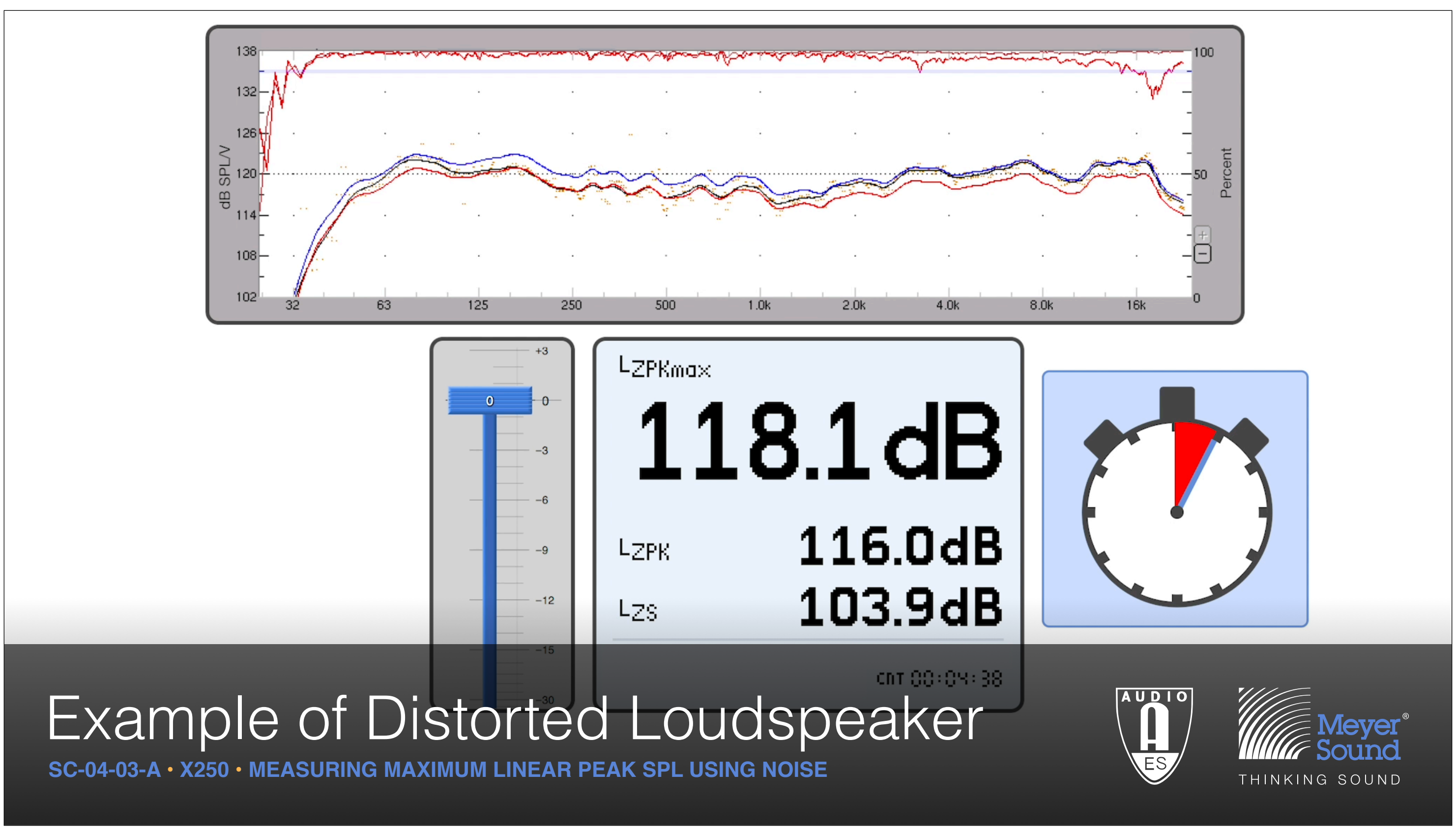
Example of Distorted Loudspeaker

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

AUDIO ES

Meyer Sound®
THINKING SOUND


Beginning of 5 Minute Test
100
dB SPL/V
138
132
126
120
114
108
102
32
63
125
250
500
1.0k
2.0k
4.0k
8.0k
16k
Maximum
linear
SPL
for M-Noise
-8
LZPKmax
112.2dB
LZPK 112.2dB
LZS 97.3dB
112.2dB
– 97.3dB
14.9dB
Crest Factor
Example of Distorted Loudspeaker
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE
AUDIO
ES
Meyer Sound
THINKING SOUND


dB SPL/V
138
132
126
120
114
108
102
32
63
125
250
500
1.0k
2.0k
4.0k
8.0k
16k
100
50
0
Percent
0
LZPKmax
118.1dB
LZPK 116.0dB
LZS 103.9dB
CNT 00:04:38
Example of Distorted Loudspeaker
SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE
AUDIO
ES
Meyer Sound
THINKING SOUND

Ripple Effect

X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

- SMPTE's "B-Chain Characteristics and Expectations Working Group" continues to evaluate the M-Noise signal—in the context of an in-situ application—to measure cinema and post-production facilities' sound systems.
- AVIXA is considering the inclusion of M-Noise in validating the end-to-end transmission quality throughout the entire signal chain in sound reinforcement and playback systems.

THINKING SOUND

AES-X250
SC-04-03-A
AES_M-Noise_DRAFT_REV_210318.doc

DRAFT

AES standard for acoustics – Measuring loudspeaker maximum linear peak SPL using noise

Published by
Audio Engineering Society, Inc.

Abstract

This standard details a procedure for loudspeaker test and measurement using a test signal called M-Noise. This test signal features a relatively constant peak level as a function of frequency, but a diminishing RMS level with increasing frequency. To measure maximum linear SPL of a loudspeaker meaningfully, a signal is required whose RMS and Peak Levels as functions of frequency approximate actual content. Previous standards incorporated the idea that typical content has a diminishing RMS level with increasing frequency. In research leading to this standard, a large variety of content has been analyzed and it has been found that Peak Levels do not reduce, but rather are relatively constant with frequency.

Imagine a long period of silence with a single loud drum hit in the middle. The peak SPL of this signal can be measured. Now imagine the same drum being hit with exactly the same strength over and over again at an increasing rate. The peak SPL of this signal is the same as the single drum hit. However, the RMS level increases as the rate of drum hits increases.

Audio Engineering Society Inc. 132 East 43rd St, Suite 405, New York, NY 10017, US.
www.aes.org/standards standards@aes.org

AES STANDARDS: COMMITTEE USE ONLY – NOT FOR PUBLICATION

Forecast

X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

- Push the standard draft to parent committee
- Call for comments within the parent committee
- Call for public comments

THINKING SOUND

SC-04-03

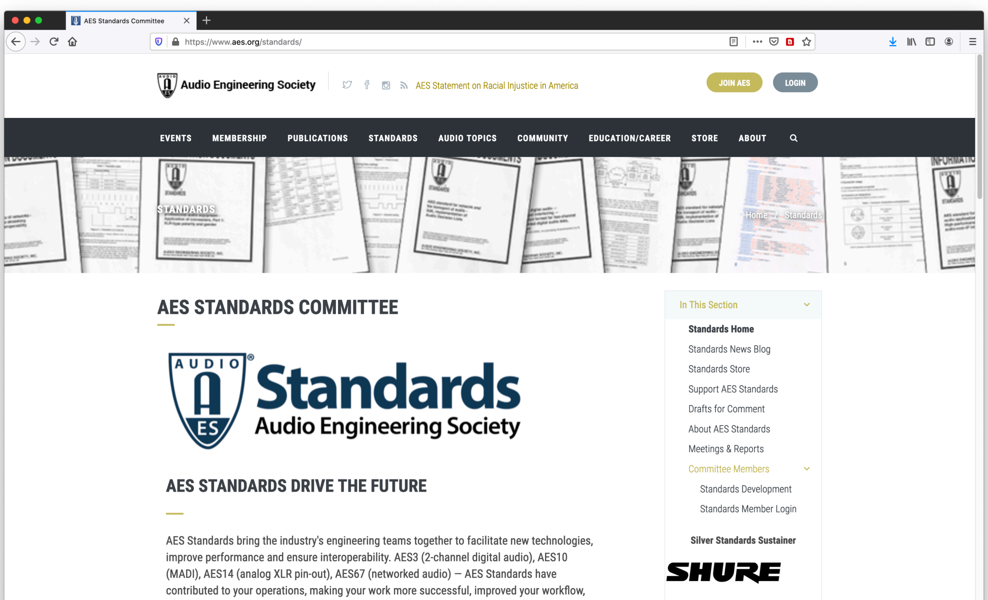
Working Group on
Loudspeaker Modeling and Measurement

Contact Standards Manager

Join the Conversation

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

THINKING SOUND



AES Standards

SC-04-03-A • X250 • MEASURING MAXIMUM LINEAR PEAK SPL USING NOISE

THINKING SOUND

Thank You

Thank You