



Electrical Representations of Sound

Why Electricity?

- Acoustical amplifiers/distribution possible but unwieldy

Electrical representation of sound is easy to:

- Record
- Manipulate (edit)
- Transmit
- Amplify

What is Electricity?

- The flow of electrons through a conductor

Electrical Charge

- The extent to which an atom has more or fewer electrons than protons



Water Analogy

- Water Reservoir analogous to electric source (battery)
- Potential energy analogous to water pressure.

Direct Current

- DC
- Typically from batteries
- Electrons flow in one direction through conductor only

Alternating Current

- AC
- Typically Mechanically Generated
- Electrons flow back and forth through conductors
- 60 Cycles Per Second in North America

Unit of Pressure

- Unit of pressure, or Electro Motive Force, is the Volt.
- Volt is defined as 1 joule of energy per coulomb of charge.
- Charge is the amount of energy in on e electron
- Colounb is a number = 6.24×10^{18} , or 6.24 quintillian
- Joule is 1 newton per meter

Current

- Analogous to water *flow*
- Unit of flow, or current, is the Ampere.
- Ampere is 1 coulomb per second (6.25 billion billion electrons)

Resistance

- Analogous to constriction in a pipe.
- Unit of resistance is the Ohm
- Ohm is defined as resistance of an object with an applied voltage of 1 volt and a current of 1 ampere.

Polarity

- Concentration of electrons on one pole or the other.
- We assume a zero point and make judgments from there.

Ohm's Law

$$E = IR$$

$$R = \frac{E}{I}$$

$$I = \frac{E}{R}$$

- E = Electromotive Force, or Voltage
- I = Current in Amperes
- R = Resistance in Ohms
- Remember EIR, or “ear”

Watt's Law, Power

- Power is combination of current (flow), and voltage (pressure)
- From Bracewell: “The capability to supply sufficient force to move a given quantity of electrons in a fixed period of time against the resistance of the load.”

Watt

- Unit of power
- Defined as 1 joule per second.
- $P=IE$
- $W=VA$
- “West Virginia” Important!
- A small amount of power is required if resistance being driven is small
- A higher power is required if resistance being driven is large.

Electricity in Sound

- Voltage used to represent audio intensity
- Power (voltage and current) used to move speaker cones

Analog/Digital

- Analog signal is direct recording of voltage, while
- Digital is a numerical representation of that voltage

Analog

- Advantages:

- ◆ Infinite variability

- Disadvantages

- ◆ Analog electronics can drift
- ◆ Noise introduced on analog line is reproduced as unwanted sound
- ◆ Successive generations degrade
- ◆ Difficult to edit/manipulate (tape and razor blades)

Digital

■ Advantages

- ◆ Digital electronics do not drift
- ◆ Noise introduced on digital line is ignored
- ◆ Successive generations are perfect copies
- ◆ Easy to edit/manipulate (computers and hard drives)

■ Disadvantages

- ◆ Not infinitely variable (amount of storage space/processing power limits resolution)

How does digital work?

- Analog, continuously varying signal is “Sampled”

Digital Characteristics

- Resolution of Loudness/
Amplitude=Number of bits
- More bits equals higher resolution
amplitude (subtle but significant effect)
- Resolution of Frequency= Number of
samples (not subtle effect)

Nyquist Frequency

- Number of samples determines how high a frequency can be sampled
- Nyquist figured out that the highest frequency to be sampled is $\frac{1}{2}$ the sampling rate

Common Digital Characteristics

- CD = 44.1kHz, 16Bits
- DAT = Up to 48kHz, 16Bits

Digital Interfacing Problems

- What happens if I play back a 48kHz recording at 44.1kHz?
- Pitch shifts down, recording goes slower

Assignment

- Read Chapter 15, Hearing