



# How Cable Works

Become a One-Hour Expert

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# Three Kinds of Cable

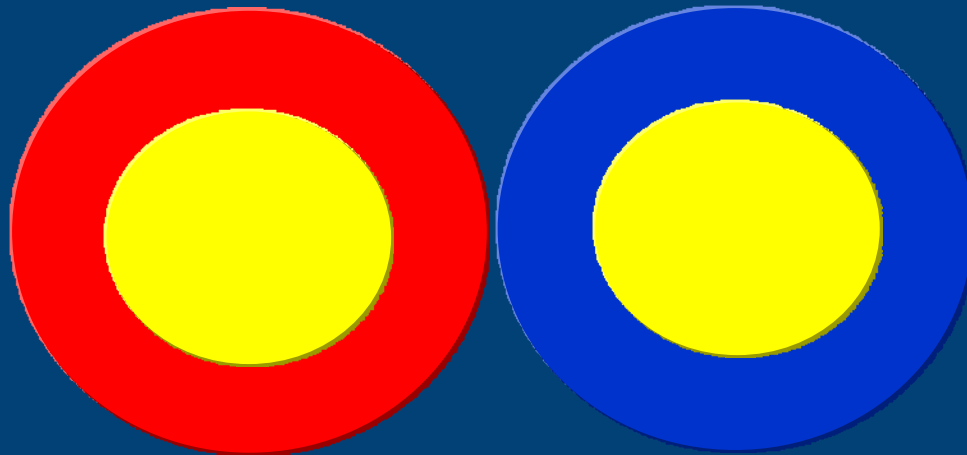
- What is a wire?
- What is a cable?
- Multi-conductor
- Twisted Pair
- Coaxial

# Multi-Conductor



Two or more insulated conductors.

# Twisted Pair



Two wires twisted together.

# Twisted Pair



An early telephone with two twisted pairs.

# Twisted Pair



Twisted pairs arrive!

# Twisted Pair



Twisted pairs become a problem.

# Twisted Pair



Pity the poor “lineman”.

# Twisted Pair



Where the wires went.

# Twisted Pair



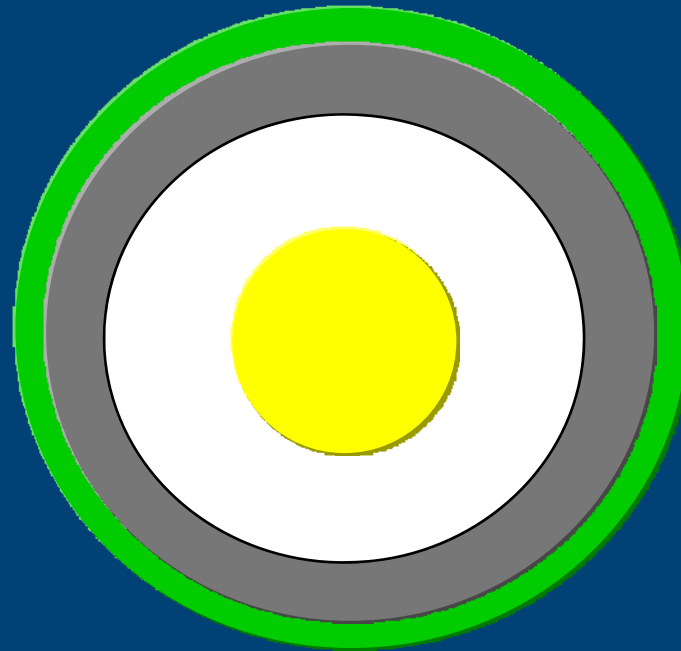
One solution.

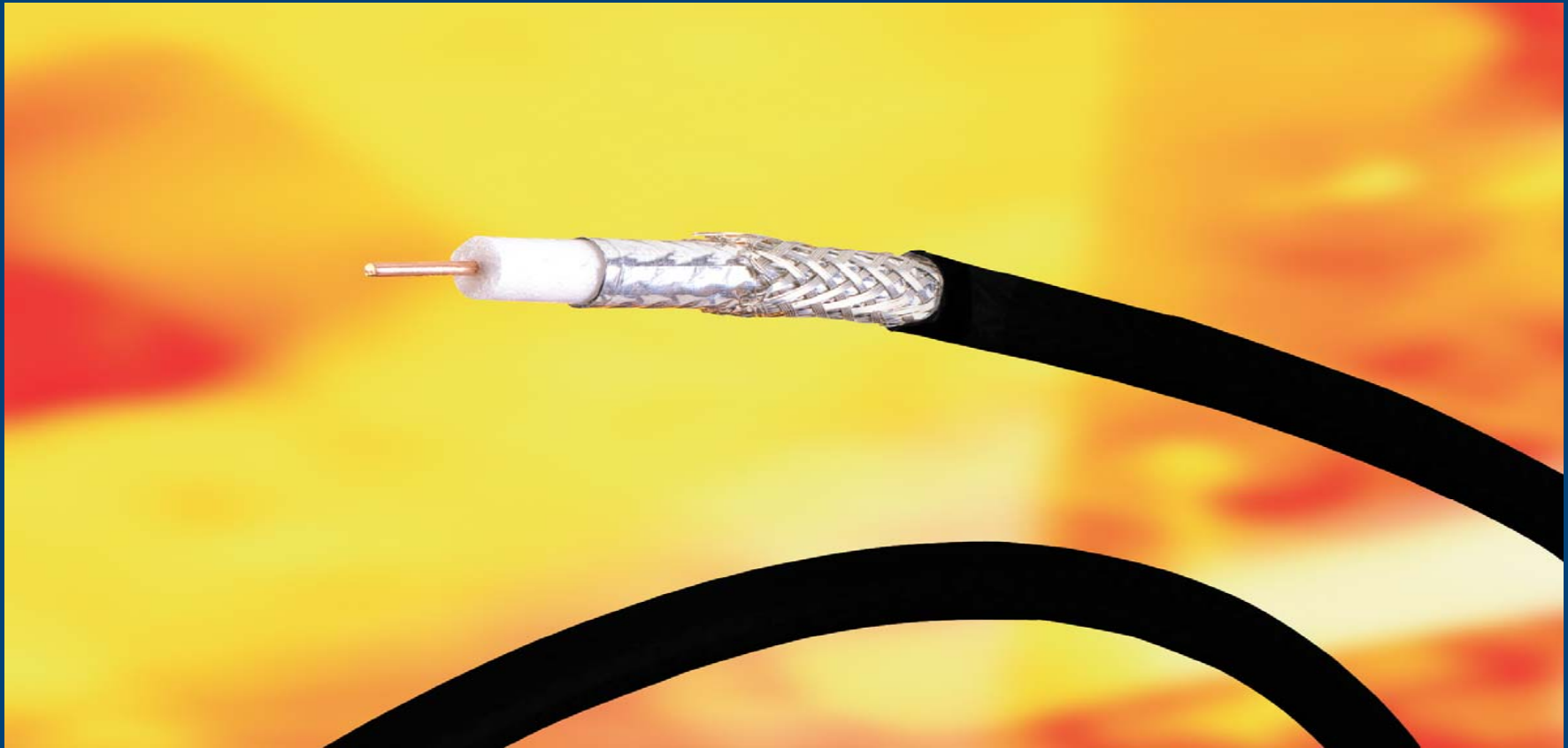
# Coaxial



Lloyd Espenscheid and Herman Affel

# Coaxial





Belden 1694A

# Electrical Parameters

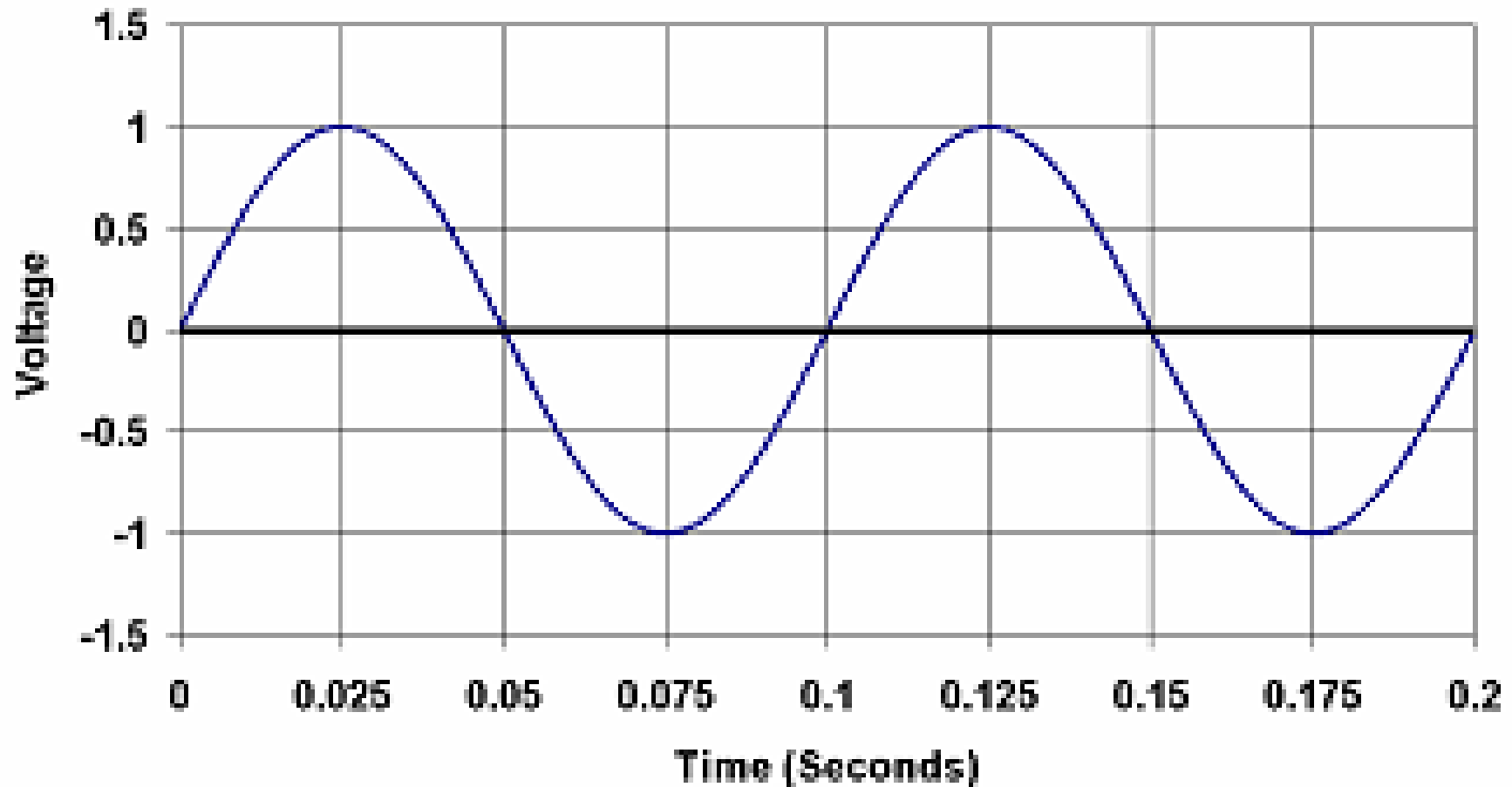
- Balanced Line
- Frequency
- Analog
- Digital
- Resistance
- Skin Effect
- Capacitance
- Inductance
- Impedance
- Wavelength
- Return Loss

# What is a Balanced Line?

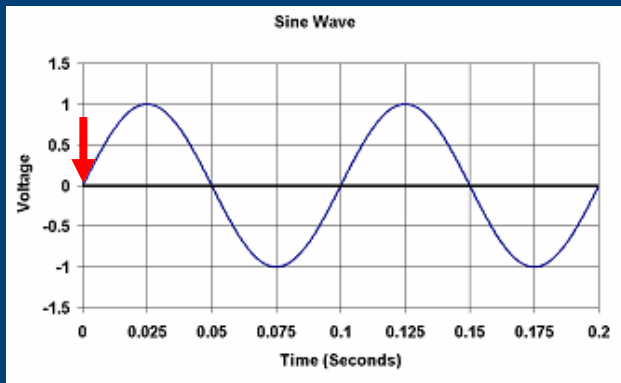
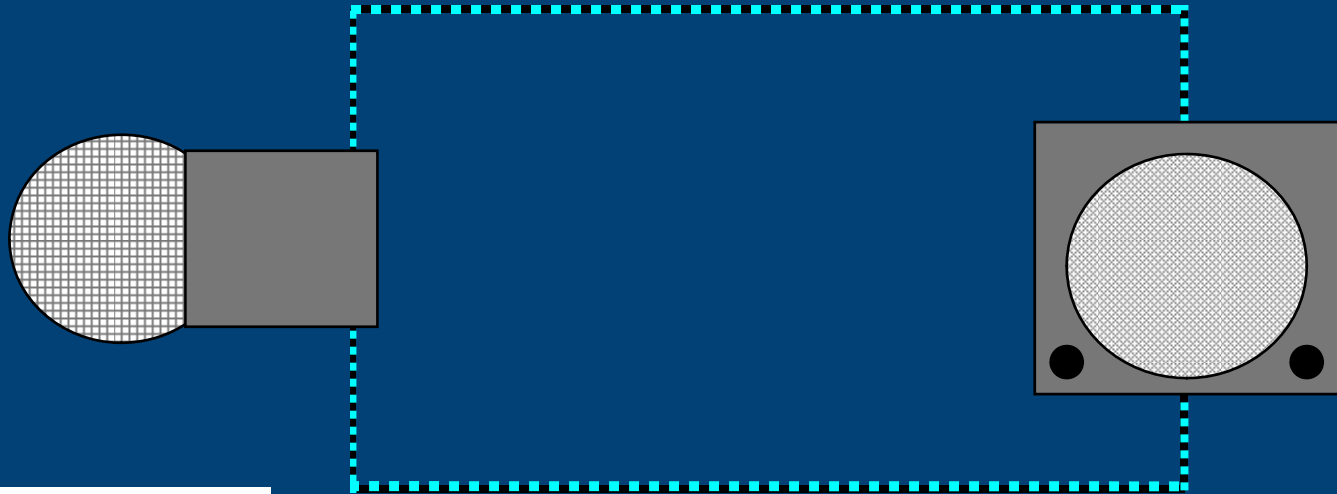


# Frequency

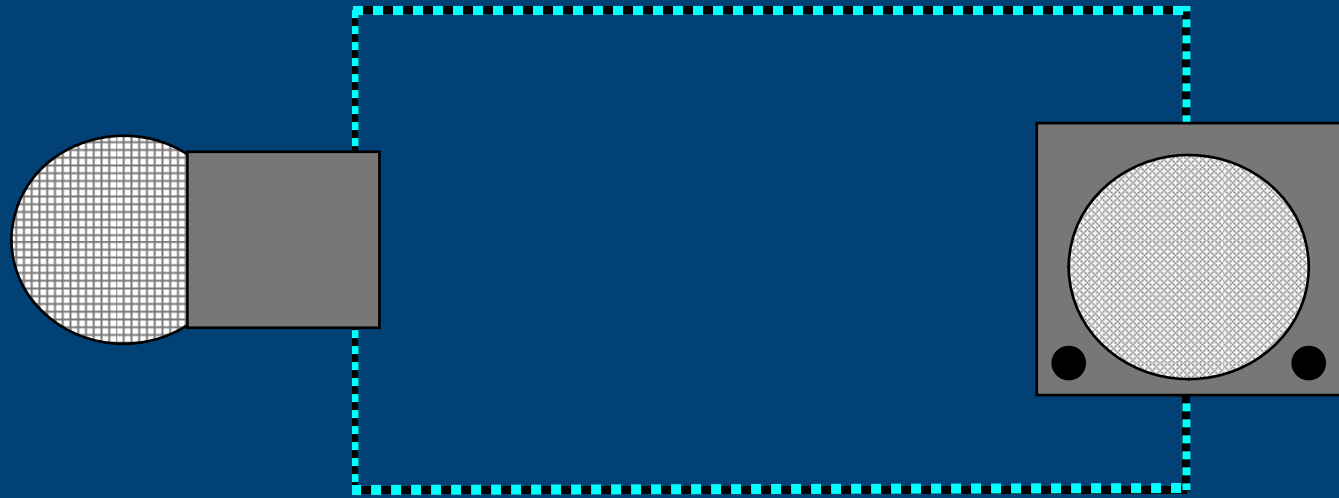
Sine Wave



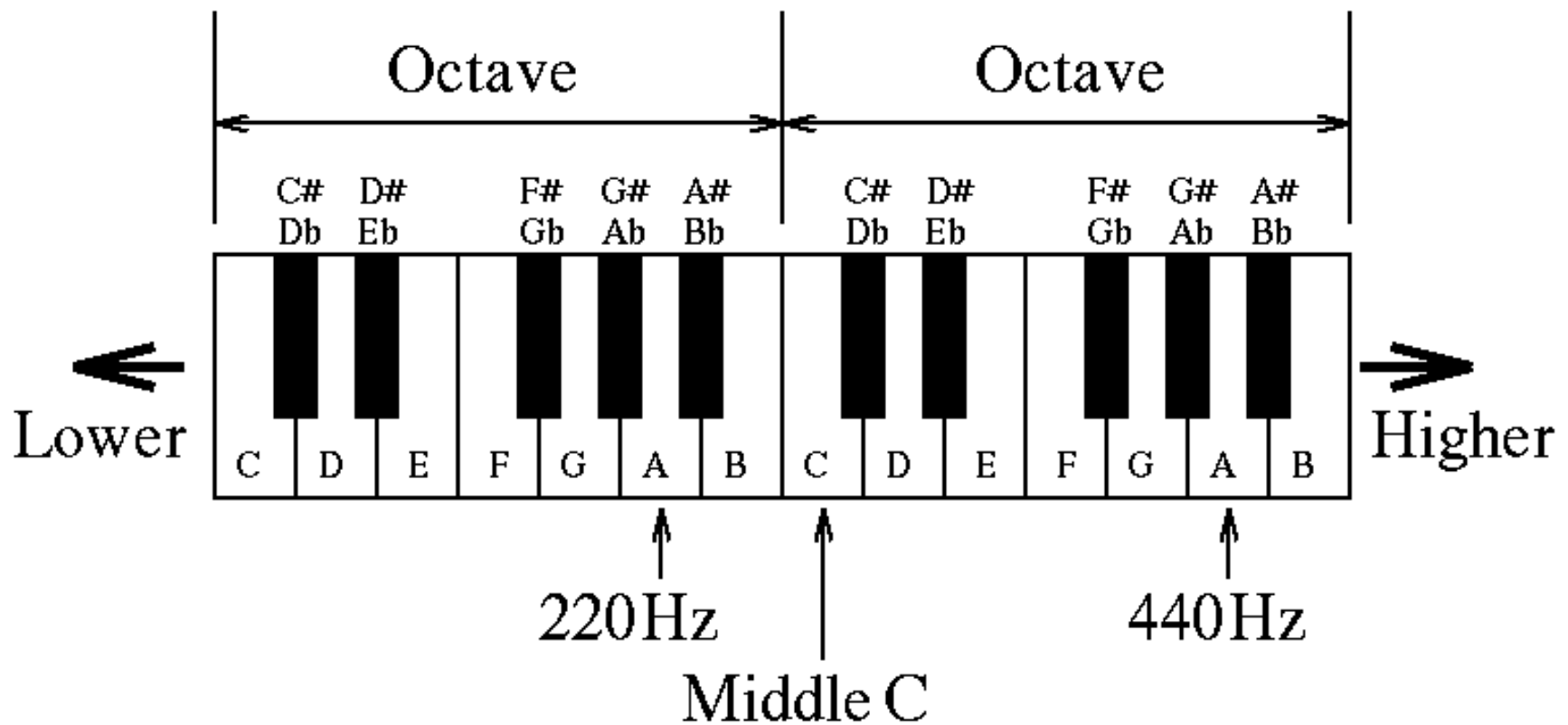
# What is a Balanced Line?



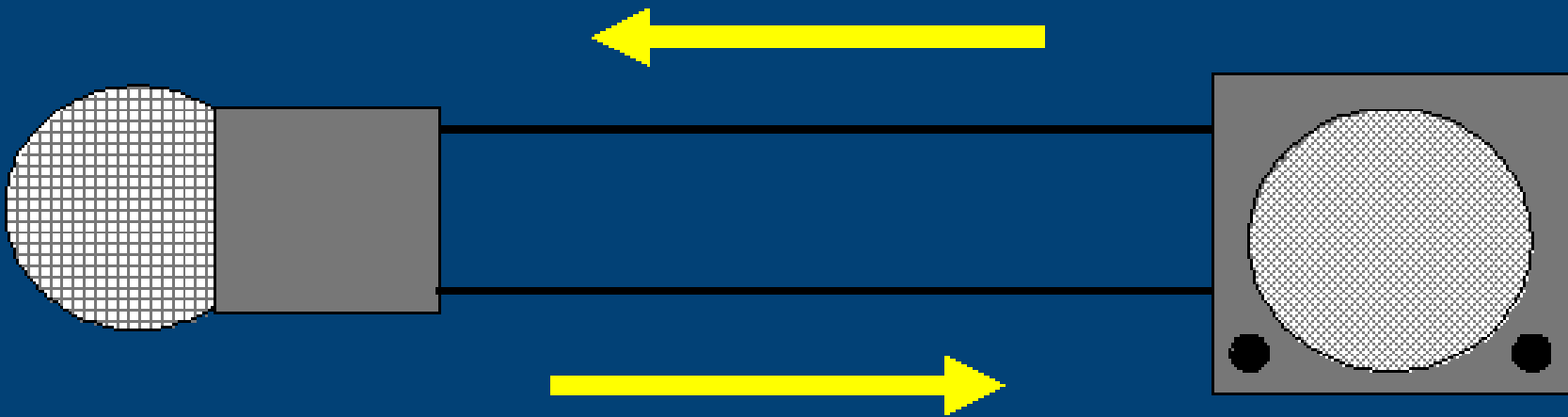
# What is a Balanced Line?



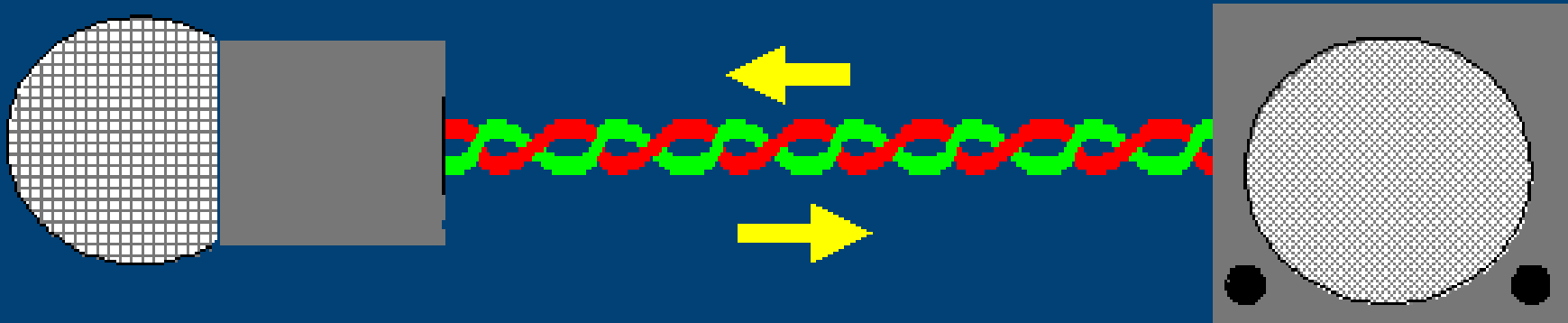
# Piano



# What is a Balanced Line?



# What is a Balanced Line?



- Number of cycles per second
  - Hertz
- Analog Audio
  - 20 Hz - 20 kHz (20,000 Hz)
- Analog Video
  - NTSC 4.2 MHz (4,200,000 Hz)
  - PAL 5 MHz (5,000,000 Hz)
- Serial Digital Interface (SDI) video
  - 135 MHz “clock” (135,000,000 Hz)
- High Definition SDI (HD-SDI) video
  - 750 MHz clock (750,000,000 Hz)
- Super HD (1080p/50 or 1080p/60)
  - 1.5 GHz clock (1,500,000,000 Hz)

# Analog

- A copy of something.
- A copy of the vibration of the piano string.
- An electrical copy of the vibration

- Analog translated into a different language
  - Mathematical language
  - Two letters in the alphabet
    - Zero, one

# Resistance

- Turns electrical flow into heat.
  - Can feel it on a power cord.
  - Can't feel it on an audio cable.
  - Can't feel it on a video cable.
- Lower resistance is better
  - Larger conductors have lower resistance
  - Larger conductors are more expensive

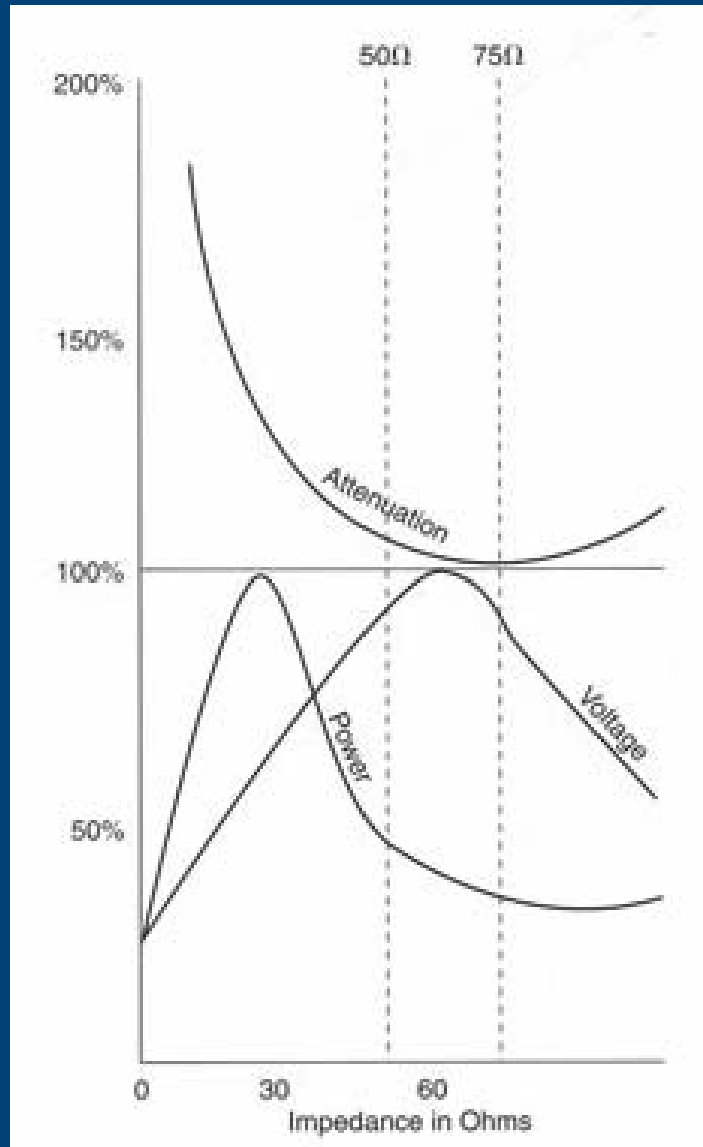
# Skin Effect

- As the signals get higher in frequency...
- Moves to the “skin” of the conductor.
  - Starts at 100 kHz
  - Important at 50 MHz
    - Copper-clad steel broadband/CATV cable

- Stores electricity in the cable.
  - Electric charge
  - Measured in picofarads
  - Listed in the catalog
- The lower the capacitance, the better

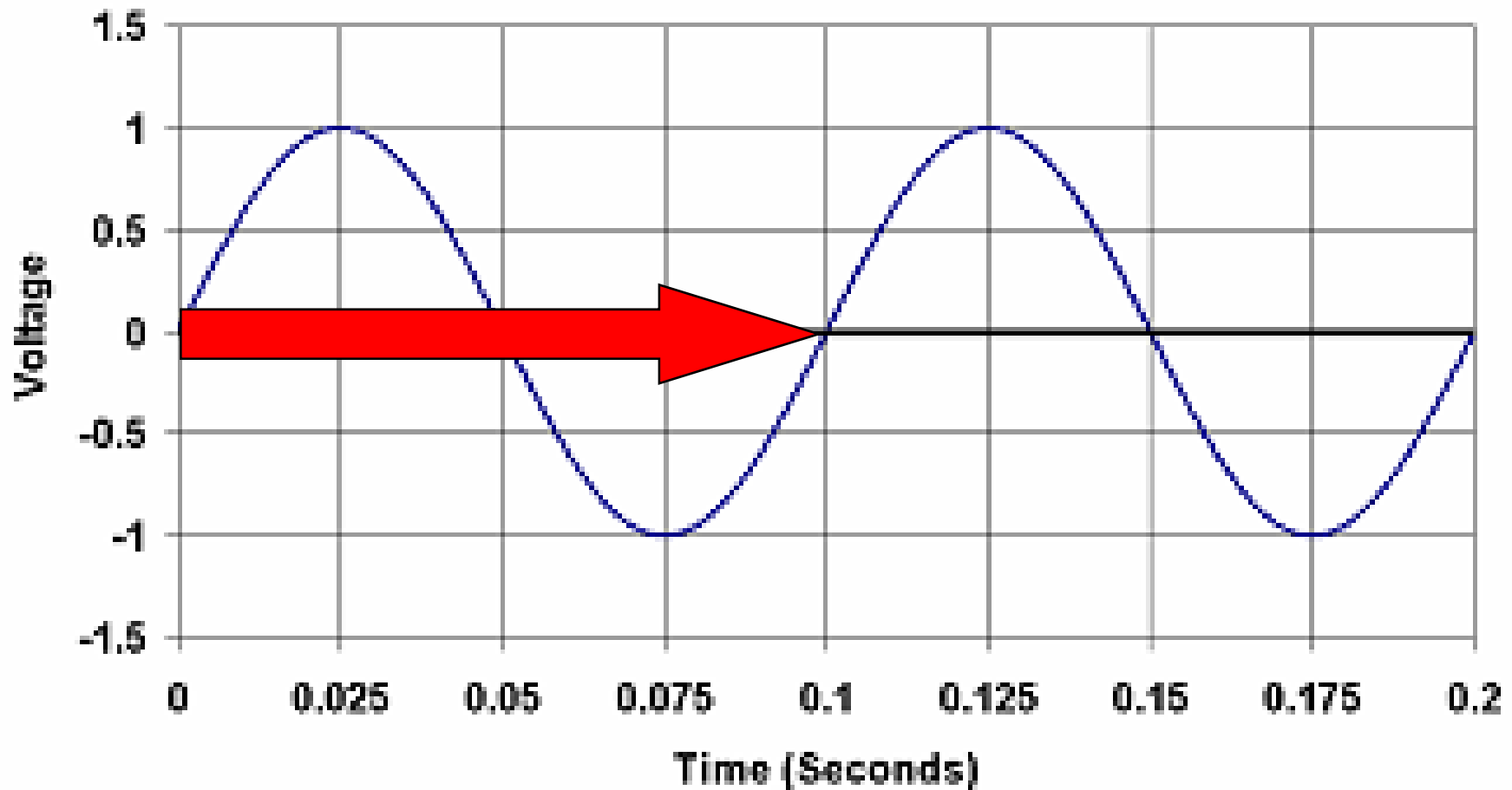
- Stores electric flow in a magnetic field
  - Very tiny effect
  - So tiny, not listed in catalog
- Capacitance and Inductance
  - Opposite effects.
  - Capacitance wins every time.
  - We ignore inductance.

# Impedance



# Wavelength

Sine Wave



- Impedance variations
  - Step on the cable
  - Bad manufacturing
- Part of the signal turns around
  - Big accident on the freeway
  - Cables that resist ‘deformation’
    - The foam inside the cable

A vertical decorative image on the left side of the slide shows a close-up of a fiber optic cable with multiple colored strands (blue, green, yellow) and a grid pattern overlaid on it.

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