Audio Players

Turn off all electronic devices

Observations about Audio Players

They are part computer, part sound system.
They require electric power, typically batteries.
They reproduce sound nearly perfectly.
They are sensitive to static charge.

4 Questions about Audio Players

1. How does an audio player "store" sound?
2. How does it move sound information around?
3. How does the audio player's computer work?
4. How does the audio player's amplifier work?

Question 1

Q: How does an audio player "store" sound?
A: It represents that sound as digital information

It uses representations of sound information,

- sequences of air pressure measurements
- that contain everything needed to recreate the sound.

Recording and recreating are done in analog form
Storing and retrieving are done in digital form

Analog Representation

One physical quantity represents one number
Any continuous physical quantity can be used:

- the voltage on a wire,
- the current in a circuit,
- the strength of a permanent magnet.

This direct representation is sensitive to noise
Analog representations are "imperfect."

Digital Representation

A group of "symbols" represents a number
A symbol can be any discrete physical quantity:

- a positive or negative charge on a capacitor
- an integer value of voltage on a wire
- a north or south magnetic pole on a magnet

This indirect representation is insensitive to noise
Digital representations can be "perfect."

Question 2

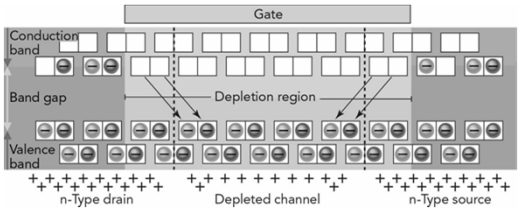
Q: How does it move sound information around?
A: It uses MOSFET electronic switches.

A MOSFET Transistor
- consists of two back-to-back pn-junctions
- with a nearby "gate" surface that can store charge.

Gate charge controls current flow in MOSFET

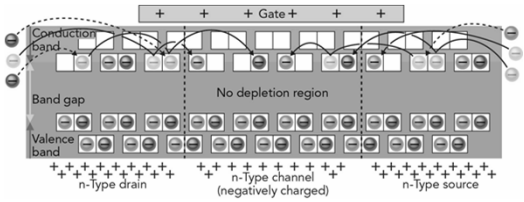
MOSFET Transistor Off

A typical MOSFET Transistor
- normally has a vast depletion region in its "channel"
- normally can't conduct electric current



MOSFET Transistor On

Charging that MOSFET's gate
- alters the filling of electron levels in the channel
- so the depletion region vanishes
- and the device can conduct electric current.



Question 3

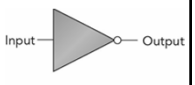
Q: How does the audio player's computer work?
A: It uses MOSFETs to form logic elements.

Computers perform logical operations with bits
- A bit is a base-two digit
- It can hold one of only two symbols: 0 or 1.
- Bit-wise representation of numbers is called *binary*

MOSFET logic elements manipulate bits

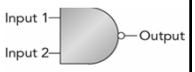
Logic Elements

Inversion (the NOT logic element)
- One input bit, one output bit
- Output bit is inverse of input bit



Input	Output
1	0
0	1

Not-And (the NAND logic element)
- Two input bits, one output bit
- Output bit is inverse "and" of input bits



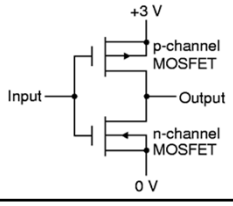
Input 1	Input 2	Output
1	1	0
1	0	1
0	1	1
0	0	1

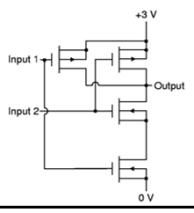
Any function and thus any computer can be built from these two logic elements

CMOS Logic Elements

Bits are represented by charge (1 is +, 0 is zero)
Uses complementary MOSFETs
- n- and p-channel MOSFETs are paired

CMOS Inverter has 2 MOSFETS
CMOS NAND has 4 MOSFETS



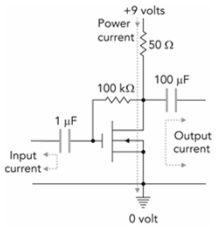


Question 4

Q: How does the audio player's amplifier work?
A: It uses MOSFETs as analog amplifiers.

MOSFET lets a tiny charge control a big current
Amplifier has three circuits:

- Input current represents sound
- Output current is amplified version
- Power current provides power



Summary about Audio Players

Represent sound in digital and analog forms
Use MOSFETs to work with sound information
Digital computer comprised of CMOS logic
Analog amplifier based on MOSFETs.