# CJS Labs

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# Lab Notes

IEEE CNSV

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**Electroacoustics & Audio**

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

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## 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.***

## IEC TC-29 Meets in Ottawa

IEC TC-29 met in Ottawa 24-28 September 2018. More than 60 delegates from 13 countries participated. I was Head of the US Delegation and participated in 4 working group meetings: WG5 on Microphones; WG13 on Hearing Aids; WG21 on Ear simulators; and WG on Modular Instrumentation. I was also named Convenor of MT25 to revise IEC 60263.A Joint *ad hoc* group was formed to align the Microphone, Calibrator, and Sound Level Meter standards.

## News and Upcoming Events

### AES New York

The AES 145th Convention takes place 17-20 October 2018 in New York City.
http://www.aes.org/events/145/

I will be presenting a tutorial entitled "**Telephonometry: The Practical Acoustics of Handsets, Headsets, and Mobile Devices**", Session AP02 on Thursday 18 Oct. at 4:30pm.
http://www.aes.org/events/145/acoustics/?ID=6220

Let us know if you will be there and would like to set up a meeting.

### ASA Meeting in Victoria, BC—CANADA

The Acoustical Society of America will meet in Victoria, British Columbia 5-9 November. ASACOS, which I chair, will meet on Tuesday 6 November at 7:30am.

Please contact us if you are planning on attending, and would like to meet.

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

Christopher J. Struck

*CEO & Chief Scientist*

***CJS Labs***

**CJS Labs**

"Sound Advice Spanning 3 Decades"

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**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, technology strategy, patent & IP evaluation, and training services**

Back issues of Lab Notes are available on our website at:

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

# Condenser Microphone Diaphragm Displacement

The typical condenser microphone consists of a thin metallic diaphragm, usually made of nickel or stainless steel, in close proximity to a rigid, charged metal back plate (see Fig 1). This forms an air dielectric

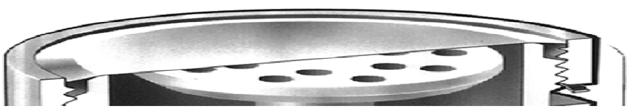

*Fig. 1. Cross section of a condenser microphone showing the diaphragm and back-plate.*

capacitor with a variable capacitance proportional to the (varying) distance between the diaphragm and the back plate. The tension on the diaphragm affects the microphone sensitivity and frequency response. For an omnidirectional microphone, the cavity behind the diaphragm is sealed and under constant pressure. A very small equalization vent prevents the diaphragm from rupturing due to large variations in ambient pressure. Sound energy impinging upon the diaphragm creates a pressure difference from front (outside) to back (inside) and causes the diaphragm to move in relationship to the fixed back plate.

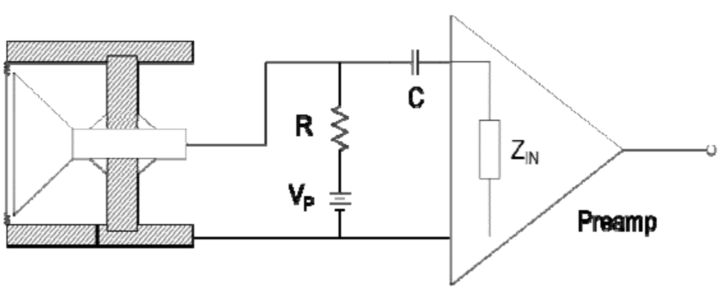


*Fig. 2. Condenser microphone functional diagram*

Diaphragm movement is converted into a varying voltage signal as

$$V = \frac{Q}{C} = \frac{Q}{\varepsilon\, S} \cdot d$$

$$\therefore \quad \Delta V = \frac{Q}{\varepsilon\, S} \cdot \Delta d$$

where

$V$ = voltage
$Q$ = charge on back plate
$C$ = microphone capacitance
$\varepsilon$ = dielectric permeability
$A$ = surface area of diaphragm
$d$ = distance between back plate and diaphragm

The linear relationship is valid as long as the movement of the diaphragm is small and the charge is constant, i.e., no current flow. Constant charge is obtained with a high polarization voltage ($V_P$ = 200V) connected through a very high resistance. A coupling capacitor blocks the DC polarization voltage, leaving only the AC acoustic signal, which is linearly proportional to the input. The preamp must be located very close to the mic capsule, due to the extremely high output impedance of the mic. The preamp also transforms the output to low impedance, so a long cable can be used.

For an input of $p$ = 1 Pa, the diaphragm displacement of a 1/2 inch microphone with a sensitivity of $S$ = -38.5 dB V/Pa can be calculated as

$$\Delta d = \frac{S \cdot p \cdot d}{V_P} = \frac{12.5\,\text{mV/Pa} \times 1\,\text{Pa} \times 20\,\mu\text{m}}{200\,\text{V}} = 1.25\,\text{nm}$$

Please contact us for more information.