CJS Labs

Technology · Research · Strategy · Solutions

Lab Notes

Electroacoustics & Audio

- *Consulting*
- *Design / Testing*
- *Training*

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Inside this issue:

Training Services

CJS Labs offers customized in-house training. Our design experience, proven processes, and measurement expertise will make your product development more efficient. Learn how to optimize both your designs and test routines. Having a thorough understanding of fundamentals, correct terminology, and proper techniques will also enable you to make more informed decisions and communicate more effectively with your customers and vendors as well as within your own organization. Understand why certain failure modes are problematic, even if they are not obvious or audible. Sample course outlines and details are available on our website:

http://www.cjs-labs.com/training_seminars.html

Contact us to schedule a training course for your organization.

AES International Conference on Headphone Technology San Francisco, CA — 27-29 August 2018

I am co-chair of the AES International Conference on Headphone Technology, which will be held 27-29 August 2019 here in San Francisco at Golden Gate Club in the historic Presidio. I will also be giving a paper entitled, "*Objective Measurements of Headphone Acoustic Noise Cancellation Performance*".

Registration is now open:

http://www.aes.org/conferences/2019/headphones/

News and Upcoming Events

AES 146th Loudspeaker Design Tutorial—Dublin

My tutorial at the AES 146th in Dublin, "Almost Everything You Ever Wanted To Know About Loudspeaker Design" was a great success, with over 60 attendees and lots of requests for the PDF lecture notes.

New Tutorial: Microphone Electroacoustics

I will be debuting a new tutorial on Microphone Electroacoustics at the AES 147th in New York in October. It covers design, principles of operation, configurations, interfacing, performance metrics, and applications. Stay tuned for details.

ASA Standards Video

The URL to the ASA Standards promo video in the last issue was incorrect. Here is the correct URL:

https://acousticalsociety.org/acoustical-society-standards/

Please contact us and let us know how we can be of service to you and your organization.

Christopher J. Struck

CEO & Chief Scientist

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NCAC National Council of Acoustical Consultants Member

IEEE CNSV

CJS Labs is a consulting firm based in San Francisco, CA. We specialize in audio and electroacoustics applications. With over 30 years of industry experience in engineering and technology management, our areas of expertise include transducers, acoustics, system design, instrumentation, measurement and analysis techniques, hearing science, speech intelligibility, telephonometry, and perceptual coding. We also offer project management, tech-

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http://www.cjs-labs.com/lab_notes_links.html

First Order Directional Microphones

A first order directional microphone is sometimes called a 'gradient' microphone, as its response is proportional to pressure gradient, rather than pressure. Any desired first order polar pattern of the cardioid family can be formed by a normalized weighted combination of omni and bidirectional (cosine) elements. For sources in the far field, the general equation for a first order directional microphone is given by

$$\rho(\theta) = \alpha + \beta cos(\theta)$$

where

ρ	is the output
α	is the omnidirectional component
β	is the cosine (bidirectional) component
k	is the wave number ($2\pi/\lambda$)
r	is the distance to the source
θ	is the angle

$$0 \geq \beta \geq 1 \quad \text{and} \quad \alpha = 1 - \beta$$

The primary single-figure directional metric is the Directivity, or Q. Directivity can be measured or calculated from the polar equation as

$$Q = \frac{1}{1 - 2\beta + \frac{4\beta^2}{3}}$$

This is the power ratio of the free field on-axis response to the diffuse field (random incidence) response. Functionally, this is the S/N for an on-axis source compared to diffuse reverberant noise. This is more commonly given as the Directivity Index, which is simply

$$DI = 10\log_{10} Q$$

The Hypercardioid pattern has the highest DI and will therefore provide approximately 6 dB of S/N improvement over an omnidirectional microphone of the same sensitivity under the same conditions. The Supercardioid is slightly lower, at 5.7 dB, while the Cardioid and Bidirectional microphones are 4.8 dB.

The family of classical first order polar patterns and corresponding directivity index are shown in Fig. 1.

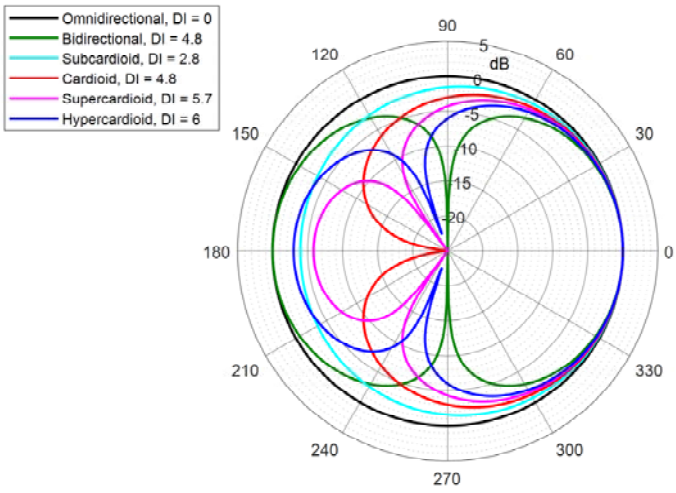

Fig. 1 First order polar patterns and Directivity Index.

Note that although the polar pattern is typically shown as 2-dimensional in a single plane, it is actually 3-dimensional — symmetric about its primary axis. The 3-D cardioid pattern is shown in Fig. 2.

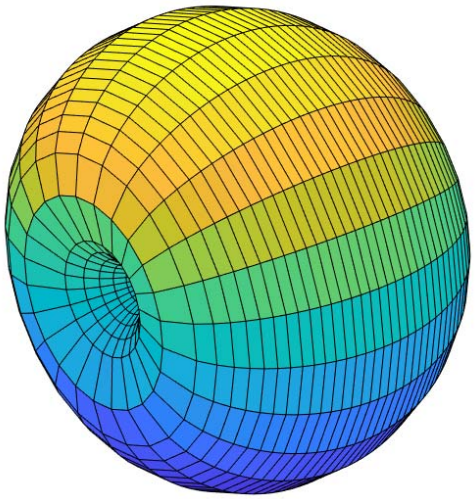

Fig. 2 3-D cardioid polar pattern.

Please contact us for more information.