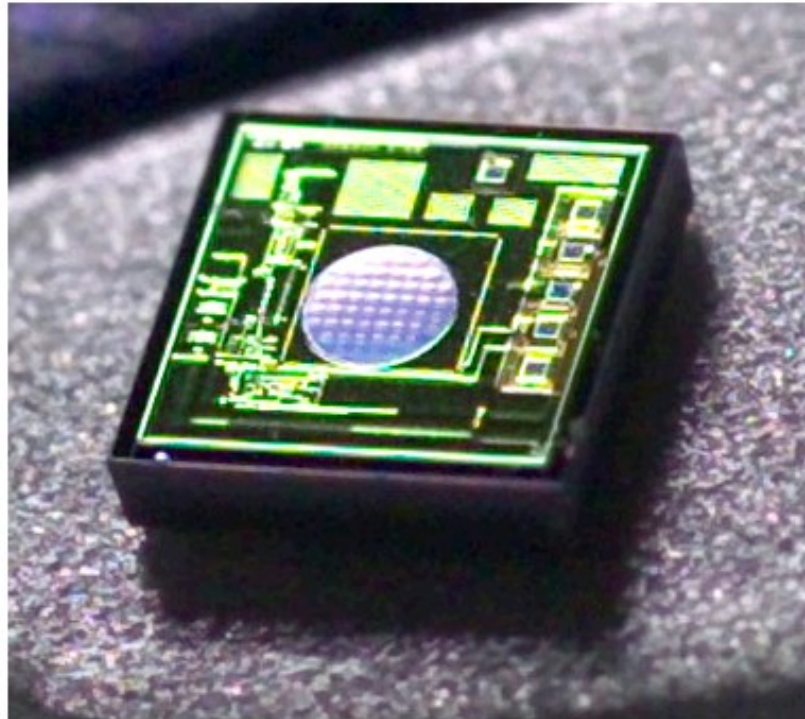


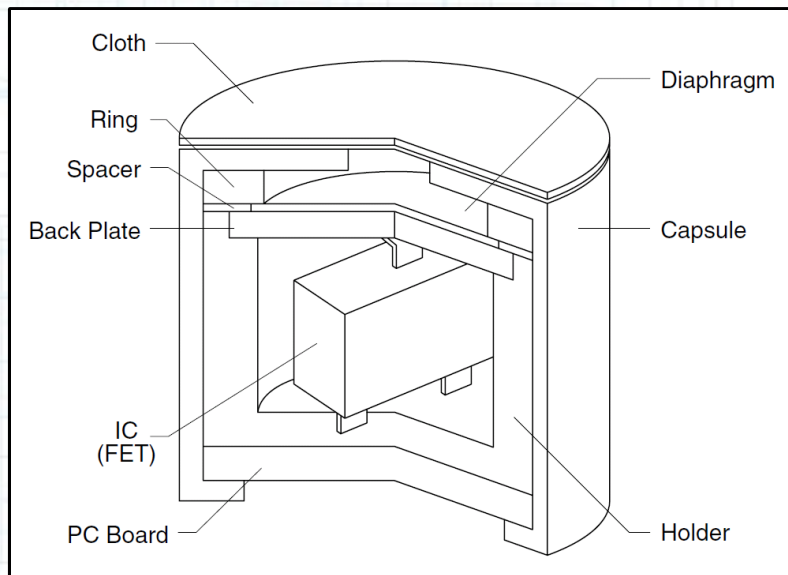
MEMS Microphone



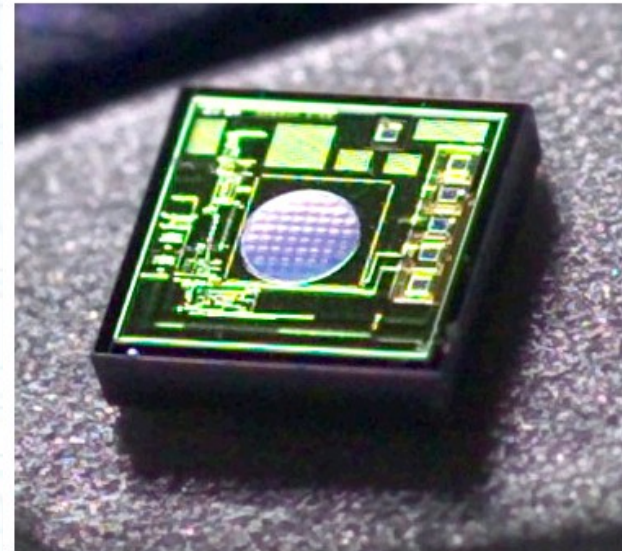
Mech 207
Oct 19, 2009
Justin Lee

General Information

- MEMS microphones are similar to the standard ECMs (electret condenser microphones) found in modern consumer electronics, except that the components are built onto a single chip using CMOS technology (material deposition & etching), rather than assembled from discrete parts.



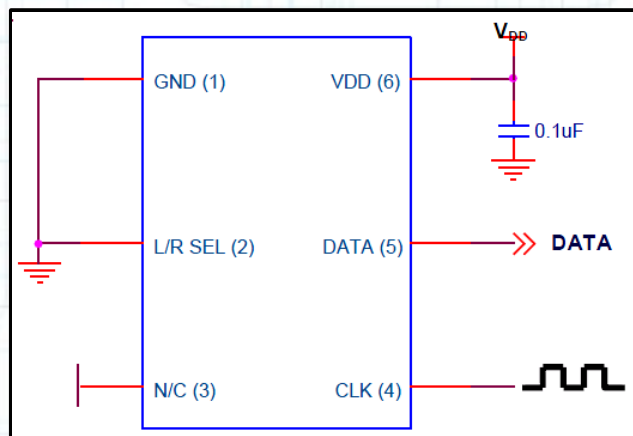
Electret Condenser Microphone



MEMS Microphone

General Information

- There are two main categories of MEMS microphones:
 - **Analog MEMS Microphones** convert a sound pressure input into an analog voltage output.
 - **Digital MEMS Microphones** convert a sound pressure input into a digital output signal, typically in pulse density modulation format (PDM).
- Typical Pin Diagram (Digital MEMS Microphone)



Pin	Name	Function
1	GND	Ground
2	L/R SELECT	Left/right select
3	N/C	Not connected (tie to ground)
4	CLK	Clock input to microphone
5	DATA	PDM data output
6	V _{DD}	Power supply and I/O voltage for microphone

Transducer Physics

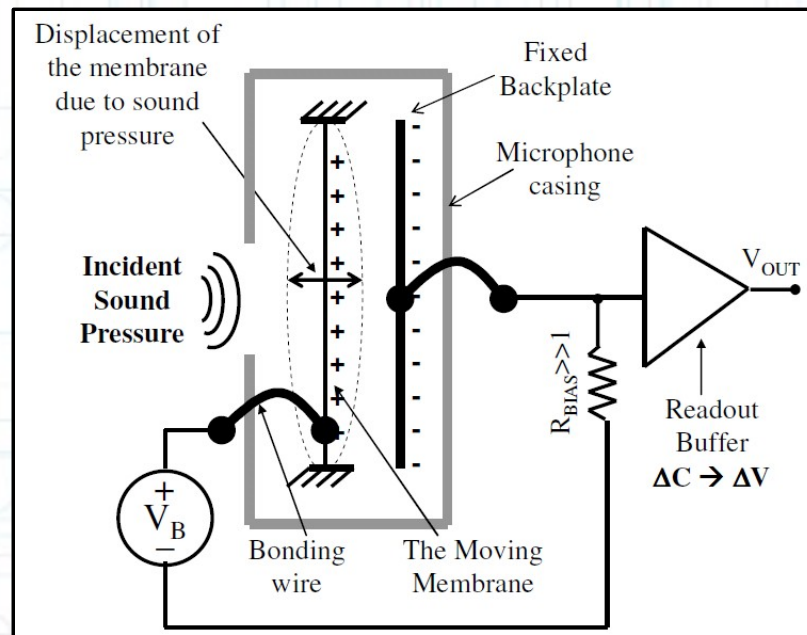
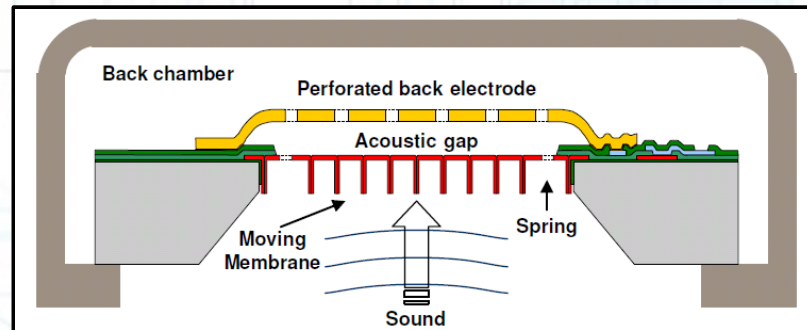
- The heart of the MEMS microphone is the variable capacitor formed by a fixed backplate and a flexible membrane.
- Sound pressure deflects the membrane, causing a change in capacitance. This change in capacitance causes a change in voltage according to:

$$C = Q / V$$

C = Capacitance [Farads]

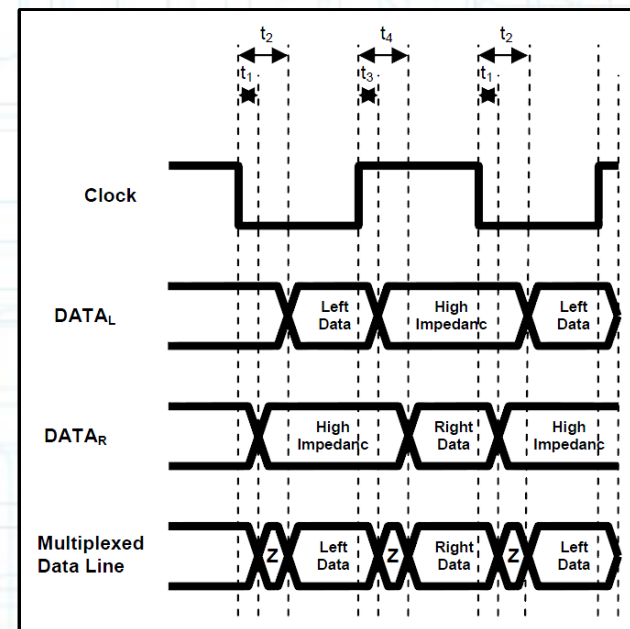
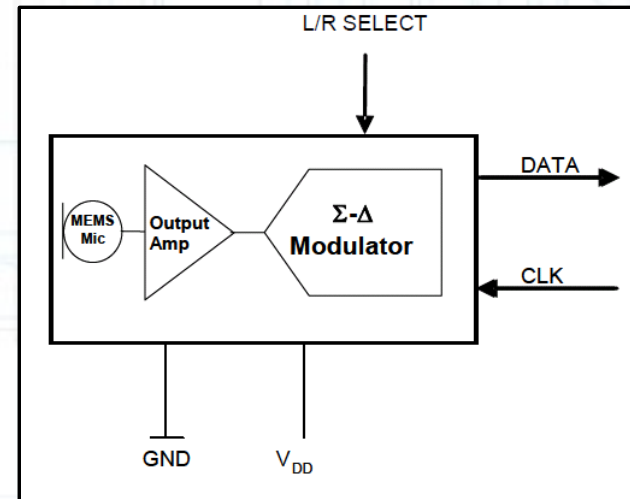
Q = Charge [Coulombs]

V = Voltage [Volts]



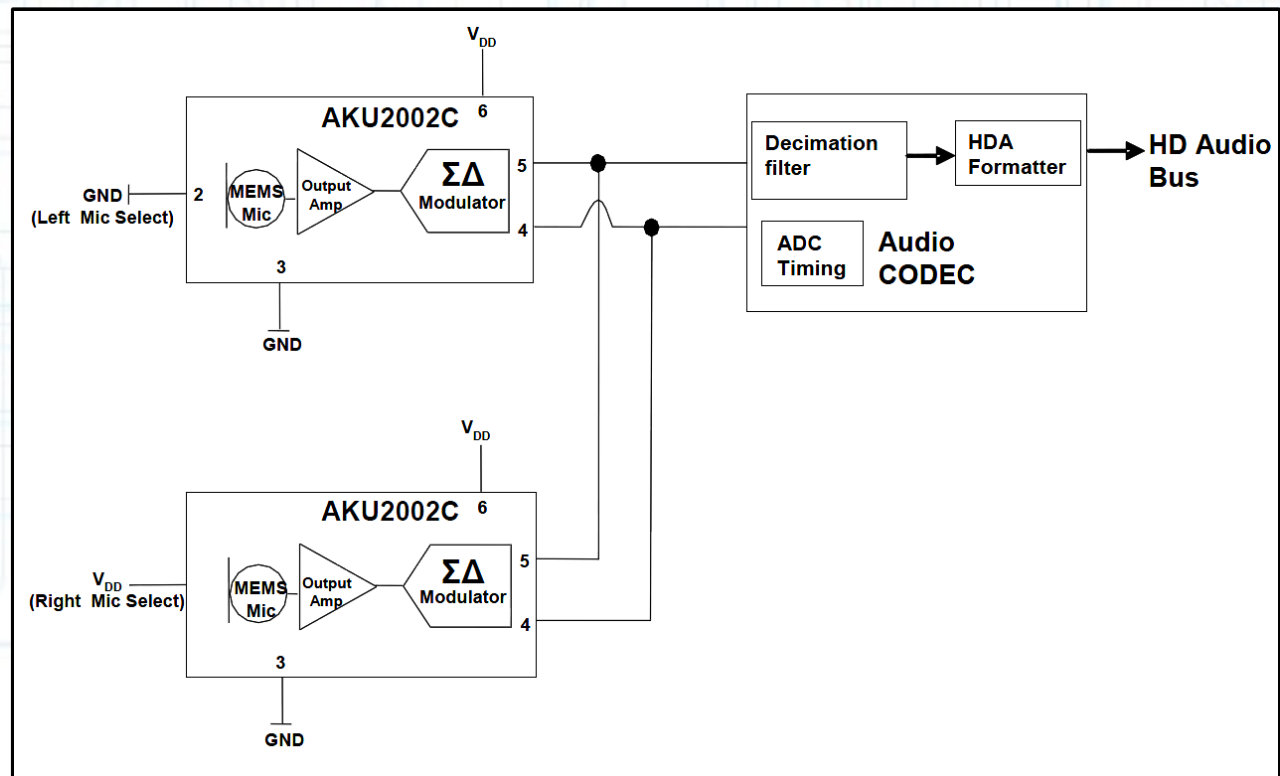
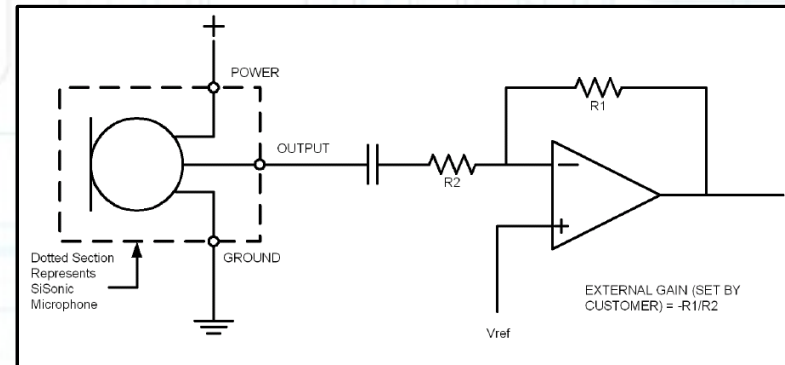
Signal Conditioning & Output

- MEMS Microphones integrate signal amplification & analog-to-digital conversion on the same chip. The digital output is typically in the pulse-density-modulation (PDM) format.
- Most versions of the digital MEMS microphone allow for two mics to multiplex on the same data line. (This is often use in noise-cancelling circuits)



Implementation

- Example circuit & block diagram for implementing an analog MEMS microphone (top) and a digital MEMS microphone (bottom)



Product Distinctions

- Advantages

- Greater reliability due to fewer parts
- Higher tolerance to mechanical vibrations
- Smaller component height & footprint
- Integrated signal conditioning & analog-to-digital conversion

- Challenges

- If using digital-output versions, many require the use of a separate codec to translate the PDM signal into a sound wave.
- Only available as a surface mount component = difficult to breadboard.

Supplemental Information

- Typical Package Size: 4x4x1mm
- Typical Electrical/Acoustic Specs:
 - Input Voltage: 1.5V-3.0V
 - Input Current: 200-300 μ A
 - Output Impedence: 150-250 Ω
 - Frequency Respose: 100Hz-15kHz
 - Signal-to-Noise Ratio: 60dBA
- Price Range: \$2-4/per part
- Major Vendors
 - Akustica
 - Knowles Acoustic
 - Analog Devices
 - Wolfson
 - Infineon
 - Freescale
 - NXP
 - STMicroelectronics