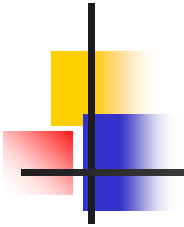
3.155J/6.152J Lecture 21: Take Home Exam Introduction and Patent Discussion

Prof. Martin A. Schmidt

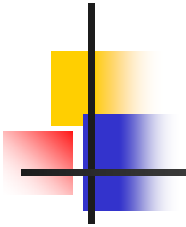
Massachusetts Institute of Technology

11/28/2005



Outline

- Review of Schedule
- Microphone Theory
- The Knowles Microphone
- Our Design Challenge
- Patents
  - Courtesy: T.A. Lober
- Course Review



Schedule

- Week of 11/28
  - Monday – Take Home Introduction*
  - Wednesday – Quiz 2
- Week of 12/5
  - Monday – Take Home Discussion*
  - Wednesday – Guest Lecture*
    - Fluids Lab Due
- Week of 12/12
  - Monday – Guest Lecture*
  - Wednesday – Analog Devices Tour*
    - Take Home Due

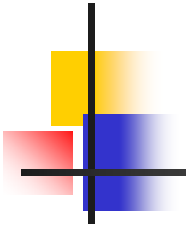
** Graded Lecture*

Lecture Grading Procedure

- Five Lectures worth 20 points = 2 HW
- System
  - Attendance = 3 points
    - Thus, '75% of life is just showing up'.
  - 'Good Questions' = 1 point/question
  - Maximum points available in one lecture = 5
- TA's will keep track of attendance and questions

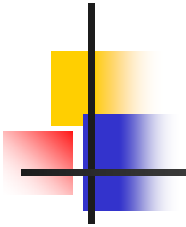
Take Home Design Challenge

- Design a process for fabrication of a microphone integrated with a depletion mode nMOSFET
- Utilize the Knowles microphone as our model device
  - U.S. Patent 6,847,090
    - ‘Silicon Capacitive Microphone’ - Loeppert



Microphones

- A pressure sensor
  - Convert acoustic pressure wave to electrical signal
  - An AC measurement
    - ~5Hz – 2000Hz
    - No DC response
      - e.g. Barometric pressure
    - No high frequency response
      - ‘Car door’ effect
- Applications of ‘Small’ Microphones
  - Hearing aids
  - Cellular phones
  - Arrays for advanced signal processing
    - Direction location
    - Background noise suppression
  - ‘Sneaky’ stuff



Microphone Transduction: Examples

- Magnetic
  - Sense motion of membrane in a magnetic field
    - Inverse of a loudspeaker
- Electrostatic
  - Capacitive
    - Measure change in capacitance
  - Electret
    - Sense motion of fixed charge

Electret Microphone

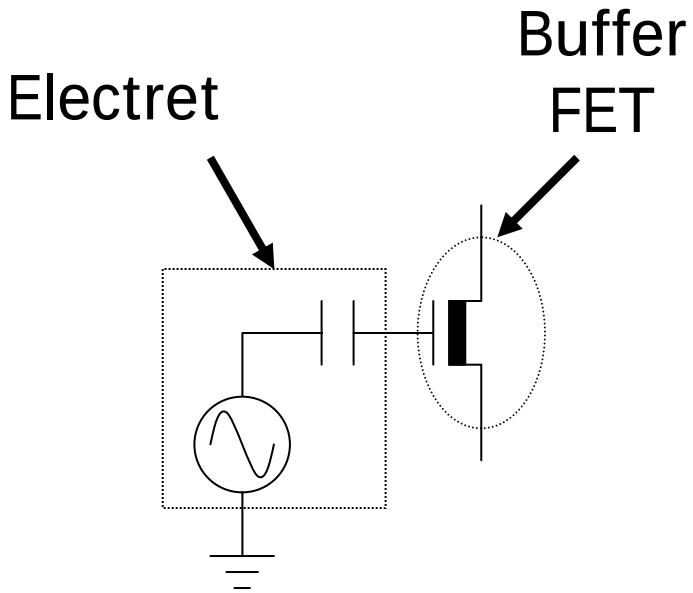


Figure removed for copyright reasons.

Figure can be viewed at http://hyperphysics.phy-astr.gsu.edu/hbase/audio/mic2.html

Electret Microphone

Figures removed for copyright reasons.

www.talkingelectronics.com

http://www.vina.co.kr/product/micro_tech1_1.html

MEMS Capacitive Microphone

Figure removed for copyright reasons.

www.vtt.fi

Knowles Microphone

Figure removed for copyright reasons.

Loeppert "Silicon Capacitive Microphone." U.S. Patent 6,847,090.

Figure removed for copyright reasons.

Motorola Razor Phone

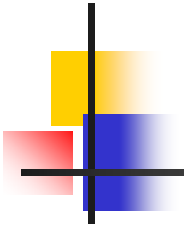
- First MEMS Microphone designed into a large volume consumer product
  - Reason: Surface-mount temperature advantage
- Result of ~15 years of research for hearing aid applications

Figure removed for copyright reasons.

See http://www.emkayproducts.com/html/sil_mic.html

Figure removed for copyright reasons.

Commercial MEMS Microphone: Knowles SiSonic SP0103N



Our Challenge

- Figure out how it is made
  - Based on U.S. Patent 6,847,090
- Design a process to make one
  - Include a depletion-mode nMOSFET
- Schedule
  - This week – Learn the Knowles device
  - Next week – Begin our design
- More materials will be distributed